



GREEN ENERGY AND ECONOMIC FABULISM

THE MIRAGE OF SUBSIDY-PROPELLED ECONOMIC GROWTH AND EMPLOYMENT

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Summary

The Inflation Reduction Act (IRA) has expanded the availability of subsidies for green energy, with direct spending estimated to be over \$1 trillion the next ten years. In addition to claims that these subsidies will address climate change, a primary justification for this increased spending is the claim that it will increase economic growth and provide millions of new jobs in green industries. The economic reality is far different.

Given rising U.S. deficits, much, if not all, of the tax credits for green energy, especially wind and solar facilities, will be financed with additional debt.

The staggering amounts of money available, more than even was spent by the government during the Great Depression, will have long-lasting and adverse consequences on energy supplies, economic growth, and the well-being of the citizenry. The subsidies will further distort energy markets and raise energy prices. The subsidies will crowd out more productive private investment and reduce the resources available for more efficient energy resources, such as nuclear power. As in Europe, the subsidies will result in higher energy prices that will cause economic and job losses throughout the entire economy. These losses will far exceed the gains provided by the subsidies themselves.

Although policy makers may choose to ignore basic economic principles in favor of political expediency and, in some cases, personal gain, those principles will not ignore them. Eventually, the profligate spending on costly, but low-value green energy will collapse under its own economic weight. The unanswered question is how high an economic and social price the U.S. will pay for this folly before that occurs.

1. Introduction

Since the first OPEC oil embargo a half-century ago, the United States — at both the federal and state levels — has enacted a variety of policies designed to develop new energy technologies and “solve” various energy-related “crises.” The initial energy “crisis” was seen as U.S. dependence on foreign crude oil (even though basic economics demonstrates that the OPEC embargo was self-defeating, which is why it collapsed just months after it began), together with forecasts of domestic resource exhaustion. Thus, it was not surprising that U.S. energy policy policies first focused on development of non-existent technologies, called “moonshot” programs, such as the manufacture of “synthetic” crude oil and electricity generation via controlled nuclear fusion, as if entirely new technologies could be created by legislative fiat, before turning to policies that subsidized alternative energy resources.

Today, dependence on foreign crude oil is no longer a stated policy concern. In fact, energy policies enacted under the Biden Administration have restricted domestic crude oil (and natural gas) production and are reducing access to uranium supplies for nuclear power. Rather, the stated focus on federal and state energy policies is now greenhouse gas emissions (GHGs) and climate change,¹ together with environmental “justice.”

Although policies to subsidize renewable energy resources, especially wind and solar power, as well as “low carbon” resources, such as biofuels, are not new, they have been enhanced under the Biden Administration, primarily through the ill-named Inflation Reduction Act of 2022, as well as federal administrative agency rules and individual state government actions.

This report focuses on subsidies for green energy resources. Although the largest of these is the federal investment tax credit (ITC), which is available to numerous technologies, the U.S. government also provides a production tax credit (PTC) for wind energy developers and for “green” hydrogen production.² In addition, there are tax credits for the purchase of electric vehicles and chargers, development of carbon-capture facilities, and subsidized loans for manufacturers of electric vehicles and their batteries, to name but three. The list is seemingly endless.

Nor are subsidies limited to monetary payments. There are also increasingly stringent federal mandates to reduce GHG emissions, such as recent Corporate Average Fuel Economy (CAFE) standards enacted by the U.S. Department of Transportation (DOT), mandates for production of corn ethanol and “advanced” biofuels, and mandates proposed by the U.S. Environmental Protection Agency (EPA) to reduce carbon emissions from fossil fuel electric generating plants.

Numerous individual states have also enacted a variety of subsidies and mandates. The most common monetary subsidies are additional tax credits for the purchase of electric vehicles and the related charging infrastructure. For states developing offshore wind projects, monetary subsidies take the form

¹ There are also policies under consideration to address GHG emissions from agricultural sources. A discussion of those policies, which focus on herd reductions and removal of agricultural lands from production, is beyond the scope of this report.

² Traditionally, hydrogen is manufactured through reformation of natural gas. Advocates envision that “green” hydrogen will be manufactured by electrolysis of water using electricity generated from zero-emission resources. At this time, no commercial-scale green hydrogen facilities exist, although several are under development.

of long-term power purchase agreements at above-market prices, tax credits, and subsidized construction staging facilities, along with tax forgiveness for new manufacturing facilities. Numerous states also provide loan guarantees and property tax reductions. New York state has enacted a law to prevent rural communities from objecting to siting large-scale wind and solar projects.

As for mandates, since the year 2000, 28 states, plus the District of Columbia, have enacted renewable portfolio standards (RPS) that mandate that increasing percentages of electricity be derived from renewable energy resources. Some standards lump all renewables together, while others have separate mandates for wind and solar energy. More recently, numerous states have adopted various “zero-emissions” mandates adopted by California, which require that all electricity supplied to consumers be carbon-free by as early as 2035, mandates to ban the sale of internal combustion vehicles, and mandates to replace fossil-fuel space and water heating with electric heat pumps. Several states have also enacted carbon cap-and-trade programs (which they euphemistically call “cap-and-invest” programs) to reduce carbon emissions and subsidize a variety of politically favored projects, such as investments in low-income and “environmental justice” communities.³

The myriad green subsidies on offer raise several important economic questions. First, do their benefits exceed their costs? Answering that question requires examining all of the projected impacts of the subsidies and comparing them to the projected benefits, notably the economic value of the GHG emissions reductions they are supposed to engender, but also the additional benefits of reductions in air pollution and, arguably, accelerated development of new technology. Alas, such an analysis is far beyond the scope of this report, as it would require a comprehensive evaluation of estimates of the social cost of carbon, as well as an evaluation of epidemiological studies of pollution exposure, and estimates of the statistical value of life used by economists.

Instead, this report focuses on an oft-stated reason to subsidize green energy: economic development and job creation. However, subsidy proponents ignore a basic economic axiom: it is impossible to subsidize an economy to greater economic growth and prosperity. The reason is that governments which choose economic winners and losers, in this case green energy technologies, invariably choose poorly because the choices made both lack the discipline of markets and frequently reflect political favoritism. There is also a broader economic cost associated with misdirecting public investments from those providing higher returns to green energy investments that have low or negative returns. The result is a reduction in economic well-being.

Finally, despite promises and assertions to the contrary, green energy subsidies raise the costs of electricity and fuels. Not only do these higher costs reduce economic output and jobs, far more so than the subsidies create, there is an additional moral component. Specifically, green energy subsidies impose disproportionate economic harm on lower-income residents and small businesses; in effect, green energy policies are forcing the least well-off in society to subsidize the most well-off, increasing economic inequality.

³ There is no single definition of “environmental justice,” although it might best be characterized as a form of distributive justice developed by the philosopher John Rawls in his *Theory of Justice*.

2. The Persistence, Scope, and Expansion of Green Energy Subsidies

Green energy subsidies and mandates are not new. They began in earnest as part of the 1978 Energy Legislation, to promote the use of domestic energy resources, notably coal, as well as develop renewable and “alternative” energy resources, including energy conservation.⁴ The legislation offered subsidies for generating electricity with renewable resources, notably wind and solar, but also small hydroelectric facilities, geothermal plants, and biomass facilities. It also included subsidies for corn-based ethanol to be blended with gasoline.⁵

Although the initial rationale for the various renewable energy subsidies was to promote U.S. energy independence, by the early 1990s improving environmental quality had entered into the rationale. Initially, the focus of environmental policies was emissions associated with fossil-fuel generating plants operated by regulated electric utilities, but it also included GHGs. To promote renewable energy, the Energy Policy Act of 1992 introduced the Production Tax Credit (PTC) for wind and biomass generating plants. Although designed to be a temporary incentive, the PTC has been repeatedly extended. The Energy Policy Act of 1992 also made permanent the investment tax credit (ITC) for solar and geothermal generating plants.⁶

In the late 1990s, state efforts to mandate renewable generation, both to reduce emissions and promote economic development, began in conjunction with efforts to deregulate the electric utility industry. The mandates took the form of Renewable Portfolio Standards (RPS) that requires increasing percentages of electricity supplied to retail customers to be sourced from qualifying renewable resources.⁷ By 2010, more than half of all U.S. states had adopted some form of RPS.⁸

⁴ The 1978 Energy Legislation included five separate Acts, including PURPA, the Powerplant and Industrial Fuel Use Act, the Energy Tax Act, the National Energy Conservation and Policy Act, and the Natural Gas Policy Act. The latter established new price controls of wellhead natural gas prices, further exacerbating forecasts of supply shortages. The Fuel Use Act mandated electric utilities and industry maximize their use of coal, which today is viewed as the *bête noire* of climate change. Among other things, the Energy Conservation Act established the Strategic Petroleum Reserve and Corporate Average Fuel Economy (CAFE) standards for automobiles. The Energy Tax Act provided an income tax credit for homeowners to install wind, solar, and geothermal energy, as well as subsidies for corn-based ethanol. It also created a sliding scale “Gas Guzzler” tax on passenger cars.

