The Siren Song that Never Ends

Federal Energy Subsidies and Support from 2010 to 2019

by Brent Bennett, Ph.D.
Karl Schmidt, Jr.
Gary Faust

Updated July 2020

Texas Public Policy Foundation

Updated July 2020

by Brent Bennett, Ph.D.
Karl Schmidt, Jr.
Gary Faust

Texas Public Policy Foundation

Table of Contents

The Siren Song that Never Ends: Federal Energy Subsidies and Support from 2010 to 2019

by Brent Bennett, Ph.D., Karl Schmidt, Jr., Gary Faust

Executive Summary

For many decades, the federal government has attempted to use energy subsidies, primarily tax breaks, direct spending, and research funding, to stimulate energy production and the development of new energy technologies. The idea that the government can create new jobs and guide the growth of industries is a siren song that has entranced politicians of all stripes and led to subsidies across a wide range of industries. However, the evolving and important debate over what energy resources should form the foundation of the U.S. energy system has placed a unique emphasis on the nature and purpose of the wide variety of energy subsidies that exist today.

One challenge in the debate over energy subsidies is cataloging what subsidies exist and how large they are. The Energy Information Administration (EIA) has tabulated federal energy subsidies every three years since 2007 (EIA 2018), and other agencies, such as the Congressional Budget Office (CBO 2012; CBO 2015; Dinan) and the Government Accountability Office (GAO 2014), have undertaken specific studies at the request of Congress. However, none of these studies, or the various studies done by outside groups, have produced a comprehensive review covering every year where complete data is available. This paper undertakes this full review in order to inform policymakers, energy policy analysts, energy industry participants, and other interested readers and to improve the quality of the national conversation about this important topic.

Applying the EIA's methodology with a few modifications, this analysis finds that cumulative energy subsidies from 2010 to 2019 for solar, wind, oil and gas, and coal have been $34 billion, $37 billion, $25 billion, and $13 billion, respectively. Nuclear has received about $15 billion, and hydropower and geothermal have each received around $1.4 billion. Arguments over whether wind and solar or fossil fuels receive more federal subsidies are of little value. Every primary form of U.S. energy production has received substantial federal subsidies over the past two decades, and the situation is unlikely to change without significant structural changes in the political environment surrounding energy issues.

It is important to look beyond the dollar values and consider the nature of different energy subsidies and their effects on markets. Wind and solar subsidies are primarily focused on the installation of generation assets using current technologies rather than on new technology development. Conversely, most energy subsidies for nuclear and fossil fuels are focused on research and specific aspects of exploration and development. The wind and solar industries depend on subsidies for a far greater portion of their revenue than other forms of energy production. Wind and especially solar are still a small part of the overall energy industry—comprising 2.7 and 1 percent, respectively, of total U.S. energy production in 2019 (EIA 2020d)—and have produced much less energy per dollar of federal subsidies than other energy sources.

Key Points

- Over the past 10 years, wind, solar, nuclear, and fossil fuels have all received substantial federal subsidies—between $13 billion and $37 billion.
- Wind has received 17 times, and solar 75 times, more subsidies per unit of electricity generated than the average for oil, gas, coal, and nuclear since 2010.
- While wind and solar have received more subsidies than other energy sources in recent years, debates about energy subsidies should not revolve around which resources receive more. The focus should be on how energy subsidies distort markets and why those distortions should be removed.
- Studies that show certain resources receiving far more subsidies than others, especially studies that report hundreds of billions of dollars in U.S. energy subsidies, are relying on cherry-picked data or inflated definitions of subsidies.

Wind and solar subsidies also have a strong distorting effect on U.S. electricity markets, most notably in Texas (McConnell; Michaels). These market distortions—including artificially low or negative wholesale prices, increases in scarcity prices during periods of high demand and low wind and solar generation, inefficient use of existing assets, and increased transmission costs—are not incorporated in the subsidy values in this report. However, they are important to keep in mind when trying to understand the true and total costs of different subsidies.

Introduction

Like the infamous "Song That Never Ends," energy subsidies rarely go away once they are introduced. The fundamental philosophy behind energy subsidies is that energy markets are somehow biased toward certain resources, too slow to develop new technologies, and unable to account for environmental externalities. Therefore, governments must step in to assist new technologies and direct energy development toward energy resources that are purported to be cleaner and more sustainable than what energy markets are currently providing. As the new businesses or industries become viable, the government support can be removed.

However, experience has shown that this rarely happens. Subsidies create a group of businesses that depend on government support to remain profitable, and those businesses become very effective at lobbying politicians to maintain that support. Just as the end to the "Song That Never Ends" leads back to its beginning, the main effect of energy subsidies is to create demand for more subsidies in a self-perpetuating process that has wasted taxpayer money and distorted energy markets for decades.

One challenge in discussing the subject of energy subsidies is defining what is and is not a subsidy. This paper largely follows the conventions of the Energy Information Administration (EIA) and groups energy subsidies into three categories: tax expenditures, direct expenditures, and research and development (R&D) expenditures (EIA 2018). Loan guarantees are not considered here because their total fiscal impact is difficult to quantify, depending on which loans are repaid and to what extent (DOE 2020).

Tax expenditures are special provisions in the federal tax code to incentivize certain activities. The government calls them expenditures, but they actually represent lost revenue relative to what would be generated if the provisions did not exist. The Office of Management and Budget (OMB) defines and calculates over a hundred of them, including nearly two dozen for energy production (OMB, 150-154). This paper follows the OMB definitions, with a few exceptions, but there are ongoing debates about these definitions, including how to define the "baseline" tax code, about whether certain tax expenditures are in fact subsidies, and about how to calculate them (Zycher).

While tax expenditures have existed since the federal income tax was established in 1913 (H.R. 3321), the modern system of energy subsidies began with the price control-induced oil crises of the 1970s and the creation of the Department of Energy in 1977 (DOE 2019a). This period saw the rise of direct federal spending on energy projects, particularly for energy efficiency and renewable energy, and the rapid expansion of federal energy research beyond nuclear energy. The most notable developments came after President Carter signed the Energy Security Act into law in 1980 (DOE 2019a), which included the Solar Energy and Energy Conservation Act, the Renewable Energy Resources Act, and the U.S. Synthetic Fuels Corporation Act.

The stated goal of most energy subsidies in recent years has been to reduce our use of fossil fuel resources, especially oil and gas. In the past, the purported problem was the notion that we would soon not have enough oil and gas resources to meet our needs, the so-called peak oil theory. The primary problem now is the supposed threat of catastrophic climate change. Despite decades of warnings, neither of these problems has yet materialized in a meaningful way, except for occasional price spikes and some mild warming of the earth's atmosphere. Nevertheless, they persist as the main justifications for federal energy subsidies.

However, energy subsidies have failed to develop viable alternative energy sources that could achieve this goal of redirecting our energy markets away from fossil fuels. In 1980, 90 percent of our total energy consumed came from fossil fuels, with 69 percent from oil and gas (EIA 2019a). Forty years later, 80 percent of our energy comes from fossil fuels and 67 percent from oil and gas (EIA 2019a). Roughly equal shares of that 10 percent change came from increases in the use of nuclear and renewable energy (EIA 2019a). As this paper shows, the small shift toward renewables over the past two decades has come at a great cost to consumers and taxpayers.

Policymakers, energy market participants, and voters must wake up to the fact that the primary results of energy subsidies have been the distortion of energy markets, higher prices for energy consumers, and the incentive to create businesses that would not exist without government support. We should stop repeating the mistakes of the past and eliminate all state and federal energy subsidies so that energy markets can do what they have done well for decades, creating wealth and environmental quality for billions of people around the world.

Total Federal Energy Subsidies from 2010 to 2019

Regarding the often-debated question about whether wind, solar, or fossil fuels are more heavily subsidized, it should first be noted that all of those energy resources received more than $10 billion in federal subsidies over the past decade. From 2010 to 2019, solar and wind received the most federal subsidies, about $34 billion and $37 billion, respectively, while coal received $13 billion and oil and natural gas received $25 billion. Fossil fuels received more federal subsidies than wind and solar prior to 2010, whereas wind and solar have received more in the past decade and are forecast to receive substantially more from 2020 to 2029.

While the subsidy amounts for different resources are not too much different, the sources of federal financial support vary significantly. As shown in **Figure 1**, oil and natural gas received most of their subsidies from tax expenditures, whereas wind and solar received nearly half of their subsidies from direct expenditures. Coal and especially nuclear receive a larger proportion of their subsidies from DOE R&D funding than the other resources do. Digging a bit deeper into the nature of the different subsidy programs reveals more about how they affect the production of each resource and how they affect energy markets on the whole. Appendix C has a detailed list of the programs included in this analysis. Here, we will explain some of the larger subsidy programs and discuss their market impacts.