⁵ For a history of ethanol and other biofuels, see Wallace Tyner, “[The US Ethanol and Biofuels Boom: Its Origins, Current Status, and Future Prospects](#),” *BioScience* 58 (July 2008), pp. 646-653.

⁶ The Energy Policy Act of 2005 increased the ITC for solar generation from 10% to 30%. For a short history of the ITC, see Molly Sherlock, “[The Energy Credit of Energy Investment Tax Credit \(ITC\)](#),” Congressional Research Service, April 23, 2021.

⁷ States vary in what qualifies as “renewable” electricity. Pennsylvania, for example, considered electricity generated by burning tires to be renewable. The effectiveness of RPS mandates is debated. See, e.g., Magali Delmas and Maria Montes-Sancho, “[U.S. state policies for renewable energy: Context and effectiveness](#),” *Energy Policy* 39 (May 2011), pp. 2273-2288.

⁸ Although various bills have been introduced in Congress to impose a federal RPS, none has been enacted. See Ashley Lawson, “[Electricity Portfolio Standards: Background, Design Elements, and Policy Considerations](#),” Congressional Research Service, Report R45913, October 21, 2020.

The U.S. government introduced the first tax credits for electric vehicles as part of the Energy Policy Act of 2005, although initially the tax credits were limited to hybrid vehicles (i.e., those containing both an internal combustion engine and a battery pack.) Those subsidies were increased in 2009, with passage of the American Recovery and Reinvestment Act. Under the IRA, the maximum federal tax credit for an electric vehicle is \$7,500. Many individual states also offer tax credits and grants, including for home chargers.

As the focus on climate change increased, a number of states began imposing specific mandates to reduce GHG emissions, either through legislation or via Executive Orders. These mandates have been all-encompassing, requiring the acquisition of specified quantities of wind and solar generation, mandating electrification of fossil-fuel end uses, such as space and water heating. Many states have also banned the sale of light-duty internal combustion vehicles by 2035 and the sale of diesel trucks by 2045. Many states also offer subsidies —on top of the federal tax credit — for the purchase of electric vehicles (EVs) and related charging infrastructure.

The Inflation Reduction Act (IRA) of 2022 expanded the magnitude and scope of green energy subsidies. Under the IRA, the base ITC is set at 30% of the capital cost of wind, solar, and battery storage projects.⁹ An additional 10% tax credit is available for projects that use content produced by U.S. manufacturing facilities. Still another 10% is available for projects built in “energy communities,” that is, brownfield sites, such as an existing coal-fired plant or mine, or areas where there is oil- and gas-related activity. There is also a 10% tax credit available for projects built in “environmental justice” communities or on tribal lands.

Green energy projects are also eligible for accelerated depreciation, which allows them to reduce their income tax burden. Wind, solar, close-loop biomass,¹⁰ and geothermal energy are also eligible for a production tax credit, currently equal to 27.50 per megawatt-hour (MWh) and indexed to the rate of inflation.¹¹ As with the ITC, the PTC can be increased by an additional \$6/MWh for projects with both domestic content and that are sited at brownfield locations. However, developers cannot claim both ITC and PTC credits; they must select only one.

Unlike most other green energy resources, offshore wind projects subsidies also include above-market long-term Power Purchase Agreements (PPAs), which states either have forced their local electric utilities to sign or, as in the case contracts signed by the New York Energy Research and Development Authority (NYSERDA), signed by the states themselves. In either case, the above-market costs are paid by electric ratepayers. There are indirect subsidies stemming from socialization of the costs associated with providing additional transmission facilities to interconnect wind and solar facilities, and the costs of supporting, dispatchable, generation needed to compensate for wind and solar energy’s uncontrollable

⁹ For projects placed in service after 2025, the base ITC will be 6%, with an additional 24% available for projects that meet wage and apprenticeship requirements.

¹⁰ Closed-loop biomass refers to facilities that burn biomass specifically grown and harvested to be burned. Open-loop biomass refers to facilities that burn agricultural waste products. The PTC for open-loop biomass is currently \$14 per MWh.

¹¹ The adjustment is based on the gross domestic product implicit price deflator (GDPDIPD), which is the broadest measure of inflation.

variability. As the percentage of that generation increases, it requires additional resources to provide back-up, either generators that remain on standby or battery storage facilities.

In total, the U.S. and individual state governments provide thousands of subsidies (including policy mandates) for renewable energy among the different states.¹² For example, New York State has 97 separate programs, Texas has 114 programs, and California has 155 programs. These run the gamut from direct payments for electric vehicle chargers and behind-the-meter solar photovoltaic systems, to sales tax exemptions and even enhanced access to high occupancy vehicle lanes on highways.

Not surprisingly, the highest-dollar subsidies are those offered by the federal government, many of which were enhanced under the IRA.¹³ These are summarized in Table 1. For offshore wind, state-level subsidies also include development of port facilities, such as the \$500 million port in southern New Jersey and the \$700 million wind port in New York for construction staging, and subsidies for needed transmission interconnection infrastructure (i.e., undersea cables and substations to deliver the electricity to the transmission grid) that likely will total several billion dollars, depending on how much offshore wind capacity is actually constructed.

¹² A comprehensive [Database of State Incentives for Renewables and Energy Efficiency \(DSIRE\)](#) is published by the North Carolina Clean Energy Technology Center. The database includes both federal and state-specific programs, including tax credits, other financial incentives, and policies.

¹³ A more detailed summary can be found at: U.S. Environmental Protection Agency, "[Summary of Inflation Reduction Act provisions related to renewable energy](#)," June 1, 2023.

Subsidy	Resource	Description
ITC	Wind (onshore and offshore), solar, municipal solid waste, biomass, landfill gas, battery storage facilities.	Base credit 30% of overnight capital cost (i.e., excluding all financing costs). Additional 10% for projects meeting domestic manufacturing requirements. Additional 10% for projects built in “energy communities” (i.e., brownfield sites). Additional 10% for projects located in “environmental justice” communities. Maximum ITC credit 60%. For projects placed in service after January 1, 2025, the base ITC is 6%, with an additional 24% for projects meeting requirements for apprentices.
PTC: Electricity	Same as ITC, except battery storage.	PTC payments during first 10 years of operation. 2023 value: \$27.50/MWh. Additional \$3/MWh for projects meeting domestic manufacturing requirements. Additional \$3/MWh for projects built in “energy communities.” Maximum PTC: \$33/MWh.
PTC: Clean Hydrogen	Manufacture of “clean” hydrogen	Sliding scale payment for 10 years, maximum of \$0.60/kilogram, based on greenhouse gas emissions. Note: if electricity from a qualifying generating facility is used to manufacture hydrogen, both PTCs can be claimed.
PPAs	Offshore wind	Long-term contracts, up to 25 years, pay developers a price that is higher than the wholesale market price.
Grants	High-voltage transmission lines	Over \$20 billion for transmission upgrades, integration of EVs, and grid “innovation.”
Cost socialization	Transmission system costs; system reliability	Intermittent wind and solar generation require back-up generation and storage to maintain system reliability. Costs are socialized across all utilities and their retail customers.
Residential Clean Energy Tax Credits	Solar panels, wind turbines, fuel cells, solar water heaters, battery storage	Federal tax credit of 30%, reduced to 26% in 2033 and 22% in 2034.
Carbon Sequestration Credit	Requires sequestration of carbon from electric generating plants and other facilities	Base credit of \$17/ metric ton and \$36/metric ton for direct air capture, increased to \$85/ metric ton and \$185/metric ton for facilities that pay prevailing wages, for the first 12 years of operation. Values adjusted for inflation after 2026. ¹⁴

Table 1: Major Green Energy Subsidies in the Inflation Reduction Act

The cumulative magnitude of the federal subsidies on offer for green energy and electric equipment is staggering. According to an April 2023 study prepared by Goldman Sachs, the IRA will

¹⁴ Angela Jones, [“The Section 45Q Tax Credit for Carbon Sequestration,”](#) Congressional Research Service, August 25m 2023.

provide an estimated \$1.2 trillion in subsidies over its first ten years.¹⁵ The Goldman-Sachs estimate excludes all financing costs associated with the government's continued deficit spending. The most recent estimate of the Federal deficit for FY 2023 is between \$1.5 trillion and \$2.0 trillion, and the Congressional Budget Office projects the deficit to increase to \$2.6 trillion by 2033.¹⁶ Through the end of FY 2023, U.S. government debt totaled \$33 trillion,¹⁷ exclusive of future entitlements, almost 30% greater than the \$25.5 billion U.S. Gross Domestic Product in 2022.^{18, 19}

Although the Goldman-Sachs analysis covers only the first ten years of the IRA, the tax credits do not end after 10 years. Rather, the tax credits on offer will be reduced only after GHG emissions from electric generation have decreased 75% below 2022 levels. Under the U.S. Energy Information Administration's (EIA) most recent "reference case" forecast, that reduction will not be achieved by 2050 (the last year of the forecast period), and under the agency's most aggressive "low carbon" forecast the reduction would not be achieved until 2046.²⁰

Wind and solar generation continue to be the two largest recipients of federal and state subsidies. Currently, state-level offshore wind (OSW) mandates total 80,700 megawatts (MW),²¹ led by California's 25,000 MW goal, which would be met with even more costly floating turbines.²² As of May 31, 2023, the U.S. Government estimates the total OSW "pipeline" to be about 53,000 MW, consisting of projects that are under construction, approved, undergoing federal and state permitting, and development potential

¹⁵ Goldman Sachs, "[The US is poised for an energy revolution](#)," April 17, 2023. The University of Pennsylvania's Wharton School of Business estimated total spending of \$1.05 trillion on just the climate and energy provisions. See Penn Wharton, "[Update: Budgetary Cost of Climate and energy provisions in the Inflation Reduction Act](#)," April 27, 2023.

¹⁶ Source: Congressional Budget Office, "[CBO's Projections of Federal Receipts and Expenditures in the National Income and Product Accounts: 2023 to 2033](#)," September 2023.

¹⁷ Source: U.S. Treasury, "[What is the national debt?](#)" Accessed September 20, 2023.

¹⁸ Source: Bureau of Economic Analysis, "[Gross Domestic Product, Fourth Quarter and Year 2022 \(Third Estimate\), GDP by Industry and Corporate Profits](#)," March 30, 2023.

¹⁹ An unanswered empirical question is whether the IRA spending will, by increasing the federal deficit, lead to higher interest rates. To the extent that the green energy subsidies in the IRA increase electricity prices, they will tend to increase the rate of inflation and, all else equal, higher inflation rates will lead to higher nominal interest rates. The magnitude of the increases, and whether they will be countered through other governmental actions, is unknown.

²⁰ According to the U.S. Energy Information Administration (EIA), GHG emissions from electricity generation were 1.5 billion metric tons. A 75% reduction means emissions would have to decrease to less than 400 million metric tons for the subsidies to be phased out. EIA, Annual Energy Outlook 2023, [Table 18](#).

²¹ See Adam Wilson, "[Strong coastal winds fueling US offshore industry looking to break through](#)," S&P Global, June 14, 2023. In New York state, legislation was introduced this past spring to increase that state's existing OSW mandate of 9,000 MW by 2035 to 20,000 MW by 2050. See, Kate Lisa, "[Lawmakers eye mandating steeper offshore wind goals](#)," Spectrum News, June 2, 2023.

²² European data indicates the few floating OSW installations are far more costly than traditional OSW. See Gordon Hughes, "[Wind Power Economics, Rhetoric and Reality, Vol. 1: Wind Power Costs in the United Kingdom](#)," Renewable Energy Foundation, 2020. The 88-MW Hywind Tampen floating OSW project off the Norwegian coast, the largest such installation to-date, cost \$7.4 billion Kroner, equivalent to around \$8,000 - \$8,500 per kilowatt, depending on the US-NOK exchange rate.

in existing lease areas.²³ The EIA, however, forecasts just 23,600 MW of OSW by 2035, remaining constant thereafter, and 344,000 MW of utility-scale onshore wind by 2046.²⁴ As for solar photovoltaic (PV) generation, the agency's most recent estimate under the IRA scenario is 898,000 MW by 2046, including both utility-scale and small-scale, behind-the-meter generation.²⁵

Estimating the Total ITC Subsidy for Wind and Solar Generation Under the IRA

Using the current EIA capital cost estimates for wind and solar generation, one can calculate a lower bound for future ITC payments, that is, excluding the additional credits available for domestic manufacturing, construction on brownfield sites, and so forth. To bracket the installed costs and resulting ITC costs, I develop two scenarios. The first scenario assumes no increase in nominal costs over time, which implies a 40% reduction in real (inflation-adjusted) costs between 2023 and 2046. The second scenario assumes no increase in inflation-adjusted costs, thus implying that nominal costs over the period increase by that same 40%.

According to the EIA, through the end of 2022, installed solar capacity was just over 81,000 MW and onshore wind capacity was just over 145,000 MW. Total offshore wind capacity was 30 MW, which represents the capacity of the sole operating OSW facility at Block Island, off the coast of Rhode Island.

The overall ITC costs will depend on how the tax credits are paid for through a combination of additional debt or higher taxes. The former adds to the deficit and incurs additional costs in the form of interest payments. The latter results in foregone private investment and thus reduces economic growth and wealth, which adds to their overall cost.

Estimates of the direct financing costs depend on a number of factors, including the coupon rate on government bonds and notes, expectation about future interest rates that determine whether those bonds and notes sell at a discount off their face value (if interest rates are expected to increase) or at a premium (if interest rates are expected to decrease), and how the government refinances maturing debt.

A detailed discussion of the potential economic and financial impacts of continued deficit spending on interest rates is beyond the scope of this report. Instead, I make three simplifying assumptions. First, I assume that interest rates remain constant and, consequently, all U.S. government notes/bonds sell at their face value. Second, I assume that the government refinances the ITC payments for wind and solar generation using one-year Treasury notes, which are refinanced when they come due. I further assume that the interest paid to bondholders is refinanced, net of federal tax collections for the portion of debt held by the U.S. public. (The Technical Appendix provides the details of the ITC financing calculations.) Third, I assume that ITC payments end after 2046 and that all outstanding debt then is recouped solely through higher income taxes.

Estimates of the direct financing costs depend on a number of factors, including the coupon rate on government bonds and notes, expectation about future interest rates that determine whether those

²³ The "pipeline" estimate does not include proposed OSW development in areas outside of existing lease areas.

²⁴ EIA, Annual Energy Outlook 2023, Table 16. "Behind-the-meter" solar refers to facilities developed on site by customers themselves, such as rooftop solar.

²⁵ Ibid.

bonds and notes sell at a discount off their face value (if interest rates are expected to increase) or at a premium (if interest rates are expected to decrease), and how the government refinances maturing debt.

To estimate the finance costs, I assume constant interest rates between 5% and 7%. As discussed in the Technical Appendix, the average current yield for all U.S. Treasury bonds is just over 5%. Prior to the quantitative easing that artificially suppressed interest rates that began in late 2008, the average yield on one-year U.S. Treasury notes was 6.54% over the previous 40 years. The average yield on 10-year U.S. Treasury bonds over that same 40-year period was 7.44%. Moreover, during that period, deficits as a percentage of U.S. GDP were far smaller than today.

Table 2 shows the results of the analysis. Under the first scenario, the overnight capital cost of the wind and solar capacity installed totals approximately \$1.78 trillion. The combined total of the 30% ITC and accompanying financing costs are between \$1.28 trillion and \$1.74 trillion based on the assumed 5% and 7% cost of debt assumptions, respectively. Under the second scenario, the overnight capital cost increases to about \$2.76 trillion and the ITC costs range between \$3.00 trillion and \$3.72 trillion.

Resource	Existing Capacity as of 12/31/2022 (MW)	Installed Capacity in 2046 (MW)	Overnight Capital Cost (2023\$ / kW)	Installed Cost (Billions of \$)	ITC at 30% (Billions of \$)	ITC with 100% Deficit Financing (Billions of \$)
	[1]	[2]	[3]	[5]	[6]	[7]
Scenario 1: Constant Nominal Costs						
Solar PV	81,109	897,500	\$1,488	\$1,215	\$365	\$704 - \$941
Onshore Wind	145,178	345,000	\$2,156	\$431	\$129	\$250 - \$334
Offshore Wind	30	23,600	\$5,486	\$129	\$39	\$75 - \$100
TOTAL	226,317	1,266,100		\$1,775	\$533	\$1,028 - \$1,375
Average ITC Subsidy per kW:			\$989 - \$1,322			
Scenario 2: Constant Inflation-Adjusted Costs						
Solar PV	81,109	897,500	\$1,488	\$1,608	\$482	\$885 - \$1,161
Onshore Wind	145,178	345,000	\$2,156	\$984	\$295	\$923 - \$1,352
Offshore Wind	30	23,600	\$5,486	\$171	\$51	\$68 - \$80
TOTAL	226,317	1,266,100		\$2,763	\$829	\$3,002 - \$3,718
Average ITC Subsidy per kW:			\$1,244 - \$1,631			

Notes:

[1] Source: EIA, Form 960.

[2] Source: EIA Annual Energy Outlook 2023, Table 16.

[3] Source: EIA, Cost and Performance Characteristics of New Generating Technologies, Annual Energy Outlook 2023.

[4] Source: Federal Reserve Bank of St. Louis, GDP Implicit Price Deflator, 2023Q2/2022Q2.

[5] Equals: [1] x [2] x [3].

[6] Equals: (0.3) x [4].

[7] Assumes ITC financed with 1-year US Treasury notes, at 5% (low) and 7% (high).

Table 2: Estimated Investment Tax Credits for Solar PV, Onshore Wind, and Offshore Wind by 2046

As shown in Figure 1, using an assumed 5% interest rate and financing solely with one-year Treasury notes, the additional financing costs alone would be \$589 billion. At an assumed 7% interest rate, the additional

financing costs would increase to \$842 billion. Hence, under the assumption of constant nominal capital costs, the total ITC costs would average between \$43 billion and \$57 billion per year. Under the second scenario, where nominal capital costs are assumed to increase at the rate of inflation, total ITC costs would average between \$54 billion and \$71 billion per year. By comparison, total government spending during the New Deal was estimated to have been just over \$800 billion in today's dollars.²⁶



Source: Author calculations.