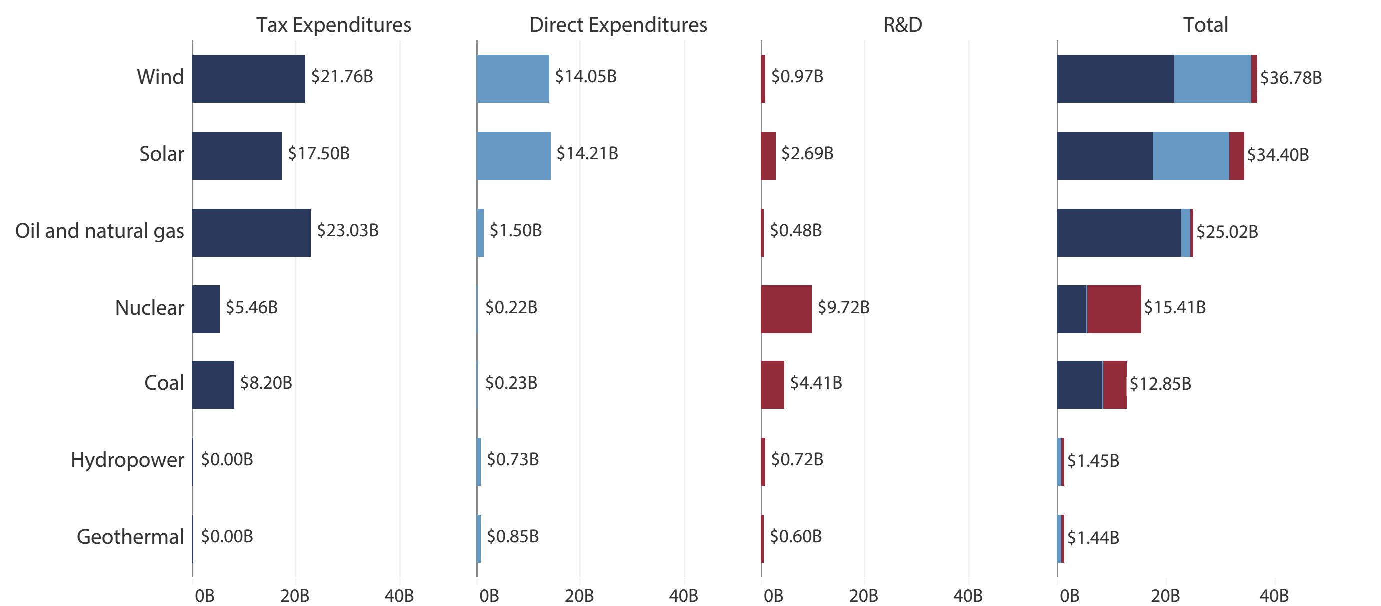
Tax Expenditures: Not All Are Created Equal

A key point about tax expenditures is that they vary significantly in their structures and their impacts on energy markets. They are the largest category of energy subsidies, accounting for more than half the total since 2010, and are also subject to the most controversy. This paper relies on OMB data to quantify tax expenditures and therefore largely follows the OMB's definitions (see sidebar). However, as mentioned in the introduction, alternative interpretations exist regarding whether certain tax provisions are in fact subsidies and what their market impacts are.

More than 90 percent of oil and gas subsidies quantified in this paper come from tax expenditures, and 76 percent comes from three specific tax expenditures: expensing of intangible drilling costs, excess of percentage cost over depletion, and master limited partnerships (MLPs). The classification of each of these tax provisions as subsidies is often challenged, and we count them as subsidies in this analysis for the sake of completeness and consistency with the rest of our work, not to make a definitive claim on their status. It is also important to clarify both how these tax provisions work and the fact that they have very small market impacts relative to tax expenditures for renewable energy resources.

The expensing of most or all intangible drilling costs in the first year is considered a subsidy by the OMB because normal tax treatment would dictate that the costs incurred during the creation of a capital asset, in this case an oil or gas well, would be depreciated over time. Because of the time value of money, expensing those costs in the first year reduces the real tax burden. However, it is often noted that exploration and drilling are more comparable to research and development activities in other industries (Zycher, 4),

Figure 1. Total federal energy subsidies from 2010 to 2019 (billions of 2019 USD)



Source: See Appendix C.

DEFINITIONS OF HIGH-VALUE FEDERAL TAX EXPENDITURES

Production Tax Credit

Also called a "Section 45 credit" in reference to its place in the tax code (26 U.S.C. 45), the PTC provides an inflation-adjusted tax credit to qualifying electricity production from one of nine renewable energy resources. The tax credits are priced per unit of electricity generation ($/MWh) and can be received for 10 years after the facility begins production. Wind receives the full value of the credit while other resources only receive half. Therefore, the vast majority of the PTC is applied to wind.

Investment Tax Credit

Also called a "Section 48 credit" (26 U.S.C. 48), this tax credit was created in the 1970s and is provided to offset a portion of the capital costs of commercial solar facilities. Originally set at a value of 10 percent, it was increased to 30 percent by the Energy Policy Act of 2005 (H.R. 6) but will be phased down to 10 percent by the end of 2022. The 2009 stimulus expanded the ITC to include most renewable energy technologies, but the vast majority still applies to solar.

Expensing of Intangible Drilling Costs

This tax provision (26 U.S.C. 263(c)), introduced in the Underwood Tariff Act of 1913 (H.R. 3321), and construction costs in the year that they occur instead of deducting them over the lifetime of a well. Non-integrated oil and gas companies—i.e., those that do not have pipeline or refinery operations—can deduct 100 percent of these costs in the first year, whereas integrated companies must deduct 70 percent in the first year and depreciate the remainder over the next five years (OMB 2019, 170).

Excess of Percentage Over Cost Depletion

This provision (26 U.S.C. 611-613A) allows independent oil and gas producers and royalty owners to deduct from their taxes a percentage of their income from an oil and gas well, instead of depreciating the costs of acquiring and developing the well over the lifetime of the well (OMB 2019, 170). The deduction is 15 percent of gross income, up to a limit of 100 percent of net income, which sometimes allows these companies to deduct more than the capital cost of the asset and to do so at a faster rate than through normal cost depletion.

in the sense that not every acre explored and not every well drilled becomes a capital asset that produces a product, or at least a consistent quantity of product. Therefore, despite the OMB classifying this provision as a tax expenditure, there is debate over whether it constitutes a subsidy.

Excess of percentage cost over depletion also suffers from some ambiguity as to its status. In theory, the baseline tax system would dictate cost depletion, in which the costs of developing and acquiring an asset are capitalized and then gradually reduced over its life (OMB, 170). Percentage depletion allows for depreciation relative to a producer's income, instead of to the capital cost of the asset. That fact in itself does not make this provision a subsidy, as the asset is still depreciated over time. However, percentage depreciation often allows the asset to be depreciated more quickly and allows depreciation beyond the total capital cost. To the extent that it does this, it is often considered a subsidy. But the structure of it and the fact that it is common to all extractive industries means that this classification is still debated.

MLPs utilize an exception in the tax code that allows certain types of energy companies to be taxed as partnerships instead of corporations while still being publicly traded (EIC). There is debate about whether the tax treatment of MLPs qualifies as a subsidy because limited partnerships are a standard business structure for private companies in many industries, and the EIA notably does not include MLPs in their analysis (EIA 2018, 25). However, we choose to include it here because it is counted as a tax expenditure by the Joint Committee on Taxation (JCT) and is consistent with our treatment of other tax expenditures. Currently, over 98 percent of the market capitalization of energy MLPs is in the oil and gas sector (Yorkville Capital Management), so we apply the JCT's numbers entirely to oil and natural gas.

The production and investment tax credits, while also classified as tax expenditures, are notably different in structure from these oil and gas tax provisions. They provide tax credits up to a certain amount per unit of electricity produced (PTC) or up to a certain percentage of a project's capital cost (ITC). Because the PTC and ITC cannot reduce a company's tax burden below zero, wind and solar developers will often partner with tax equity investors in order to take full advantage of the credits. The investors pay for a portion of a project's capital costs in return for the project's tax credits. The tax credits and revenues from selling electricity enable the wind or solar project to pay back its steep capital costs and provide a return to its investors.

Therefore, while the PTC and ITC are tax credits relative to the tax equity investors and the government, their effect on wind and solar developers and on electricity markets is more like that of direct expenditures. Because tax equity financing contributes a large portion of initial project capital and the marginal cost of operating is very low, with zero fuel cost, wind and solar generators are often incentivized to build units and produce as much electricity as possible regardless of market conditions. This is especially true for the PTC, which requires wind generators to produce energy to receive the subsidy, in some cases leading them to sell electricity at negative prices simply to receive the subsidy (McConnell). The PTC and ITC have a strong distorting effect on electricity markets, suppressing prices when wind and solar generation are high and causing high prices when wind and solar resources are low.

Another key problem with the PTC and ITC is that they do not require wind or solar generators to demonstrate an advancement in technology in order to qualify. Therefore, the tax credits primarily promote the scale-up of older technologies that can be deployed quickly rather than promoting new technologies that might improve the efficiency or reduce the cost and environmental impact of wind and solar. Contrast that with the recently issued tax credit for carbon capture utilization and storage (CCUS), which is supporting a technology that is not yet commercially demonstrated—the capture of carbon dioxide from an anthropogenic source (e.g., a power plant, refinery, or a steel mill) and its permanent sequestration underground. Add in the fact that DOE research funding for wind and solar accounted for only 7 percent of their total subsidies from 2003 to 2019, and it is evident that most federal subsidies for wind and solar are not well-targeted toward new technology development.

Direct Expenditures and R&D Expenditures

The second category of subsidies is direct expenditures, the largest of which by far are Section 1603 grants, so named after the provision's location in the American Recovery and Reinvestment Act of 2009 (H.R. 1 §1603), referred to hereafter as the 2009 stimulus. These grants were cash payments for up to 30 percent of a project's eligible cost that companies could take in lieu of the PTC or ITC, usually if they could not take full advantage of the tax credits. They were enacted as part of the 2009 stimulus and were exclusively available to renewable energy technologies that entered service between 2009 and 2013. According to Treasury data (Treasury), a total of $26.2 billion in grants were awarded, including $10.3 billion to solar and $13 billion to wind, and the last grant was awarded in November 2017.

Other direct expenditures include a wide variety of programs from the Department of Agriculture (DOA), especially the Rural Energy for America program, and from other agencies that are not normally associated with energy. While direct expenditures are probably what first comes to mind when a person thinks of subsidies, they represent less than a quarter of total subsidies from 2010-2019. Outside of the Section 1603 grants, they accounted for only about $8 billion in outlays from 2010 to 2019.

R&D expenditures are the third and smallest category of subsidies, constituting just under $20 billion since 2010. Coal and nuclear are the largest recipients of R&D expenditures, with $4.4 billion and $9.7 billion, respectively, since 2010 (see **Figure 1**). More than half of total nuclear subsidies and about a third of coal subsidies come from DOE R&D. While R&D spending might be assisting the growth of those industries through new technology development, it is not significantly affecting the profitability and survival of their core businesses. Therefore, it might be argued that R&D expenditures should not be counted in the same way as direct expenditures and tax expenditures.

Ultimately, the relevance of energy subsidies to the larger debate about energy resources in the U.S. boils down to their impact on energy markets. A common refrain from renewable energy advocates is that other energy sources would be more competitive if subsidies were not inducing more drilling for oil and gas and keeping oil and gas prices artificially low. However, the few billion dollars a year in U.S. subsidies pale in comparison to the multi-trillion-dollar global market for fossil fuels. The Bureau of Economic Analysis estimated that U.S. oil and natural gas extraction alone—not counting transportation, refining, and end uses—generated an average of $189 billion in economic activity annually from 2003 to 2017 (FRED 2020b), compared to an annual average of $2.1 billion in federal subsidies for the entire oil and gas industry over that time.