Figure 1: Wind and Solar Costs: Nominal Capital Costs Constant

²⁶ Price Fishback and Valentina Kachanovskaya, "The Multiplier for Federal Spending in the States During the Great Depression," *Journal of Economic History* 75 (March 2015), pp. 125-162.



Source: Author calculations.

Figure 2: Wind and Solar Costs: Real Capital Costs Constant

As shown in Table 1, under the first scenario, the overall ITC subsidy averages between \$989/kW and \$1,322/kW. Under the second scenario, the subsidies range between \$1,244/kW and \$1,631/kW. By comparison, the EIA estimates the average overnight capital cost for a new combined-cycle natural gas plant to be \$1,367/kW. Hence, under these financing scenarios, which are, if anything, conservative, on a per-kW basis the ITC subsidies alone would be as large or larger than the entire overnight capital cost of a combined-cycle plant.

As discussed, these two scenarios encompass a wide range of capital costs, with the first scenario assuming a reduction in real, inflation-adjusted capital costs of 40% by 2046. If inflation rates are higher than the 2.35% assumed value used by the EIA, the reduction is even larger. For example, if inflation averages 3.0% per year, Scenario 1 would imply a reduction in inflation-adjusted costs of over 50% by 2046.

If one examines a recent analysis of the “Net-Zero Pathway” using the Rapid Energy Policy Evaluation and Analysis Toolkit (REPEAT), which was prepared by the Princeton University “ZERO” Lab, the annual costs would be even higher.²⁷ The Net-Zero Pathway envisions a total of 915,000 MW of utility-

²⁷ Jesse Jenkins, et al., “Climate Progress and the 117th Congress: The Impacts of the Inflation Reduction Act and Infrastructure Investment and Jobs Act,” Zero-carbon Energy Systems Research and Optimization (ZERO) Laboratory, July 2023.

scale and distributed (i.e., behind-the-meter) solar photovoltaics, 103,000 MW of OSW, 583,000 MW of onshore wind, and 283,000 MW of storage, all by 2035.²⁸ Using a similar analysis over a 13-year period, that is, assuming the ITC is financed through 2035, but then all costs are recouped with higher income taxes, the average ITC cost would increase to between \$136 billion and \$163 billion per year. Combined with the estimated \$3.3 trillion overnight capital cost, the total costs for wind, solar, and storage would be between \$5 trillion and \$5.4 trillion (excluding private financing costs), or between \$388 billion and \$415 billion annually.²⁹

It is difficult to imagine that the government would increase taxes sufficiently to avoid the need to finance any ITC expenditures. Under the REPEAT analysis, total ITC payments to cover the installed solar, wind, and storage assets, assuming no change in nominal costs, would be \$3.3 trillion between 2023 and 2035, or just over \$250 billion annually. Raising taxes by that amount, especially if the tax increases were limited to “the rich” as many politicians like to claim, would surely have adverse economic consequences. Section 4 discusses these consequences in more detail.

Renewable energy proponents claim, contrary to recent evidence, that renewable energy costs will nevertheless decrease significantly over time because of improved technology and, especially in the case of offshore wind, economies of scale arising from ever-larger turbines. Suppose, then, one assumes an average annual reduction in nominal overnight capital costs of 2% per year. Then, by 2046, those costs will have fallen by 40% in nominal terms below 2023 levels and 65% on an inflation-adjusted basis using the EIA’s assumed inflation rate of 2.35% annually.

Given the dependence of green energy on basic raw materials, then barring some unknown technological advance, it is difficult to comprehend how capital costs would decrease to this extent. Yet, even so, under this highly optimistic scenario the installed cost for solar PV, onshore wind, and offshore wind would still be over \$1.4 trillion, a savings of around \$350 billion versus the constant nominal cost scenario, as shown in Table 3. The resulting ITC subsidy would still range between \$859 billion and \$1,167 billion, using the same 5% - 7% range of financing costs, and the subsidy would range between \$826/kW and \$1,123/kW.

Resource	Existing Capacity as of 12/31/2022 (MW)	Installed Capacity in 2046 (MW)	Overnight Capital Cost (2023\$ / kW)	Installed Cost (Billions of \$)	ITC at 30% (Billions of \$)	ITC with 100% Deficit Financing (Billions of \$)
	[1]	[2]	[3]	[5]	[6]	[7]
Solar PV	81,109	897,500	\$1,488	\$973	\$292	\$588 - \$799
Onshore Wind	145,178	345,000	\$2,156	\$345	\$103	\$209 - \$283
Offshore Wind	<u>30</u>	<u>23,600</u>	\$5,486	\$104	<u>\$31</u>	<u>\$63 - \$85</u>
TOTAL	226,317	1,266,100		\$1,421	\$426	\$859 - \$1,167
Average ITC Subsidy per kW:			\$826 - \$1,123			

Table 3: Sensitivity Analysis – Assumed 2% Annual Decrease in Nominal Capital Costs

²⁸ Ibid, p. 72.

²⁹ A complete review of the REPEAT analysis is beyond the scope of this report.

3. Case Study: Offshore Wind Subsidies and the Cost of Green Jobs

One current justification for green energy subsidies is the creation of new industries and accompanying “green” jobs, which together will spur additional economic growth.³⁰ This is especially true for OSW projects requiring long-term contracts at above-market prices for developers to commit to their construction, in addition to ITC payments. To examine the implicit costs of these subsidies, consider seven OSW projects slated for development along the mid-Atlantic coast, as shown in Table 4.

Project	State	Capacity (MW)	Construction Job-Years	O&M Job-Years	Total Job-Years
Empire Wind I	NY	816	1,892	1,902	3,794
Empire Wind II	NY	1,260	2,921	2,937	5,858
Beacon Wind	NY	1,230	2,851	2,867	5,718
Sunrise Wind	NY	880	1,600	2,723	4,323
Atlantic Shores Wind	NJ	1,510	3,500	2,200	5,700
Ocean Wind I	NJ	1,100	3,103	1,725	4,828
Revolution Wind	RI	704	1,632	1,641	3,273
TOTALS		6,500	17,499	15,995	33,494

Source: Ocean Wind I COP, Individual project websites, and calculations by the author.

Table 4: Estimated Direct Construction and O&M Job-years for Selected OSW Projects

The developers of these projects all emphasize, among other benefits, the jobs they will create during both construction and ongoing operations. The mandatory Construction and Operations Plan (COP) submitted to the Bureau of Ocean Energy and Management (BOEM) by Ørsted, the developer of the Ocean Wind I project to be built off the coast of New Jersey, claims the project will create 3,103 direct job-years during the two-year construction period.³¹ (A “job-year” is economic jargon for one full-time-equivalent job for one year. Hence, two half-time workers employed for one year would be equivalent to one job-year.) The COP also claims it will require 69 full-time operations and maintenance (O&M) workers. Over an estimated 25-year project lifetime, that is the equivalent of 1,725 O&M job-years.

Calculating the subsidy amounts for each job-year entails estimating: (i) the ITC amounts for each project, including the additional costs to finance the ITC by issuing government debt;³² and (ii) the

³⁰ For one such study, see American Wind Energy Association, “[U.S. Offshore Wind Power Economic Impact Assessment](#),” March 2020.

³¹ All of the projects also claim they will create indirect and induced jobs, based on input-output studies. As the estimates of these jobs are speculative, they are excluded from the analysis. Moreover, those estimates do not account for lost jobs owing to increased electricity prices that are caused by the projects’ above-market electricity prices.

³² Because projects are not eligible for both the ITC and the PTC, I assume each project claims the ITC, which is larger.

subsidies embedded in each project's PPA cost relative to forecast wholesale market prices. (The details are presented in the Technical Appendix.)

Using the EIA's most recent estimates, the estimated overnight capital cost to construct these seven projects will be \$51.4 billion, which implies an ITC of \$15.4 billion. The additional ITC financing costs depend on the form of government financing. For example, if one assumes the ITC costs for each individual OSW project are financed with one-year Treasury notes that are subsequently repaid with higher taxes the following year, then the financing costs would be only \$687 million (after accounting for tax revenues collected on the interest). If, however, the projects were financed with 10-year U.S. Treasury bonds, after which the costs would be recovered with higher income taxes, the financing costs would increase to \$25.1 billion.

The resulting subsidies per job-year created are shown in Table 5 for this range of ITC financing, based on an assumed interest rate of 5%. As the table shows, the subsidies per job-year range between \$360,000 and \$1.1 million for the Revolution Wind project,³³ to between \$3.53 million and \$4.23 million for the Beacon Energy Wind project, based on the higher PPA pricing the project developers submitted to the New York Public Service Commission (NY PSC) for approval.³⁴ Although the requested price increases were rejected by the NY PSC,³⁵ it is likely the developers simply will rebid the projects at those higher prices in subsequent auctions. Taken together, the estimated subsidies per job-year for all seven projects average between \$2.2 million and \$2.9 million. It should be emphasized that the calculated job-year subsidies represent are annual values. Thus, even under the lowest cost financing assumption, taxpayers and electric ratepayers will be forced to pay subsidies far greater than the actual annual salaries workers will be paid.