Despite declining prices for building wind and solar power plants, those industries are still far smaller than their fossil fuel competitors and far more dependent on subsidies for their survival. In 2019, wind and solar produced 300 TWh and 107 TWh of electricity (EIA 2020a) and received $4.3 billion and $4.4 billion in federal subsidies, respectively. In other words, they received about $14.40 and $40.74 in federal subsidies per MWh of electricity generated, amounts that are comparable to wholesale electricity

TREATMENTS OF EXTERNALITIES AND INDIRECT SUBSIDIES IN OTHER STUDIES

A significant problem in the literature on energy subsidies is that many studies expand the definition of a subsidy to give the impression that developed nations still subsidize fossil fuels and nuclear far more than renewable energy sources. The fact that governmental bodies such as the International Monetary Fund (IMF) and World Bank propagate many of these flawed subsidy definitions makes the problem even worse (Coady et al.; Flochel and Gooptu).

One of the most common mischaracterizations of subsidies is classifying energy-related poverty assistance programs as subsidies for fossil fuels. For example, the Low-Income Home Energy Assistance Program (LIHEAP) pays out several billion dollars annually to assist low-income households with heating and electricity bills, far more than any single subsidy for energy production. Some studies call "end-use" programs like this one a fossil fuel subsidy (Whitley et al., 6), when the goal of the subsidy has nothing to do with supporting fossil fuels. The same error is often made when classifying tax breaks that are not directed at energy industries but that benefit certain energy companies. While these programs are market-distorting and, for the most part, ineffective policies, we do not classify them as energy subsidies.

Some studies go even further by trying to quantify environmental and societal costs related to our use of fossil fuels, such as air pollution, global warming, and car accidents. Not only is it an egregious overstatement to classify these assumed costs as subsidies, but there are also numerous scientific flaws in how these supposed costs are calculated.

These studies often attribute hundreds of billions of dollars in costs to air pollution from fossil fuels (Coady et al. 13; Flochel and Gooptu 16), even though the vast majority of the United States is "in attainment" with national air quality standards (EPA). The idea that current levels of air pollution in the U.S. are causing measurable public health consequences is being heavily criticized both inside and outside the EPA (Cox et al.; White and Bennett), yet these studies proceed as if there is a definite cost that constitutes a subsidy for fossil fuels.

The most recent IMF study goes even further and classifies the future costs of global warming as a fossil fuel subsidy. The study uses a price of $40 per ton of CO2 emissions (Coady et al., 9), which includes forecasted damages more than a century into the future, to claim that the U.S. subsidizes fossil fuel CO2 emissions to the tune of more $200 billion annually (Coady et al.). Even if the U.S. eliminates all fossil fuel CO2 emissions by 2030, the rise in global temperatures by 2100 would likely only be reduced by 0.14 degrees Celsius (Bennett), hardly enough to mitigate $200 billion in annual damages.

The IMF study also quantifies increased costs related to traffic congestion and car accidents as a fossil fuel subsidy (Coady et al., 13), even though increasing the use of hybrid and electric vehicles will not reduce accidents and congestion. Such costs are more logically tied to the design of our cities and transportation systems than to a government-induced advantage for fossil energy. Expanding public transportation or forcing people to use it may reduce congestion and accidents but will increase taxes and other societal costs.

While these studies inflate the societal costs of fossil fuels, they also ignore (1) the enormous societal benefits of using domestic, affordable, and energy-dense fuels and (2) the costs, both societal and environmental, of alternative energy sources.

Inflating the definition of a subsidy and trying to classify certain externalities as subsidies only serve to confuse the public and policymakers and increase support for more government intervention in energy markets. Using the standard definition of a subsidy as a government payment or tax break to support a certain type of energy production leads to the conclusion that fossil fuels and nuclear do not receive more federal subsidies than wind or solar.

prices in many areas of the country. Even as the cost to build wind and solar power plants declines, the electricity they produce becomes less valuable as more generation is built. Therefore, as wind and solar generation reach saturation levels in many markets, new builds will likely decline or stop without additional subsidies.

Historical Trends in Federal Energy Subsidies

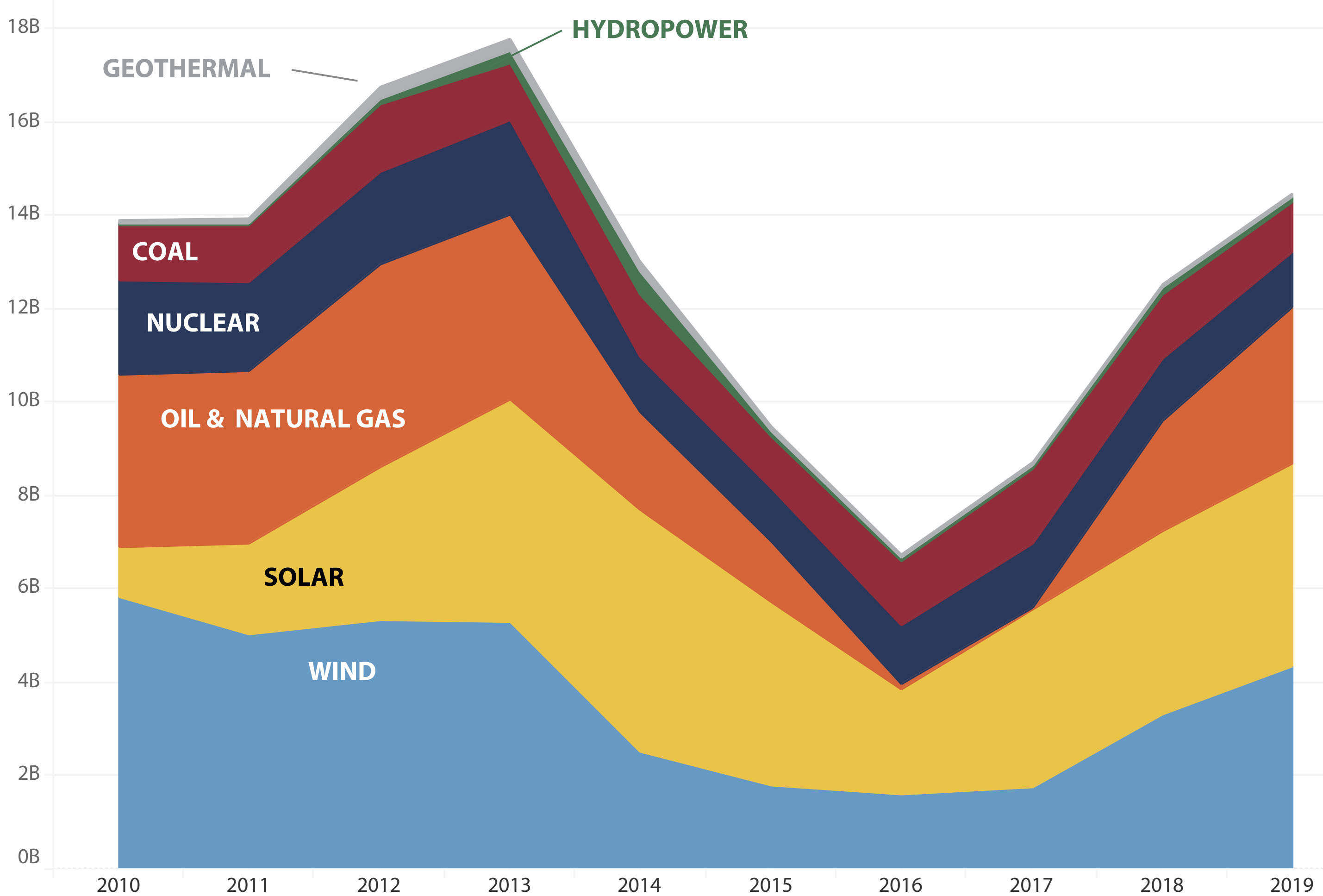
One reason the debate over energy subsidies is often confusing is that most studies look at only a single year or a discontinuous subset of years. As **Figure 2** shows, the subsidies for each resource can vary widely from year to year, which makes it imperative to look at averages over a longer period—such as the 10 years highlighted in this study. Examining the evolution of subsidies over time also provides a more complete picture of the effects of policies being enacted.

Oil and natural gas subsidies come primarily in the form of tax provisions that are permanent features of the tax code. Those subsidies are largely dependent on the amount of activity and the profitability of oil and gas companies. From 2010 to 2013, oil prices were high, and drilling and exploration boomed. Then from 2014 to 2017, as prices sank and activity dwindled, oil and gas subsidies shrank dramatically. The decline was also driven by the expiration at the end of 2013 of a temporary measure that allowed for special expensing of certain refinery equipment. This tax expenditure is discussed further in Appendix C.

Coal has received most of its support since 2010 from tax provisions allowing for the amortization of pollution control equipment and for carbon capture and sequestration research and demonstration programs. Subsidies for nuclear are primarily DOE research funds and have been very consistent since 2010. Hydropower and geothermal received some boosts in direct expenditures from programs in the 2009 stimulus, but, otherwise, subsidies for those two energy sources have been relatively low.

Section 1603 of the 2009 stimulus provided more than $23 billion directly toward the capital costs of new wind and solar projects from 2009 until the last award in 2018. These funds constituted a large majority of wind and solar

Figure 2. Annual federal energy subsidies from 2010 to 2019 (billions of 2019 USD)



Source: See Appendix C.

Table 1. Total federal energy subsidies by decade from 2003 to 2020 and forecasted tax expenditures from 2020 to 2029 (thousands of 2019 USD)

Subsidy Category	2003-2009	2010-2019	2020-2029
Solar	1,832,763	34,396,471	26,920,000
Wind	5,649,669	36,775,850	33,750,000
Hydropower	605,076	1,453,016	0
Geothermal	252,854	1,444,460	0
Nuclear	10,110,230	15,406,083	100,000
Coal	24,183,293	12,847,537	3,750,000
Oil and natural gas	18,888,018	25,016,144	27,260,000
Energy efficiency	10,816,860	57,200,867	10,130,000
Bioenergy	30,046,669	44,464,690	0
Transmission	8,838,308	2,856,905	200,000

Source: See Appendix C.

subsidies from 2010 through 2013. Programs through the Department of Agriculture, such as the Rural Energy for America program, have added another $2.7 billion in direct expenditures. In recent years, the PTC and ITC returned to being the primary wind and solar subsidies. In 2019, wind and solar each received more than $3 billion from the PTC and ITC, respectively, making them the most subsidized energy resources in the most recent year of available data.