³³ Revolution Wind has not yet requested a change to its PPA contract prices. However, at the current average price of \$99.04/MWh for the project, which does not escalate over the 20-year PPA term, a cash flow analysis demonstrates the project is not economically viable. Nevertheless, I have included the project in the job-year subsidy calculations.

³⁴ The developers of Atlantic Shores Wind have also informed the state of New Jersey that the project may be cancelled if the state does not provide additional subsidies. See Wayne Parry, "[New Jersey's other wind farm developer wants government breaks, too; says project 'at risk'](#)," AP, July 3, 2023.

³⁵ New York Public Service Commission, [In the Matter of Offshore Wind Energy, Case No. 18-E-0071](#), Order Denying Petition Seeking to Amend Contracts with Renewable Energy Projects, October 12, 2023.

Project	ITC Subsidy, incl. Finance Costs (Millions of \$)	PPA Subsidy (Millions of \$)	Total Subsidy (Millions of \$)	Subsidy per Job-Year (Millions of \$)
Empire Wind I	\$1,754 - \$4,414	\$9,370	\$11,124 - \$13,784	\$2.93 - \$3.63
Empire Wind II	\$2,707 - \$6,814	\$16,051	\$18,758 - \$22,865	\$3.20 - \$3.90
Beacon Wind	\$2,644 - \$6,654	\$17,560	\$20,204 - \$24,214	\$3.53 - \$4.23
Sunrise Wind	\$1,892 - \$4,761	\$7,496	\$9,388 - \$12,257	\$2.17 - \$2.84
Atlantic Shores Wind	\$3,245 - \$8,167	\$4,088	\$7,017 - \$11,939	\$1.23 - \$2.09
Ocean Wind I	\$2,364 - \$5,949	\$3,772	\$6,136 - \$9,721	\$1.27 - \$2.01
<u>Revolution Wind</u>	<u>\$1,513 - \$3,807</u>	<u>(\$340)</u>	<u>\$1,173 - \$3,467</u>	<u>\$0.36 - \$1.06</u>
Totals	\$16,118 - \$40,566	\$57,997	\$73,799 - \$98,247	\$2.20 - \$2.93

Source: author calculations.

Table 5: Calculated Subsidies / Job-Year for Selected OSW Projects

4. The False Justifications for Green Energy Subsidies

Justifications for subsidies for renewable energy have changed over time. Initially, the subsidies were justified based on three arguments. The first was an “infant industry” argument, that is, renewable energy technologies were new and could not compete fairly with their fossil fuel counterparts.³⁶ After 45 years (and counting) of continuous subsidies, it is difficult to argue that wind and solar generation remain “infant” industries. As such, this argument is rarely employed, although protective tariffs have been introduced in the last few years for solar panels to restrict imports of lower-cost panels manufactured in China.

A second argument was that renewable energy would promote energy independence by reducing the need to import crude oil and reduce exposure to volatile fossil fuel prices. Although the “energy independence” argument is still invoked, recent actions by the federal government have increased dependence on foreign supplies of crude oil and uranium for nuclear plants. Moreover, there is no empirical evidence that increased renewable energy has reduced the volatility of petroleum, natural gas, or coal prices.³⁷ And, even if there were such evidence, it would be less costly to use existing financial hedging instruments to reduce volatility.

Increased quantities of wind and solar generation have increased price volatility of electricity in organized wholesale power markets.³⁸ The reason is that, under organized wholesale power market rules,

³⁶ In the past, proponents have used the “infant industry” argument to justify tariffs that insulate domestic industries from foreign competitors.

³⁷ Of course, it is true that, if renewable energy were to replace all fossil fuel consumption, there would be no fossil fuel price volatility.

³⁸ All U.S. regional transmission organizations (RTOs) oversee organized wholesale power markets. These include the California Independent System Operator (CAISO), the New York Independent System Operator (NYISO), the Electric Reliability Council of Texas (ERCOT), the Southwest Power Pool (SPP), the Midcontinent Independent System Operator (MISO), PJM Interconnection, and the New England Independent System Operator (NE-ISO). Only western states and states in the southeast are not included in these RTOs.

generators offer to supply electricity at their marginal cost, which for wind and solar power effectively is zero. During hours when they are fully available, this suppresses market prices and drives fossil fuel generators (primarily natural gas generators) from the market. However, when wind and solar are not available, electricity supplies are reduced, causing prices to shoot upwards. This has created what California refers to as the “duck curve,” in which market prices collapse in the middle of the day when solar generation peaks and increases rapidly in the early evening when solar generation disappears.³⁹

A third argument was that, because of high upfront capital costs, renewable energy faced “market barriers,” which require subsidies to overcome. But high costs, such as the rapidly escalating costs for offshore wind generation (discussed in the next section), are not a market barrier. If they were, then one could argue that Rolls-Royce faces market barriers because the cars the company manufactures are expensive.⁴⁰

A fourth argument is that green energy subsidies increase the rate of innovation and lead to technological innovation that reduces cost. In a similar vein, advocates claim that subsidies for end-use products accelerate adoption of these new technologies by consumers. This is the most common argument made for subsidizing electric vehicles.

Although subsidies for research and development activities can increase economic growth,⁴¹ subsidies that reduce firms’ capital and operating costs reduce the incentive to innovate. Just as a tax on emissions increases the incentive for a firm to adopt new technology that reduces its emissions and, hence, reduce its tax exposure, subsidies provide a competitive “crutch” that allows otherwise uncompetitive firms and technologies to participate in a market. Moreover, when governments provide subsidies for specific technologies, they are selecting “winners” and “losers.” There is no empirical evidence that the selections made are economically sound. Indeed, the historical success of such selections, such as the bankruptcy of solar panel maker Solyndra, which received a half-billion-dollar government loan in 2009 and went bankrupt in 2011,⁴² and the 2023 bankruptcy of Proterra, a maker of electric buses that received a \$10 million government loan, is dismal. Not only do governments have no expertise in identifying technologies with the highest potential economic value, but public choice theory suggests that the granting of subsidies to specific technologies is primarily concerned with rent seeking, rather than increasing economic well-being.⁴³

Green Energy Subsidies Distort Energy Markets

³⁹ For additional discussion, see U.S. Energy Information Administration, “[As solar capacity grows, duck curves are getting deeper in California](#),” June 21, 2023.

⁴⁰ This is the most common argument made to justify continued subsidies for EVs.

⁴¹ See, e.g., Carl Davidson and Paul Segerstrom, “R&D subsidies and economic growth,” *RAND Journal of Economics* 29 (Autumn 1998), pp 548-577.

⁴² David Boaz, “[Solyndra: A Case Study in Green Energy, Cronyism, and the Failure of Central Planning](#),” CATO Institute, August 27, 2015.

⁴³ Public choice theory was developed by the Nobel prize-winning economist James Buchanan. For a brief introduction, see his article, “[What is Public Choice Theory?](#)” American Institute for Economic Research 43 (May 2003).

Green energy subsidies distort competitive energy markets. In wholesale electric markets, for example, subsidies for wind and solar power crowd out other, unsubsidized generators, in what I have previously termed “Gresham’s law of green energy.”⁴⁴ For example, nuclear plants in Illinois, New Jersey, and New York have been granted subsidies, in part to account for their inability to compete in a wholesale market with increasing quantities of zero marginal cost wind and solar generation. More recently, the Texas legislature passed legislation to provide low-interest loans to support development of 10,000 MW of new gas-fired generation that is needed to improve system reliability when wind and solar generation (also subsidized) is not available. Enacting subsidies to counteract the market-distorting impacts of other subsidies does not promote a well-functioning competitive market.⁴⁵

As discussed previously, California’s “duck curve,” which has been caused by development of subsidized solar PV and excess solar generation during the day, has distorted that state’s wholesale electricity market. In hours when solar generation peaks, the state must pay to export solar generation to other states. More broadly, as solar and wind generation capacity have increased, there are more hours where wholesale prices are below zero. The reasons are twofold: (i) wind generators that receive the PTC can bid into the market at a below zero price and still profit; and (ii) some generators, especially nuclear plants, but also baseload coal plants, cannot be cycled on and off. Therefore, they must bid their generation into the market at all hours. When prices turn negative, owners of those generating resources must pay to dispose of the electricity generated.⁴⁶

The additional subsidized generation thus crowds out more efficient generators who are needed to maintain reliability. Hence, states like Illinois, New Jersey, and New York provide subsidies to nuclear plant owners to ensure those projects do not shut down and the associated jobs are not lost. Moreover, as peaking natural gas generators needed when electricity demand peaks become uneconomic to operate because of a flood of subsidized wind and solar power, then those generators must be subsidized to continue operating. A system of subsidies that cause economic distortions in electric markets and required creating additional subsidies to overcome those distortions economic madness.

Not only do the subsidies for wind and solar require additional subsidies for other resources needed to keep the light on, but increased generating capacity of intermittent wind and solar generation requires adding greater amounts of backup generation. In New York, for example, the system operator estimates that, if that state’s mandates for wind and solar generation are met, the required “reserved margin” to preserve system reliability will increase from its current 20% (around 6,600 MW) to over 100%

⁴⁴ Jonathan Lesser, “Gresham’s Law of Green Energy,” *Regulation*, Winter 2010/2011, pp. 12-18.

⁴⁵ In fact, once wind and solar reach a threshold level, wholesale competitive electric markets will collapse entirely. The reason is that generation owners will bid at their marginal cost (zero) when their resources are available, forcing the price to zero or near zero in most hours. But when wind and solar are unavailable, prices will skyrocket. Fossil fuel generators will be unable to compete and drop out of the market. If the number of zero-price hours is sufficient, then wind and solar generation owners will be unable to recoup their costs, leading to a complete collapse of the wholesale market. The aforementioned California “duck curve” is a harbinger of this impact.

⁴⁶ Corn ethanol subsidies are another example of a market distortion. Because ethanol production accounts for about 40% of the U.S. corn crop, it artificially increases corn prices and, thus, prices for many foods. The resulting higher prices disproportionately affect the poor, both in this country and elsewhere, which can then require additional government programs to offset higher food costs.

(50,000 MW) by 2040 to maintain reliability.⁴⁷ Adding almost 40,000 MW of generation and storage to maintain reliability will cost billions of dollars; money that could otherwise be invested elsewhere, such as in new nuclear plants that generate electricity around the clock and would not require higher reserve margins. (Reducing reliability, while avoiding back generation costs, will impose its own economic costs, especially given efforts to electrify most end uses, including transportation, all of which will increase electricity consumption.)

The Broader Economic Impacts: Foregone Economic Growth and Lost Jobs

Today, the most prominent justifications for renewable energy subsidies made are that: (i) green energy will reduce GHG emissions from fossil fuels and thus “solve” climate change; and (ii) subsidies will create new “green” industries, leading to increased economic growth, and the creation of millions of new jobs.⁴⁸ A detailed discussion of the first argument is beyond the scope of this report, as it would require analysis of the life-cycle emissions of green energy investments and electrified end-uses, such as electric vehicles. Hence, in this report, I focus solely on the second argument.

The overarching economic fallacy of justifying green energy subsidies based on jobs created is that an investment’s economic value is not measured by the number of jobs it creates. The purpose of investing in electric generating resources and related infrastructure is to ensure that electricity supplies are adequate, affordable, and reliable. The purpose is not to create jobs. If it were, then the highest value energy resources would be the most labor-intensive ones.

For any industry or firm, employers will hire employees as long as the additional economic value in greater than the cost of hiring them. Creating “make-work” jobs, often called “featherbedding,” increases costs without commensurate benefits and thus reduces economic value.

Forcing consumers and taxpayers to subsidize green energy producers with a system of tax credits, federal and state mandates, and above-market price power purchase contracts to create employment has the same adverse economic impact. Subsidizing green energy development may create new jobs for developers and their employees, but when tallying the entire economic ledger the net impact of those subsidies will be reduced economic growth. The reason is simple: it is impossible for a system of green energy tax credits and other subsidies to increase economic growth. To believe otherwise is to believe in “free lunch” economics. Europe is experiencing this painful economic reality. As green energy investments have increased in Great Britain and Germany electricity prices have soared, leading to deindustrialization, as energy-intensive industries either shutdown or relocate to other countries with lower electricity costs.

As shown in Table 4, the economic cost of job subsidies for OSW projects will be millions of dollars per year for each job created. If taxpayers and electric ratepayers are forced to spend, say, \$2 million per year to employ a single worker at a wage of, say, \$100,000, doing so cannot possibly improve economic

⁴⁷ New York State Department of Public Service, “Initial Report on the New York Power Grid Study,” January 19, 2021, [Appendix E](#).

⁴⁸ The REPEAT analysis, for example, claims that the proposed electrification policies will create three million new jobs, while causing the loss of only 133,000 jobs in the oil and natural gas sectors. See *supra*, note 26, at p. 99.

well-being unless it can be demonstrated that (i) at least \$1.9 million in broader economic and social benefits will be realized by the remainder of the country; and (2) those additional benefits cannot be achieved otherwise at a lower cost. In the case of OSW, that is assuredly not the case, as it one of the costliest and least-efficient forms of electricity generation.⁴⁹

In addition to the distortions to energy markets themselves, green energy subsidies induce broader economic distortions. First, by investing in technologies with low (or, in some cases, negative returns), government subsidies misallocate scarce resources that could be better spent on other, superior technologies, such as modular nuclear power plants, and basic research and development activities. Moreover, by diverting resources to less productive investments, green energy subsidies affect market prices, further reducing economic growth.

These are not surprising economic results. Subsidized investment in green energy resources that, absent the subsidies themselves,⁵⁰ would not be made in the market, diverts scarce resources from other, more productive investments. Consider the subsidy estimates in Table 2, which show just seven OSW projects siphoning off between an estimated \$16 billion and \$41 billion in government spending that could be invested in R&D for alternative generation technologies, especially small modular nuclear reactors (SMRs). Unlike OSW projects, SMRs can provide reliable electricity, avoiding the need to invest in additional backup generation and storage resources. SMRs also can be sited close to cities where electricity demand is greatest. Finally, they would avoid the likely economic and environmental damages associated with offshore wind, including harm to commercial and recreational fisheries, and harm to seabirds and whales, including the highly endangered North American right whale.

As another example, refinery owners are converting existing refineries to produce more costly “renewable” fuels such as biodiesel to meet state and federal government mandates, and take advantage of the subsidies on offer.⁵¹ For example, the Phillips 66 refinery outside of San Francisco, will convert 120,000 barrels/day of capacity to produce biodiesel.⁵² Reducing the productive capacity of existing refineries will, all else equal, reduce the supply of “traditional” refinery products like gasoline and diesel, and increase prices. At the same time, the average price of motor gasoline in the San Francisco area

⁴⁹ Moreover, one must account for social costs. Wind and solar energy use tremendous amounts of land and, if developed to the extent envisioned, will require at least doubling the miles of high-voltage transmission lines to deliver electricity from remotely sited generators to urban load centers. Wind generation creates other economic and social costs, such as killing bats needed for pollination. Solar facilities have been sited on productive agricultural lands, lessening food supplies. And OSW will have adverse impacts on commercial and recreational fishing, and most controversially, may increase whale deaths, including of the endangered North American right whale.

⁵⁰ Here again, I define subsidies broadly to include mandates.

⁵¹ For example, the state of California has a Low Carbon Fuel Standard (LCFS) that requires refineries and wholesalers of fossil fuels to meet GHG emissions standards that decrease over time. Because the GHG emissions from, say, gasoline and diesel, are fixed based on their chemical composition, the LCFS means that refineries and wholesalers must purchase emissions credits and sell increasing quantities of “renewable” fuels, including biodiesel and renewable natural gas (e.g., natural gas produced from wastewater treatment plants, animal waste, and landfills.)

⁵² Robert Brelsford, [“Phillips 66 progresses Rodeo Renewed refinery conversion project,”](#) Oil & Gas Journal, August 3, 2023.

already is the highest in the nation.⁵³ Higher gasoline and diesel prices, in turn, will increase the costs to transport goods, leading to higher prices, and reductions in economic well-being. To take one example, for the week ending September 18, 2023, the average price of diesel fuel in California is over \$6/gallon, double the average price in 2017.⁵⁴

More direct government actions, such as GHG cap-and-trade programs in Washington and California,⁵⁵ create what effectively are government “slush” funds. Washington state’s program, for example, which began this year, is projected to raise over \$2 billion dollars from the sale of emissions credits. The money will be spent on programs the state legislature and state agencies deem worthwhile, with little oversight, rather than on investments having the highest economic returns. This is public choice theory in action.

Second, government spending also can crowd out private investment. Crowding out refers to the adverse impacts of higher government spending on private investment. If government spending increases, but there is no corresponding increase in total economic activity, then the private sector is said to have been “crowded out” by that government spending.⁵⁶ Even increased R&D spending on green energy has been shown to crowd out private investment in more productive areas.⁵⁷ Another recognized issue associated with crowding out by government spending is higher interest rates caused by deficit spending, as the U.S. is experiencing, in part because of the trillions of dollars in subsidies promised under the Inflation Reduction Act. Deficit spending that results in higher market interest rates reduces private investment by increasing opportunity costs for private investors.