The reason this study focuses on the past decade is to capture the full effect of subsidy policies following the 2009 stimulus, most of which are still in place, while avoiding subsidies that have long expired and are not currently affecting energy markets. However, it is still useful to look further back to 2003, which is the first year with complete data from many of our sources.

As shown in **Table 1**, fossil fuel subsidies were dominant prior to 2010. While the PTC and ITC existed prior to 2010, the wind and solar industries were so small that they did not take in many subsidies. Coal subsidies were elevated by the alternative fuels production credit, a program resulting from the peak oil scare that sought to produce synthetic fuels from coal. Contrary to most subsidies, this credit largely expired in 2007 and went away entirely in 2013, accounting for the large drop in coal subsidies in recent years. Over the entire 2003 to 2019 timeframe, wind, solar, coal, and oil and natural gas all received comparable amounts of federal subsidies.

While this study focuses on technologies used for electricity generation, we also include energy efficiency, bioenergy (primarily biofuels), and transmission in this table for completeness. Bioenergy took in almost as much in subsidies as wind and solar combined from 2003 to 2019, the majority of which came from tax credits for ethanol and biodiesel. That number does not account for the subsidy impacts of the renewable fuel standard, which is difficult to quantify. Energy efficiency expenditures grew dramatically after the 2009 stimulus, especially from the Weatherization Assistance Program and tax credits for energy efficiency improvements to homes and businesses. These programs remain popular ways to funnel money to favored constituencies, despite research showing that they have low or negative rates of return (Fowlie et al.).

While the past offers useful lessons, it is important to consider the impacts of current and proposed policies on energy markets over the next decade. The OMB, which is our primary source for tax expenditure data, forecasts those expenditures forward 10 years in their annual report, and we show the cumulative totals in **Table 1**[1]. Even if the PTC and ITC are not extended beyond their current phaseout periods, wind and solar will dominate future subsidies. Oil and natural gas will also be large recipients because their tax credits are not set to expire. OMB does not provide a forward forecast for bioenergy tax expenditures, leading to the zero in that ledger, but the continuation of those tax credits and the renewable fuel standard are all but certain.

On the positive side for taxpayers, direct expenditures are likely to be a small part of future subsidies, with the exception of subsidies for solar and bioenergy through Department of Agriculture programs. Coal and nuclear subsidies will continue to come primarily from R&D spending—likely on the order of $5 billion and $12 billion, respectively, if current trends in DOE appropriations hold. R&D spending for other resources will likely be low relative to total subsidies. If taxpayers can take some solace from these forecasts, it is that current policies are not set to increase subsidies over the next decade.

Federal Subsidies for Electricity Generation

Because wind, solar, hydroelectric, geothermal, and nuclear are only used for electricity generation, whereas fossil fuels are also used for heating, transportation, and other applications, the effects of different subsidies are often compared within the context of electricity markets. In order to make this comparison, we adjust the subsidies for natural gas, oil, and coal by the percentage of the total energy from those

1 Some tax expenditure data was sourced from the Joint Committee on Taxation, which only forecasts tax expenditures through 2023. More information can be found in Appendix C.

fuels used for electricity production each year. The adjustment method is described in detail in Appendix E, and the adjusted subsidy totals are shown in **Figure 3**.

When measuring the impact of subsidies, it is important to compare the amount of subsidies to the size of the industry, and in electricity, the most common measure of size is net generation, i.e., the amount of electricity that is actually put into the electric grid. **Figure 4** shows the trends in U.S. net generation for each resource from 2010 to 2019.

Until 2015, coal was the largest source of electricity in the U.S., comprising 46 percent of U.S. net generation as late as 2010. It has since been overtaken by natural gas. Because it is difficult to separate the subsidies for oil and natural gas, we continue to keep them grouped together. While some petroleum coke and liquids are still used for electricity generation, oil's contribution to U.S. net generation has declined from about 3.1 percent in 2003 to 0.5 percent in 2019 (EIA 2020a).

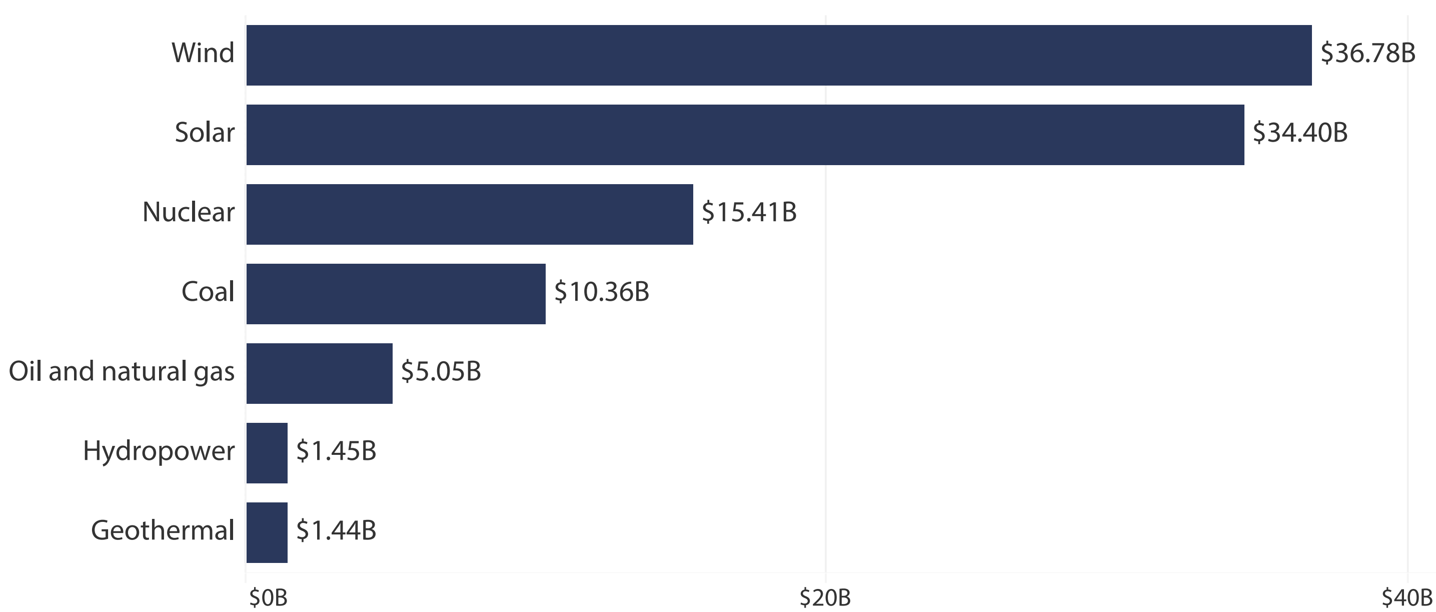
Nuclear and hydroelectric generation remained steady as very few expansions or closures occurred during this period. Wind and solar have risen steadily but still only comprised 7.4 percent and 2.3 percent, respectively, of U.S. net generation in 2019 (EIA 2020a). Only in 2019 did wind overtake hydroelectric as the largest source of renewable electricity in the U.S.

Dividing total federal subsidies from 2010 to 2019 (**Figure 3**) by total electricity generated (**Figure 4**) provides a common metric for the subsidies received relative to the size of the industry, which is shown in **Figure 5**. Clearly, solar has received the most subsidies per unit of electricity because it is one of the largest recipients of subsidies while producing the second least amount of electricity since 2010. Wind is second on this list because, while it produced more electricity than solar, it is still a small part of the U.S. electricity mix. Nuclear and fossil fuels generate much more electricity relative to the subsidies they received, which indicates they are less dependent on subsidies for their revenue and profitability than wind and solar.

Another way to view this data is to compare the amount of subsidies to the value of electricity from these energy sources. DOE estimates place the average wholesale value of electricity from wind in 2018 between $17/MWh and $41/MWh, depending on the regional market, with the largest wind markets (ERCOT, SPP, and MISO) all at or below $22/MWh (DOE 2019c, 65). Therefore, we estimate that wind generators on average have received nearly as much money from subsidies as they have from selling electricity in these markets. Similar DOE estimates for the wholesale value of solar electricity are not available, but given that the average wholesale price of electricity in the U.S. in 2018 was about $44/MWh (EIA 2020b), it is likely that the subsidy/revenue ratio for solar is greater than1:1.

A major problem for wind and solar is that, absent the ability to store their electricity and dispatch it during periods of high demand and high prices, they will depress prices during the times when they are producing electricity and

Figure 3. Total federal subsidies for electricity generation, 2010 to 2019 (billions of 2019 USD)



Source: See Appendix C.

increase prices when they are not producing. These market distortions are becoming more evident in regions with high wind and solar penetration, especially in Texas (McConnell; Michaels), which, despite increasing wind generation capacity, has seen more fossil fuel generation used during high demand periods (Potomac Economics, 26) and increased scarcity pricing (18). As a result, average wholesale market prices almost doubled from 2016 to 2019 despite little change in natural gas prices (7).

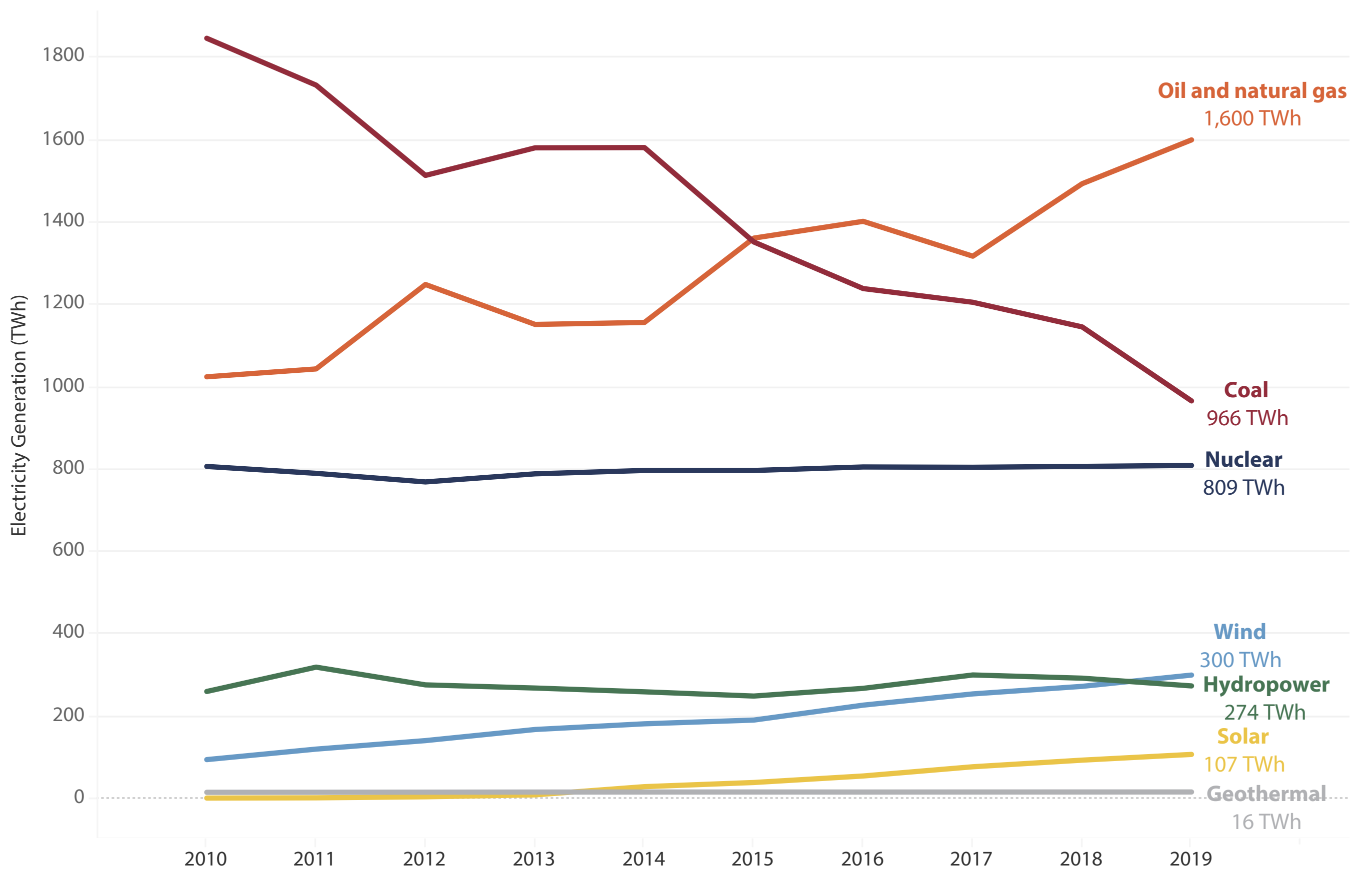
Conclusion

Unfortunately for U.S. taxpayers and advocates for limiting government intervention in energy markets, energy subsidies have become a permanent feature of the U.S. energy landscape. Without political pressure from taxpayers and energy consumers, the prospect of reducing energy subsidies and preventing the creation of new subsidies is dim. While the PTC is set to expire in 2021 and the ITC is set to phase down to 10 percent, the growing size and lobbying power of the wind and solar industries, along with the consistent drumbeat from the environmental lobby to reduce carbon dioxide emissions by building more wind and solar, will keep up the pressure for further extensions. Plans for hastening an "energy transition" to renewable energy, such as the multitude of proposed Green New Deals, would only serve to increase the problems and costs of government intervention exponentially.

Meanwhile, many of the tax breaks for oil and gas production are permanent features of the tax code with no set expiration dates, and new programs for carbon capture and other technologies will expand the scope of fossil fuel subsidies into the foreseeable future. As explained above, most of these subsidies have fewer market-distorting effects than wind and solar subsidies, particularly on electricity markets. However, their existence perpetuates the idea that all energy production is subsidized and justifies more government interventions in the U.S. energy economy.

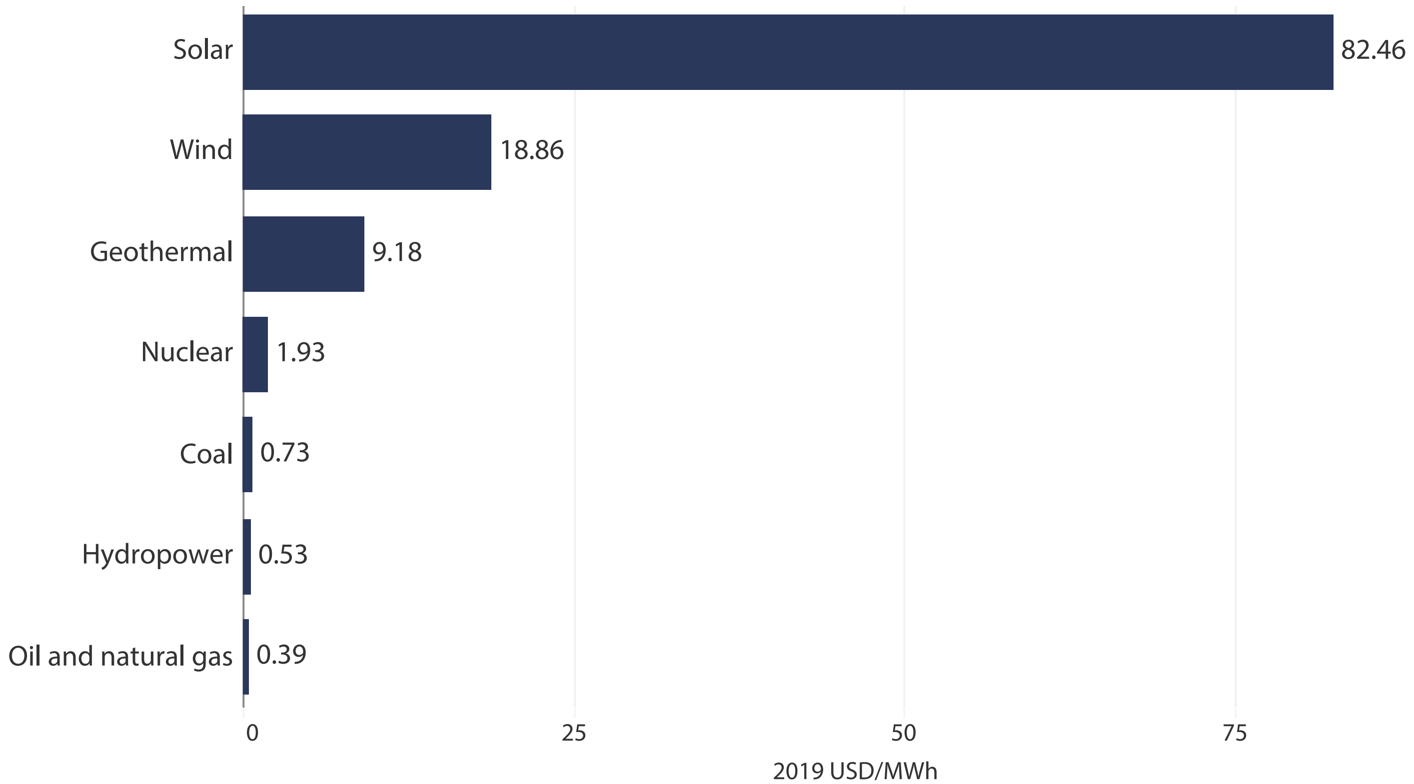
Another problem that confounds the policy landscape is the multitude of studies that are designed and written to give the impression that fossil fuels and nuclear receive far more subsidies than renewable energy sources. The fact that many of these flawed studies come from governmental bodies like the IMF makes the problem even worse. Attempts to classify inflated externalities as subsidies and failures to document the effects of subsidies on energy markets, especially

Figure 4. U.S. net electricity generation by source, 2010-2019 (TWh)



Source: EIA Electricity Data Browser (EIA 2020a)

Figure 5. Federal subsidies per unit of electricity generated, 2010 to 2019 (2019 USD/MWh)



electricity markets, do not advance the goal of eliminating energy subsidies and improving energy markets. We hope this paper will encourage policymakers to move past the arguments about which energy sources receive the most subsidies and to learn more about the market-distorting effects of subsidies that harm energy consumers, businesses, and taxpayers.

Instead of correcting supposed flaws in energy markets, energy subsidies create more flaws by fostering industries and subindustries that depend on government support for their existence and profitability. As with all forms of cronyism, energy subsidies benefit politically connected businesses at the expense of taxpayers who do not notice the effects enough to demand changes. In order to effect that change, voters and businesses that pay for the subsidies should pressure lawmakers to eliminate these damaging policies.

References

Bennett, Brent. 2019. "Data: Banning Fossil Fuels Won't Stop Climate Change." *Life:Powered*, November 6.

CBO (Congressional Budget Office). 2012. *Federal Financial Support for the Development and Production of Fuels and Energy Technologies*. CBO.

CBO (Congressional Budget Office). 2015. *Federal Support for the Development, Production, and Use of Fuels and Energy Technologies*. CBO.

CFDA (Catalog of Federal Direct Assistance). 2020. "*Index of /pub/outgoing/govs/singleaudit*." U.S. Census Bureau. Accessed April 8.

Coady, David, Ian Parry, Nghia-Piotr Le, and Baoping Shang. 2019. *Global Fossil Fuel Subsidies Remain Large: An Update Based on Country-Level Estimates*. International Monetary Fund.

Cox, Louis Anthony, James Boylan, Mark W. Frampton, Sabine Lange, Corey M. Masuca, and Steven C. Packham. 2019. "CASAC Review of the EPA's Policy Assessment for the Review of the National Ambient Air Quality Standards for Particulate Matter (External Review Draft – September 2019)." U.S. Environmental Protection Agency Clean Air Scientific Advisory Committee, December 16.

Damodaran, Aswath. 2020. "Effective Tax Rate by Industry." Accessed January 20.