Third, because subsidies increase energy costs, despite claims to the contrary, they cause a reduction in overall economic growth and jobs. For example, as shown in Table 3, the projected subsidies in the form of above-market prices paid to OSW developers is \$58 billion. Higher electric prices reduce economic growth in several ways. First, as is being experienced in Europe, electric prices can become so high as to cause deindustrialization because energy-intensive industries move elsewhere. The problem is particularly acute in Germany. Second, as electricity prices increase, consumers and businesses have less money to spend on all other goods and services, which leads to reduced economic growth. In previous research, I estimated the direct employment impacts of higher electricity prices in Pennsylvania to be the loss of six job-years per million dollars of higher prices.⁵⁸ Hence, using the \$58 billion estimate of above-

⁵³ EIA, [Weekly Gasoline and Diesel Fuel Update](#), September 18, 2023.

⁵⁴ Ibid.

⁵⁵ These programs are euphemistically referred to by their proponents as “cap-and-invest” programs because the money collected by state governments is then “invested” in projects government officials choose. New York state is in the process of developing its own cap-and-invest program.

⁵⁶ See, e.g., William Butler, “‘Crowding out’ and the effectiveness of fiscal policy,” *Journal of Public Economics* 7 (June 1977), pp. 309-328.

⁵⁷ See, e.g., John Welche, “[Does green corporate investment crowd out other business investment?](#)” *Industrial and Corporate Change* 28 (October 2019), pp. 1279-1295. See also, Özgür Arslan-Ayaydin, et al., “The Crowding-Out Effect of Green Energy Innovation,” in Andre Dorsman, et al., (eds.), *Energy Economy, Finance and Geostrategy*, (Springer International Publishing 2018).

⁵⁸ Jonathan Lesser, “[Renewable Energy and the Fallacy of ‘Green’ Jobs](#),” *The Electricity Journal* 23 (August/September 2010), pp. 45-53.

market costs of electricity associated with the seven OSW projects, the the resulting job losses would be almost 350,000 job-years, ten times larger than the number of jobs the projects claim they would create.

5. Conclusions

Over the last half century, the U.S. government's track record of selecting "winning" energy technologies has been a dismal failure. Current U.S. and state government energy policies will continue that record of failure. The staggering amounts of money on offer through the IRA will have long-lasting and adverse consequences on energy supplies, economic growth, and the well-being of the citizenry.

Federal investment tax credits, which can be as high as 60% of the costs of certain green energy projects, must be paid for. Given the country's profligate spending and rapidly increasing deficit, for the foreseeable future federal green energy subsidies are likely to be financed with additional debt. The financing costs alone to service that additional debt will be huge and will increase the deficit still further.

As growing deficits increase interest rates, they crowd out more productive private investment. Moreover, federal spending on green energy itself is inefficient: Rewarding low-quality energy resources like wind and solar energy, rather than high-quality sources like nuclear power. Subsidies for these low-quality resources then further crowds out spending on more higher quality ones by distorting competitive markets and raising energy prices, whose impacts ripple through the entire economy and further restrict economic growth and wealth creation. Moreover, higher energy prices disproportionately affect the least well off in society. Advertising specific green energy projects for their economic development and job creation potential may be politically appealing, but the true economic costs will be far greater.

Politicians and policy makers may choose to ignore basic economic principles in favor of political expediency and, in some cases, personal gain. However, basic economic principles will not ignore them. Eventually, the profligate spending on costly, but low-value green energy will collapse under its own economic weight. The unanswered question is how high an economic and social price will the U.S. pay for this folly before that occurs.

About the Author

Jonathan Lesser is the president of Continental Economics, an economic and energy consulting firm, an Adjunct Fellow with the Manhattan Institute, and a Senior Fellow with the Discovery Institute. Over his 40-year career, he has studied energy and environmental policies, as well as served as an expert of rate regulation. The following articles and reports are a selection of his many writings on energy policy: *“California’s Green Debacle”* (City Journal, 2023); *“The Biden Administration’s Offshore Wind Fantasy”* (Manhattan Institute, 2022); *“Out to Sea: The Dismal Economics of Offshore Wind”* (Manhattan Institute, 2020); *“The EPA’s Mileage Standards Are a Stealth Electric-Vehicle Mandate,”* (The Wall Street Journal 2021); *“The Fallacy of ‘Jeopardy’ Policy Making,”* (The Hill, 2020); *“Is there a Future for Nuclear Power in the United States?”* (Manhattan Institute, 2019); and *“Short Circuit: The High Cost of Electric Vehicle Subsidies”* (Manhattan Institute, 2017). He holds a B.S. in Mathematics and Economics from the University of New Mexico, and a Ph.D. in Economics from the University of Washington.

Technical Appendix: General Formula for Calculation of ITC Financing Costs and Application to Six OSW Projects

How ITC payments are financed by the government. The alternatives are raising taxes, issuing new debt, or a combination of both. Hence, the total cost of the ITC will be the direct outlay plus the associated financing costs, F_{ITC} , i.e., $ITC_{TOTAL} = ITC_{DIRECT} + F_{ITC}$.

Assume that a percentage, ρ , of the ITC cost is financed, that all bonds have the same coupon rate, r , and the same term of T years. The initial sale price of such a bond depends on the assumed path of interest rates. If, for example, current interest rates are expected to increase over time because of rising deficits, then bonds will sell at a discount and the financing costs will be higher. If interest rates are expected to decrease, then bonds will sell at a premium and the financing costs will be lower. For simplicity, I assume a constant interest rate over time which means all bonds sell at their face value.

Although Treasury bonds themselves do not compound interest (although savings bonds do), refinancing bonds, including interest payments, results in compounding of the total ITC cost. Specifically, for an initial ITC expenditure, ITC_0 , the interest expense, I_{ITC} , will equal:

$$I_{ITC} = \rho \times ITC_0 \times (1+r)^T, \quad (A-1)$$

where ρ = percentage of ITC financed with debt; r = annual coupon rate on that debt; and T = bond term in years.

Because 78% of Treasury bonds are held by the US public,⁵⁹ the interest payments on this percentage of bonds issued will be subject to federal tax collection, which reduces the ITC financing cost. For a given financing percentage, ρ , and income tax rate, t , the net financing cost, F_{ITC} , is therefore:

$$F_{ITC} = I_{ITC} \times (1 - 0.78 \times t) = \rho \times ITC_0 \times (1+r)^T \times (1 - 0.78 \times t), \quad (A-2)$$

where t = the average tax rate paid by bond holders.

According to the Tax Foundation, the top 50% of taxpayers account for 98% of all taxes paid and pay an average tax rate of 14.8%.⁶⁰ I assume all Treasury debt is held by these taxpayers. Therefore, the net ITC financing cost is:

$$F_{ITC} = \rho \times ITC_0 \times (1+r)^T \times 0.891, \quad (A-3)$$

For the ITC financing costs shown in Table 1, I assume that the wind and solar targets for 2046 are acquired at a constant rate in all years, 2023 – 2046. I further assume that all of the ITC payments and after-tax

⁵⁹ Peter Peterson Foundation, "[The Federal Government Has Borrowed Trillions, but Who Owns All That Debt?](#)" May 11, 2023.

⁶⁰ Erica York, "[Summary of the Latest Federal Income Tax Data, 2023 Update](#)," Tax Foundation, January 26, 2023.

financing costs are recovered by issuing more debt (i.e., that $\rho = 100\%$) in the form of one-year Treasury notes, rather than through higher income tax rates. At the end of 2046, I assume all outstanding debt is recovered through higher income taxes.

Subsidy Costs for OSW Projects and Calculations of Costs per Job-year

The total subsidy costs for an OSW project equals the ITC cost plus the above-market cost associated with long-term PPA contracts. (Projects cannot obtain both the ITC and the PTC. As the former is larger than the latter, I assume a rational developer opts for the ITC.)

Using estimates of total overnight capital costs for seven OSW projects — Empire Wind I, Empire Wind II, Beacon Wind, Revolution Wind, Atlantic Shores Wind, and Ocean Wind I — the next step is to calculate the ITC costs, including financing costs.

Capital Cost and the ITC Subsidy

Because offshore wind developers do not publish data on construction costs, I estimate the costs using the most recent overnight capital cost (i.e., excluding all financing costs) estimate published by the EIA, which is \$5,338/kW (2022\$), for a project assumed to be on-line in 2026.⁶¹ In addition, EIA includes a 25% technological optimism factor that “reflects the demonstrated tendency to underestimate actual costs for a first-of-a-kind unit.” Applying this factor, the overnight capital cost of offshore wind units is \$6,672/kW in 2022\$. Adjusting this for inflation between 2022 and 2023, as measured by the Gross Domestic Product Implicit Price Deflator (2023Q2 = 125.62, 2022Q2 = 122.22), yields an overnight capital cost of:

$$\$6,672 \times (125.62 / 122.22) = \$6,858/\text{kW}.$$

In light of recent applications by offshore wind developers to (i) cancel existing PPAs (Massachusetts) and (ii) adjust the PPA pricing (New York) to reflect increased costs of key inputs, including raw materials and assembly costs,⁶² the EIA’s higher capital cost estimate is a reasonable baseline. Assuming an OSW project qualifies solely for the 30% ITC (but not the additional 10% for domestic manufacturing), the resulting ITC credit = $(0.30) \times \$6,858 = \$2,057/\text{kW}$, or \$2.057 million / MW (2023\$).