Dinan, Terry. 2017. "Federal Support for Developing, Producing, and Using Fuels and Energy Technologies." Testimony to the U.S. House Committee on Energy and Commerce, Subcommittee on Energy, March 29.

DOA (Department of Agriculture). 2020. "Application Data Downloads: Energy Investments Map Data." Accessed March 27

DOE (Department of Energy). 2019a. "Timeline of Events: 1971-1980." Accessed December 13.

DOE (Department of Energy). 2019b. "Budget (Justification & Supporting Documents)." Accessed December 13.

DOE (Department of Energy). 2019c. *2018 Wind Market Technologies Report*. DOE.

DOE (Department of Energy). 2020. "Loan Programs Office: Portfolio Projects". Accessed June 22.

EIA (Energy Information Administration). 2008. *Federal Financial Interventions and Subsidies in Energy Markets 2007*. EIA.

EIA (Energy Information Administration). 2018. *Direct Federal Financial Interventions and Subsidies in Energy in Fiscal Year 2016*. EIA.

EIA (Energy Information Administration). 2019a. "Primary Energy Consumption by Source." Accessed December 13.

EIA (Energy Information Administration). 2019b. "Electric Sales, Revenue, and Average Price: Residential average monthly bill by Census Division and State." Last updated October 1.

EIA (Energy Information Administration). 2020a. "Electricity Data Browser." Accessed March 20.

EIA (Energy Information Administration). 2020b. "Wholesale Electricity and Natural Gas Market Data." Last updated January 16.

EIA (Energy Information Administration). 2020c. "Electric Power Sector Energy Consumption." Accessed January 27.

EIA (Energy Information Administration). 2020d. "Primary Energy Overview." Accessed March 27.

EIA (Energy Information Administration). 2020e. "Coal Consumption by Sector." Accessed January 27.

EIC (Energy Infrastructure Council). 2020. "Basic Tax Principles." Accessed January 27.

EPA (Environmental Protection Agency). 2020. "Current Nonattainment Area Counties for All Criteria Pollutants." Last updated February 29.

Erickson, Angela C. 2018. *The Production Tax Credit: Corporate Subsidies and Renewable Energy*. Texas Public Policy Foundation.

FRED (Federal Reserve Economic Data). 2020a. "Consumer Price Index for All Urban Consumers: All Items Less Food and Energy in U.S. City Average." Accessed January 27.

FRED (Federal Reserve Economic Data). 2020b. "Gross Domestic Product by Industry: Private Industries: Mining: Oil and Gas Extraction for United States." Accessed January 27.

Flochel, Thomas, and Sudarshan Gooptu. 2018. *Guidance for Comprehensive Energy Subsidy Reforms: Energy Subsidy Reform Assessment Framework (ESRAF) Good Practice Note, Overview*. World Bank.

Fowlie, Meredith, Michael Greenstone, and Catherine Wolfram. 2018. "Do Energy Efficiency Investments Deliver? Evidence from the Weatherization Assistance Program." *Quarterly Journal of Economics* 133(3): 1597–1644.

GAO (Government Accountability Office). 2007. "Oil and Gas Royalties: Royalty Relief Will Cost the Government Billions of Dollars but Uncertainty Over Future Energy Prices and Production Levels Make Precise Estimates Impossible at this Time." Agency comments, April 12.

GAO (Government Accountability Office). 2008. *Oil and Gas Royalties: The Federal System for Collecting Oil and Gas Revenues Needs Comprehensive Reassessment*. GAO.

GAO (Government Accountability Office). 2013. *Oil and Gas Resources: Actions Needed for Interior to Better Ensure a Fair Return. Report to the Chairman, Senate Committee on Energy and Natural Resources*. GAO.

GAO (Government Accountability Office). 2014. *Information on Federal and Other Factors Influencing U.S. Energy Production and Consumption from 2000 through 2013*. GAO.

Griffiths, Benjamin W., Gürcan Gülen, James S. Dyer, David Spence, and Carey W. King. 2017. *Federal Financial Support for Electricity Generation Technologies*. University of Texas at Austin Energy Institute.

H.R. 1. 2009. Enacted. 111th United States Legislature.

H.R. 6. 2005. Enacted. 109th United States Legislature.

H.R. 3321. 1913. Enacted. 63rd United States Legislature.

IER (Institute for Energy Research). 2011. *EIA Releases New Subsidy Report: Subsidies for Renewables Increase 186 Percent*. IER.

IER (Institute for Energy Research). 2015. *EIA Report: Subsidies Continue to Roll In For Wind and Solar*. IER.

IER (Institute for Energy Research). 2018. *EIA Report: Renewable Energy Still Dominates Energy Subsidies*. IER.

Internal Revenue Code. Title 26.

JCT (Joint Committee on Taxation). 2019a. "Publications on Tax Expenditures." Accessed December 13.

JCT (Joint Committee on Taxation). 2019b. *Estimates of Federal Tax Expenditures for Fiscal Years 2019-2023*. JCT.

Koplow, Doug. 2011. *Nuclear Power: Still Not Viable Without Subsidies*. Union of Concerned Scientists.

McConnell, Charles. 2018. *The Cautionary Tale of Wind Energy in ERCOT*. Texas Public Policy Foundation.

Michaels, Robert. 2019. *Intermittent Generation Comes to Texas: The High Cost of Renewable Energy*. Texas Public Policy Foundation.

OMB (Office of Management and Budget). 2020. *Analytical Perspectives, Budget of the United States Government, Fiscal Year 2021*. OMB.

Potomac Economics. 2020. *2019 State of the Market Report for the ERCOT Electricity Markets*. Potomac Economics.

Treasury. 2019. "1603 Program: Payments for Specified Energy Property in Lieu of Tax Credits." Accessed December 13.

White, Kathleen Hartnett, and Brent Bennett. 2019. *EPA's Pretense of Science: Regulating Phantom Risks*. Texas Public Policy Foundation.

Whitley, Shelagh, Han Chen, Alex Doukas, Ipek Gençsü, Ivetta Gerasimchuk, Yanick Touchette, and Leah Worrall. 2018. *G7 fossil fuel subsidy scorecard: Tracking the phase-out of fiscal support and public finance for oil, gas, and coal*. Overseas Development Institute.

Yorkville Capital Management. 2020. "Master Limited Partnerships: Asset Class Breakdown." Accessed January 22.

Zycher, Benjamin. 2017. "Do Federal Energy-Related Tax Policies Improve Economic Well-Being?" Testimony to the U.S. House Committee on Energy and Commerce, Subcommittee on Energy, March 29.

Appendix A: Previous Reviews of Federal Energy Subsidies

This paper is far from the first to catalog and comment on federal energy subsidies. Several government reports along with numerous academic research papers and studies from nonprofit organizations have sought to define what energy subsidies exist and how much they cost. However, most of these studies look only at subsidies in the year or two prior to their publishing date or consider only certain types of energy subsidies, rather than compiling a complete set of data over multiple years. This practice leads to confusion because energy subsidies can vary dramatically from year to year depending on policies and market conditions. All energy subsidies are also not created equal. Subsidies for different energy sources tend to come through different avenues and have very different effects on energy markets.

The Energy Information Administration publishes a report every three years titled "Direct Federal Financial Interventions and Subsidies in Energy" (EIA 2018). The upside to this report is that it is comprehensive of all types of energy production and uses all available government data. Most of the methodology detailed in the next section follows the EIA's methodology. This report's downside is that it only takes annual snapshots, rather than looking at all the data over the three years since the prior report.

Many studies rely on EIA data or follow their methodology, including this study. Previous work from our group has taken this approach, with a particular focus on wind subsidies (Erickson). The University of Texas at Austin's Energy Institute released a study in 2017 (Griffiths et al.) that largely follows the EIA's methodology but explores in greater detail the different types of financial assistance and the practical effects of those subsidies on energy markets.

The Institute for Energy Research, a non-profit research institute focused on energy policy, has released a brief report following each of the last three EIA reports (IER 2011; IER 2015; IER 2018) detailing how wind and solar received more subsidies than fossil fuels in recent years, especially relative to the size of the respective industries. To perform this comparison, they divide the total subsidies for each resource by the amount of electricity generated by that resource to get the subsidy amount per megawatt-hour (MWh). We perform a similar comparison in this report.

The Government Accountability Office has released several reports over the past decade and a half. A 2014 report (GAO 2014) commissioned by Sen. Lisa Murkowski offered the most comprehensive review of energy subsidies performed up until that time, covering all subsidies granted from 2000 to 2013. Other GAO studies include reviews of oil and gas royalty payments on federal lands in 2007 (GAO 2007), 2008 (GAO 2008), and 2013 (GAO 2013), in particular the effects of the Outer Continental Shelf Deep Water Royalty Relief Act of 1995. Outside of the obvious subsidies granted in that bill, it is not well-determined whether the royalty rates on most federal lands are below market rates and constitute a subsidy. This topic will be discussed further in Appendix D, where we outline different forms of possible financial support that we did not include in this paper.

The Congressional Budget Office has produced a series of reports and congressional testimony over the past decade under the title "Federal Support for the Development, Production, and Use of Fuels and Energy Technologies" (CBO 2012; CBO 2015; Dinan). These reports cover the longest time series, at least 30 years, but they only offer a detailed breakdown of the data for the most recent year.

By compiling annual data back to 2003, with a particular focus on the past decade, we can look at average subsidies over a long period and see the trends in different subsidies over time. Much of the discussion about energy subsidies has been confused by misunderstandings about what qualifies as a subsidy, the disparate impacts of different types of subsidies, and the large year-to-year variations in subsidy amounts. We hope this paper can help clarify that discussion and serve as a valuable reference for policymakers and energy policy observers.

Appendix B: Methodology

In general, this paper follows the methodology used by the EIA in their latest report (EIA 2018) but compiles data every year instead of in three-year increments. The three primary forms of financial support covered in that report are tax expenditures, direct expenditures, and research and development spending. We chose not to include loan guarantees because the value of those subsidies is difficult to quantify and because they are infrequently used outside of some one-time programs from the 2009 stimulus. In total, we estimate that this report covers over 90 percent of federal subsidies directed toward energy-producing industries, excluding biofuels and end-use subsidies. A complete list of the federal programs covered in this report is provided in Appendix C.

This report emphasizes the energy industries that have some role in electricity production—coal, natural gas, petroleum, wind, solar, hydroelectric, geothermal, and nuclear. The purpose of this restriction is to enable a more even comparison between renewable resources that only produce electricity and fossil fuels that have a variety of other end uses. This distinction helps eliminate the complexities of including subsidies for transportation fuels, heating fuels, electric vehicles, and other products. Some data on those subsidies are mentioned briefly here but are not within the scope of this study.

An important comparison is the subsidies per unit of electricity produced from each energy resource. Because natural gas, petroleum, and coal have other end uses aside from producing electricity, we apply a conversion factor when making this comparison that reduces the subsidies for those fuels by the percentage used for electricity production. While we report the total amount of subsidies throughout the paper, in the section on subsidies for electricity, we only consider these adjusted amounts. This adjustment is described in greater detail in Appendix E.

As noted in the introduction, tax expenditures are the oldest and most common form of energy subsidy. Tax expenditures primarily take the form of reduced taxes or accelerated depreciation for certain activities and materials and tax credits that can be sold and traded to finance certain types of energy projects. While the former directly reduce the tax bill of the energy producer, the latter reduce the tax bill for a financing company while providing extra capital or revenue for the energy producer.

Our primary source of tax expenditure data is the Office of Management and Budget's *Analytical Perspectives* reports on the federal budget (OMB). In a couple of cases where OMB data was missing, noted in Appendix C, we use data from the Joint Committee on Taxation's annual Estimates of Federal Tax Expenditures (JCT 2019a).

Direct expenditures are, as the name suggests, direct financial support for commercial projects. These types of programs were not common until the late 1970s but have become more prevalent in the past decade. Over the period from 2003 to 2019, Section 1603 grants (Treasury) for renewable energy from the 2009 stimulus and rural energy programs within the Department of Agriculture (DOA) account for a large portion of direct expenditures.

Following the EIA's methodology (EIA 2018), we also include a wide variety of programs supporting oil and gas, coal, and nuclear energy, most of which can be found in the Catalog of Federal Direct Assistance (CFDA). Direct expenditures to support energy consumption are not counted in this study. Some of these expenditures, e.g., the Low-Income Heating Assistance Program (LIHEAP), are very large, costing billions of dollars over the past 15 years. However, this study considers only subsidies that directly support energy production, not end-use subsidies that support certain energy resources as a side effect. A full list of federal programs that are excluded from this study is provided in Appendix D.

Research and development grants are awarded to governmental institutions, academia, and private businesses in order to achieve goals such as national defense, public health, or, in this case, energy technologies that are more affordable and less harmful to the environment. The main premise of federal R&D spending is that private markets tend to underinvest in high-risk research or basic research without a near-term commercial purpose. Therefore, it is in the national interest for the federal government to invest in these types of projects.

This paper only covers R&D spending under the DOE, using the data from the agency's annual budgets (DOE 2019b). The Statistical Tables by Appropriation section breaks down the R&D expenditures by each energy technology. Department of Defense energy R&D spending is not included because those projects are usually developed to support specific military applications and not to develop energy technologies for public use, although sometimes certain technologies do make their way into the public domain.

Finally, all dollar values are reported in constant 2019 dollars, adjusted for inflation using the consumer price index, excluding food and energy, from the St. Louis Federal Reserve Bank (FRED 2020a).

Appendix C: Financial Support Included in This Analysis

Tables A1 to A7 provide a detailed list of the programs included in this analysis and their total value from 2003 to 2019. For all tables in Appendices C and D, all amounts are in thousands of constant 2019 dollars. The references under the Source column are all provided in the Methodology section of the paper.

A couple of key assumptions for solar and wind subsidies are that the ITC is used entirely for solar and the PTC entirely for wind. The ITC applies to many different types of energy projects, but the EIA found that the vast majority went to solar (EIA 2018, 23). A separate ITC for homeowners, also called the "Credit for Residential Energy Efficient Property" (26 U.S.C. 25D), applies to several kinds of home energy generation technologies. While it is likely that the vast majority have been used for solar PV installations, we follow the EIA and count it as an end-use subsidy (EIA 2018, 27).

Table A1. Financial support for solar

Program	Total Assistance	Source
Energy investment credit (ITC, assumed to be all solar)	17,880,862	OMB
Credit for residential purchases and installations of solar and fuel cells (assumed to be all solar)	179,845	OMB
Section 1603	11,195,704	Treasury
Department of Agriculture	3,112,401	DOA
Solar energy R&D	3,860,422	DOE
Total Solar	**36,229,233**	

Wind became eligible for either the ITC or PTC following the 2009 stimulus, but it is not possible to determine in any given year how many projects took one credit or the other. Following the EIA's methodology (EIA 2018, 23), we assume that any wind projects not taking Section 1603 grants received the PTC. The JCT finds that more than 95 percent of the PTC goes to wind energy producers in most years (JCT 2019a), so we choose to apply the PTC entirely to wind in this analysis.

Table A2. Financial support for wind

Program	Total Assistance	Source
Energy production credit (PTC)	21,759,274	OMB
New technology credit (PTC)	3,907,154	OMB
Section 1603	14,722,501	Treasury
Department of Agriculture	541,812	DOA
Wind energy R&D	1,494,777	DOE
Total Wind	**42,425,519**	

Hydropower and geothermal electricity production received no tax credits from 2003 to 2019 but did receive support from Section 1603 grants, the DOA, and consistent R&D spending.

Table A3. Financial support for hydropower

Program	Total Assistance	Source
Section 1603	587,523	Treasury
Department of Agriculture	200,658	DOA
Hydroelectric R&D	1,269,911	DOE
Total Biofuels	**2,058,092**	

Table A4. Financial support for geothermal

Program	Total Assistance	Source
Section 1603	838,054	Treasury
Department of Agriculture	15,682	DOA
Geothermal R&D	843,579	DOE
Total Biofuels	**1,697,314**	

A large subsidy for nuclear comes in the form of a reduced tax rate for decommissioning, which was created by the Energy Policy Act of 2005 (H.R. 6) to facilitate the sale of aging nuclear plants. Befitting the origins of the DOE as the Atomic Energy Commission, nuclear continues to receive more R&D than any other energy generation technology.

Table A5. Financial support for nuclear

Program	Total Assistance	Source
Reduced tax rate for nuclear decommissioning funds	9,963,353	OMB
Advanced nuclear power production credit	0	OMB
Nuclear waste disposal siting	181,698	OMB
Transport of transuranic waste	409,761	CFDA
Nuclear Education Grant Program	41,652	CFDA
Nuclear R&D	14,919,850	CFDA
Total Nuclear	**25,516,313**	

In the 2000s, the largest subsidy for coal production was the alternative fuel production credit, which provided a tax credit for plants producing synthetic fuel from coal and biomass. This credit expired after 2007, although a portion of the credit for coke and coke gas applied to plants that were placed into service before 2010. Coal has received relatively few direct expenditures but did receive more than $3 billion in R&D funding from the 2009 stimulus.

Table A6. Financial support for coal

Program	Total Assistance	Source
Amortization of certain pollution control facilities	4,708,151	JCT
Credit for investment in clean coal facilities	2,296,920	OMB
Capital gains treatment of royalties on coal	2,161,577	OMB
Exclusion of special benefits for disabled coal miners	758,037	OMB
Alternative fuel production credit	14,619,325	OMB
Clean Coal Power Initiative	2,199	CFDA
Carbon capture and storage - Future Gen	214,479	CFDA
University Coal Research	45,433	CFDA
Coal R&D	12,224,710	DOE
Total Coal	**37,030,830**	

One program for oil and natural gas that bears some further explanation is the temporary 50 percent expensing for the equipment used in the refining of liquid fuels (26 U.S.C 179C). This tax provision was enacted in the 2005 Energy Policy Act (H.R. 6) and allowed for accelerated cost recovery for refinery investments up to the end of 2013. It also applied to biomass refining (26 U.S.C. 45K), but since it is unclear how much applied to different types of refineries, we follow the EIA (EIA 2018, 25) by applying the entire provision to oil and gas.

This tax expenditure is unique in that it is negative over the life of the program. A negative tax expenditure occurs when a provision provides a less favorable treatment than normal income tax law (JCT 2019b, 3), i.e., the opposite of a subsidy. Sometimes, this situation can occur temporarily when a tax break causes tax payments to be shifted over time, which is the case here. However, both OMG and JCT data show that there was more negative expenditure after the provision's expiration in 2013 than there was positive expenditure before it. None of the reports explain why this is the case, but for the sake of consistency, we choose to follow their accounting and simply note the discrepancy.

Table A7. Financial support for oil and natural gas

Program	Total Assistance	Source
Alternative fuel and fuel mixture tax credit	4,476,027	OMB
Excess of percentage over cost depletion, fuels	14,294,029	OMB
Natural gas distribution pipelines treated as 15-year property	1,622,116	OMB
Amortize all geological and geophysical expenditures over 2 years	1,463,178	OMB
Exception from passive loss limitation for working interests in oil and gas properties	490,026	OMB
Expensing of exploration and development costs, fuels	10,479,380	OMB
Temporary 50 percent expensing for equipment used in the refining of liquid fuels	-3,075,166	OMB
Marginal wells credit	183,009	OMB
Enhanced oil recovery credit	2,583,971	OMB
Pass through low sulfur diesel expensing to cooperative owners	52,364	OMB
Expensing of capital costs with respect to complying with EPA sulfur regulations	85,643	OMB
Exception for publicly traded partnership with qualified income derived from certain energy-related activities	8,565,215	JCT
Industrial CCS application	76,486	CFDA
State Heating Oil and Propane Program	5,151	CFDA
Clean Diesel Emissions reduction	562,723	CFDA
State Clean Diesel Grant Program	247,187	CFDA
Pipeline Safety Program base grant	526,244	CFDA
Pipeline Safety Program one call grant	10,202	CFDA
Air Emissions and Energy Initiative	1,681	CFDA
Clean fuels	297,940	CFDA
Oil and natural gas R&D	956,757	DOE
Total oil and natural gas	**43,904,163**	

Table A8. Financial support for biofuels

Program	Total Assistance	Source
Alcohol fuel credits	1,279,757	OMB
Biodiesel and small agri-biodiesel producer tax credits	793,804	OMB
Alcohol fuel exemption	42,216,178	OMB
Biodiesel producer tax credit	20,764,229	OMB
Section 1603	1,504,063	CFDA
Department of Agriculture	3,343,936	CFDA
Biofuel Infrastructure Partnership	61,475	CFDA
Bioenergy Program for Advanced Biofuels	46	CFDA
Biomass Crop Assistance Program	16	CFDA
State Bulk Fuel Revolving Fund Grants	11,080	CFDA
Forest Biomass for Energy	299	CFDA
Repowering assistance	246	CFDA
Community Wood Energy Program	29	CFDA
Regional Biomass Energy Programs	99,195	CFDA
Bioenergy R&D	4,437,003	DOE
Total Biofuels	**74,511,359**	

Appendix D: Financial Support Not Included in This Analysis

As mentioned briefly in the methodology, this analysis only covers subsidies for energy resources used in electricity generation. By design, it does not cover subsidies for alternative transportation fuels, electric vehicles, and energy consumption or end-use subsidies. This appendix will explain a few of the important subsidies in these categories and show how large some of them are, often larger than the subsidies for electricity generating technologies that receive far more attention. These subsidies will be the focus of future studies.