⁶¹ Source: EIA, “Cost and Performance Characteristics of New Generating Technologies, Annual Energy Outlook 2023,” March 2023. The estimates are based on a 2019 study published by Sargent and Lundy.

⁶² For example, a June 7, 2023, filing by the developers of the 816 MW Empire Wind 1 and 1,260 MW Empire Wind 2 projects filed a petition to adjust the long-term PPA prices which calculates an overall increase of 23% for wind turbine materials alone, excluding higher financing costs and higher costs for interconnecting the projects to the mainland. See, *In the Matter of Offshore Wind Energy*, Case 18-E-0071, “Verified Petition of Sunrise Wind LLC for an Order Authorizing the New York State Energy Research and Development Authority to Amend the Offshore Wind Renewable Energy Certificate Purchase and Sale Agreement,” June 7, 2023, p. 21. Similar increases are projected for the 924 MW Sunrise Wind and 1,230 MW Beacon Wind projects. Overall, NYSERDA shows that first-year prices would increase in PPA prices Empire Wind 1 would rise from \$118.38 per megawatt hour (MWh) to \$159.64/MWh and for Empire Wind 2 from \$107.50/MWh to \$177.84/MWh. Beacon Wind would see the strike price rise from \$118.00/MWh to \$190.82/MWh.

Financing Costs for OSW Projects

The low range of estimates of ITC subsidies for the OSW projects shown in Table 2 assumes the ITC payments are financed with one-year Treasury notes that, upon maturity, are recovered fully from increased taxes. Given the pattern of U.S. deficit spending, that is almost certainly an overly optimistic scenario. The high range of ITC costs assumes the specific ITC payments are all financed with 10-year U.S. Treasury bonds. Over the 10-year period, interest compounds as in equation (A-3). However, at the end of 10 years, the outstanding ITC costs are assumed to be recovered fully from higher income taxes.

Subsidies Associated with Above-Market Pricing of PPAs

Estimating the subsidy associated with an OSW PPA depends on: (i) the specific terms of the PPA; and (ii) the forecast wholesale electric price in the specific RTO in which the project will be located. The three Regional Transmission Organizations where OSW projects will be located along the Atlantic coast are: ISO-NE, New York ISO, and PJM Interconnection.

The EIA Annual Energy Outlook 2023 publishes forecasts of average retail electric rates and the components (i.e., generation, transmission, and distribution) that make up those rates. Because New Jersey, New York, and most New England states restructured their electric industries, few generating plants are owned by regulated electric utilities. Instead, most generating facilities participate in the different RTO wholesale generation markets.

I assume the EIA generation cost forecasts (Figure A-1) are reasonable proxies for average annual wholesale prices for generation paid by distribution utilities and competitive suppliers. These generation costs include the price paid for generation in the wholesale market, plus the additional costs for installed capacity, and ancillary services (i.e., maintaining sufficient reserve generation, voltage support, and frequency control).

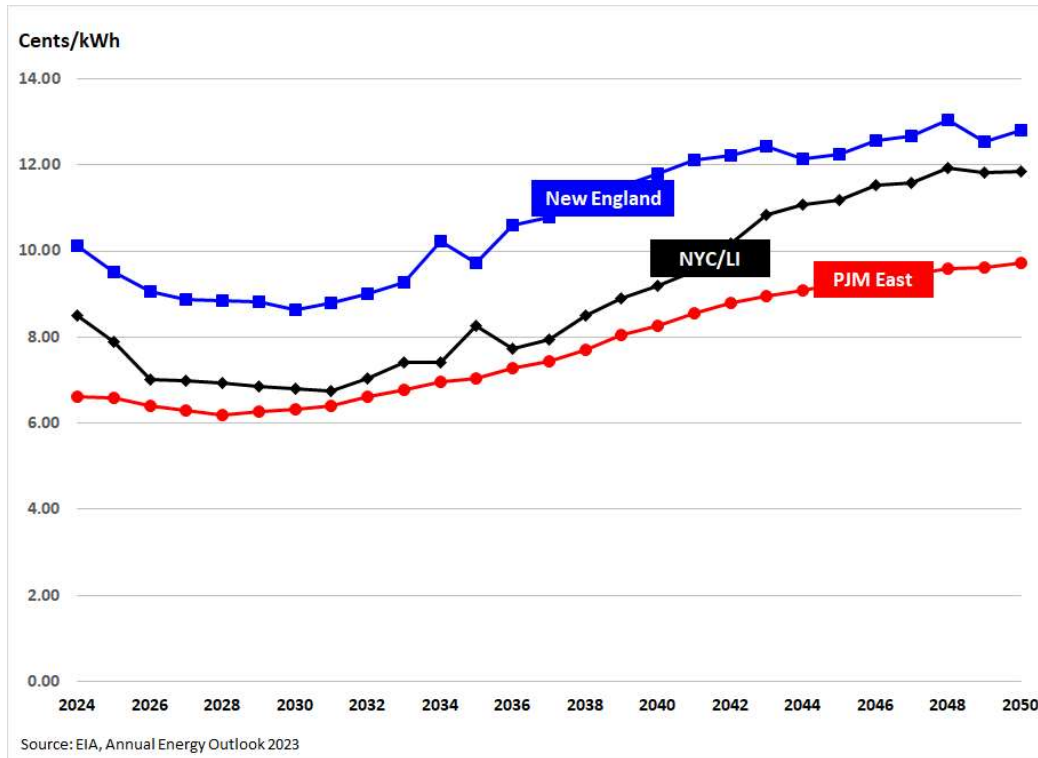


Figure A-1: EIA Forecast Generation Costs, 2024 - 2050

The resulting PPA subsidy, S_{PPA} , for an individual project equals the difference between the prices set forth in the PPAs and the forecast generation costs in Figure A-1 for the corresponding RTO, multiplied the expected annual generation for the duration of the PPA:

$$S_{PPA} = (MW \times cf \times 8,760) \times \sum_{n=1}^N [P(n) - WP(n)] \quad (A-4)$$

Where MW = the rated capacity of the project, cf = the assumed capacity factor, $P(n)$ = the PPA price in year n , $WP(n)$ = the average wholesale electric price in year n , and N = the duration of the PPA project in years.

For each project, I assume an annual capacity factor of 45%. These are slightly lower than developers' projections. However, the average capacity factor for the Block Island Wind Farm of the Rhode Island coast, the only OSW project in operation in the U.S., has been 42% since the project's coming on-line in 2016,⁶³ lower than the initially assumed capacity factor of about 48%.

For example, because the Revolution Wind project is located in Rhode Island, the corresponding generation cost is the one shown for New England. The subsidies are calculated based on the stated

⁶³ Source: Generation data from EIA Form 923.

duration of the PPAs. (I have also used the PPA price adjustments for the four New York projects requested by the developers, on the assumption that, absent those price adjustments, the projects will not be developed.)

Estimating Annual Full-time Equivalent Jobs (Job-years)

Estimates for the number of construction jobs and ongoing operations and maintenance jobs for specific projects can be found either on the project websites or in the Construction and Operation Plans (COP) project developers are required to file with the Bureau of Ocean Energy Management. The only available COP with employment estimates for an OSW project is the Ocean Wind project, which is to be built off the New Jersey coast.⁶⁴ The COP for Sunrise Wind treats the employment impacts as confidential. However, the Sunrise Wind website provides projected jobs data on its website. Both COPs project a two-year construction period, after which I assume a 25-year operating period. Although some OSW projects claim a physical lifetime of 35 years, observed failure rates for newer OSW projects support a shorter, 25-year economic life,⁶⁵ which also corresponds to the longest PPA contract term.

The Ocean Wind I COP projects a total of 3,103 job-years during the construction period.⁶⁶ It projects a total of 69 operations and maintenance (O&M) jobs each year for the project's operating life. Based on a 25-year operating life, that results in a total of 1,725 O&M-related job years. The Sunrise Wind website claims the project will create eight hundred construction jobs. Although the website does not provide an estimate of O&M-related jobs, the Sunrise COP refers to a Massachusetts study that estimates between 35 and 64 O&M jobs for a 400-MW reference project, or between 0.088 and 0.160 jobs/MW. I use the average of these two values, 0.124 jobs/MW, which implies 109 annual O&M jobs for the project. For the remaining four projects, I use averages of the Ocean Wind and Sunrise values.

Calculation of Total Subsidies per Job-Year

The total subsidy for each job-year for each project equals the sum of its corresponding ITC subsidy and its PPA subsidy, divided by the project's job-year estimates. Those estimates are shown in Table 3.

⁶⁴ The developer of Sunrise Wind has also filed to increase its PPA contract prices to reflect increases in materials, construction, and financing costs. However, the filing does not contain any actual requested prices. To be conservative, I have inflated the current Sunrise PPA by the 23% materials price increase.

⁶⁵ Gordon Hughes, "Wind Power Economics, Rhetoric and Reality, Vol. 1: Wind Power Costs in the United Kingdom," Renewable Energy Foundation, 2020.

⁶⁶ One job-year corresponds to one full-time-equivalent job for one year.