Biofuels take in far more subsidies than any other energy resource—more than $60 billion from 2003 to 2019—and receive many other forms of support through mandates like the Renewable Fuels Standard. Because biofuels are not used for electricity generation, and their markets are largely separate from the fuels used for electricity, we do not include them in this study.

Subsidies for energy efficiency programs also topped $60 billion over the 2003 to 2019 period. The EIA includes these subsidies in their reports, but we do not include them because they are consumer programs that only affect electricity demand and do not apply to any specific electricity production technologies.

Table A9. Financial support for energy efficiency programs

Program	Total Assistance	Source
Credit for residential energy efficient property	12,269,930	OMB
Credit for energy efficiency improvements to existing homes	13,545,324	OMB
Exclusion of utility conservation subsidies	4,872,438	OMB
Credit for construction of new energy-efficient homes	1,220,640	OMB
Allowance of deduction for certain energy-efficient commercial building property	1,178,719	OMB
Qualified energy conservation bonds	618,587	OMB
Credit for energy-efficient appliances	1,602,783	OMB
Weatherization Assistance Program	9,799,043	DOE
Weatherization Assistance Program LIHEAP	6,196,061	LIHEAP
Department of Agriculture	1,172,225	CFDA
Energy Efficiency and Conversation Block Grant Program	4,549,973	CFDA
Energy Efficiency Appliance Rebate Program	366,616	CFDA
Green Retrofit Investments Program	510,759	CFDA
Energy Efficiency R&D	7,126,518	DOE
Total Energy Efficiency	**65,029,618**	

Electric vehicles and alternative fuel vehicles also receive significant tax credits and R&D support, nearly $10 billion over the past 16 years. The tax credits for clean fuel-burning vehicles and refueling property apply to plug-in electric vehicles, alternative fuel vehicle refueling property, two-wheeled electric vehicles, and fuel cell vehicles.

Table A10. Financial support for vehicle technologies

Program	Total Assistance	Source
Tax credits for clean fuel-burning vehicles and refueling property	5,770,509	OMB
Vehicle technology R&D	5,167,956	DOE
Total Vehicles	**10,938,464**	

Certain transmission and utility assets receive favorable depreciation and expensing in the tax code, and the DOE has spent several billion dollars on electricity delivery R&D, with more than $4 billion from the 2009 stimulus. Although a large portion of new transmission over the past several years has been built to support wind and solar development, these subsidies are not directed toward any specific generation technology and therefore cannot be categorized as is done in this study.

Table A11. Financial support for electricity delivery and reliability

Program	Total Assistance	Source
15-year MACRS for certain electric transmission property	1,330,495	JCT
Deferral of gain from dispositions of transmission property to implement FERC restructuring policy	1,711,426	OMB
5-year carryback period for certain net operating expenses of electric utility companies	126,819	JCT
Electricity delivery and energy reliability R&D	8,426,472	DOE
Total Electricity Delivery and Reliability	**11,595,213**	

Subsidies for energy consumption, also called end-use subsidies, are by far the largest category of energy subsidies, thanks to the Low-Income Home Energy Assistance Program (LIHEAP), which spent nearly $50 billion during the past 16 years.

We also include the Strategic Petroleum Reserve (SPR) and other energy reserve programs in this category because their purpose is to support energy consumers, not energy producers.

Table A12. Financial support for energy consumption

Program	Total Assistance	Source
Low Income Home Energy Assistance Program	48,087,756	LIHEAP
Strategic Petroleum Reserve	3,791,651	DOE
Naval Petroleum & Oil Shale Reserve	345,099	DOE
Northeast Home Heating Oil Reserve	140,359	DOE
Total End-Use	**52,364,864**	

Programs to provide royalty relief to oil and gas companies drilling on federal land may be considered an in-kind subsidy if royalties are not being paid at market rates. According to a 2008 GAO study (GAO 2008), royalty relief offered to oil companies in the 1990s when oil prices were low may have led to $21 billion to $53 billion in unrealized revenue during the 2000s when oil prices were high. However, both the GAO and EIA (EIA 2008, 13) note that optimizing royalty rates is difficult in light of future price uncertainty and the balance of lower royalties vs. higher revenues from leasing. While the GAO places a large value on the royalty relief programs, that value is, in fact, very difficult to quantify. Following the EIA methodology, we do not count royalty relief programs as a subsidy in this analysis.

There are also many subsidy programs that apply to multiple energy technologies and therefore cannot be used for comparative purposes. Most of these programs apply to renewable energy technologies and cannot be broken out by individual technologies. An example is the Industrial CO_2 Capture and Sequestration tax credit, which incentivizes power plants to install carbon capture technologies to reduce CO_2 emissions. Because this tax credit can be used by coal or natural gas power plants, it is difficult to calculate how much of an impact this tax expenditure has on each type of technology.

Table A13. Unclassified forms of financial support

Program	Total Assistance	Source
State Energy Program	4,638,884	CFDA
State Energy Program Special Projects	303,108	CFDA
Partial expensing for advanced mine safety equipment	36,079	JCT
Credit for business installation of qualified fuel cells and stationary microturbine power plants	200,097	OMB
Advanced energy manufacturing facility investment tax credit	1,811,579	OMB
Industrial CO_2 capture and sequestration tax credit	1,007,900	OMB
Exclusion of interest on energy facility bonds	651,502	OMB
Credit for holding clean renewable energy bonds	1,289,331	OMB
Renewable energy outreach	533,832	CFDA
Green Jobs Innovation Fund Grants	1,079,085	CFDA
Capital Assistance Program	236,289	CFDA
Denali Commission Program	1,406,912	CFDA
Advanced Research Projects Agency - Energy	3,225,153	DOE
Total Unclassified	**16,419,751**	

Appendix E. Natural Gas, Petroleum, and Coal Subsidies for Electricity

When comparing the total subsidies for electricity generation, it is important to note that natural gas, petroleum, and coal have a wide variety of uses outside of electricity, whereas wind, solar, hydroelectric, geothermal, and nuclear are used solely for electricity. About 20 percent of the total energy we produce from natural gas and petroleum are used for electricity, with the rest going to transportation, heating, and other uses (EIA 2020b; EIA 2020c). Seventy-eight percent of our coal production is used for electricity production, with the rest being used for steel, combined heat and power production, and exports (EIA 2020d).

When comparing subsidies for electricity production, we account for these alternative uses of coal, natural gas, and oil by multiplying the total subsidy by the percentage of energy production that is used for electricity.

$$Energy\ Subsidy\ \$_{Fuel\ X,\ Year\ i} \times \frac{Energy\ Used\ in\ Electricity_{Fuel\ X,\ Year\ i}}{Total\ Energy\ Produced_{Fuel\ X,\ Year\ i}} = Electricity\ Subsidy\ \$_{Fuel\ X,\ Year\ i}$$

Using the formula above, we calculated an adjustment factor for coal, natural gas, and oil each year from 2003-2019 and used the adjusted numbers, as noted in the paper, to compare subsidies for electricity generation. The energy used for electricity generation (EIA 2020b) and the total energy produced (EIA 2020c) from each fuel source comes from the EIA.

ABOUT THE AUTHORS

Brent Bennett, Ph.D., is a policy analyst for Life:Powered, an initiative of the Texas Public Policy Foundation to reframe the national discussion on energy and the environment. As part of the Life:Powered team, Dr. Bennett regularly speaks with policymakers, energy experts, and industry associations across the country, and he has written extensively on how America has improved its environment while growing its energy use. Prior to joining the Foundation, Dr. Bennett worked for a startup company selling carbon nanotubes to battery manufacturers, and he continues to provide technology consulting to energy storage companies.

Dr. Bennett has an M.S.E. and Ph.D. in materials science and engineering from the University of Texas at Austin and a B.S. in physics from the University of Tulsa. His graduate research focused on advanced chemistries for utility-scale energy storage systems.

Karl Schmidt, Jr., was a research associate for the Texas Public Policy Foundation. He has worked in the Office of the Texas Governor and in other state and federal offices and campaigns. His interests include energy policy, financial markets, and automation. He studies quantitative finance and government at the University of Texas at Austin.

Gary Faust was a research associate for the Texas Public Policy Foundation. He is an independent journalist, freelance writer, podcaster, content creator, and radio contributor. He also works as a reporter for a Texas-based talk show. Faust studied English at Santa Barbara City College and is at the University of Texas at Austin studying journalism.

About Texas Public Policy Foundation

The Texas Public Policy Foundation is a 501(c)3 non-profit, non-partisan research institute. The Foundation promotes and defends liberty, personal responsibility, and free enterprise in Texas and the nation by educating and affecting policymakers and the Texas public policy debate with academically sound research and outreach.

Funded by thousands of individuals, foundations, and corporations, the Foundation does not accept government funds or contributions to influence the outcomes of its research.

The public is demanding a different direction for their government, and the Texas Public Policy Foundation is providing the ideas that enable policymakers to chart that new course.

Texas Public Policy Foundation

901 Congress Avenue | Austin, Texas 78701 | 512.472.2700 | www.TexasPolicy.com