

No. 147 — February 2018

### Public Policy and Coal-Fired Power Plants

By Isaac Orr and Fred Palmer\*  
*Third in a Series*

#### Introduction

Why would anyone scrap perfectly good high-quality computers, smartphones, or cars for more costly, lower quality, and less reliable products? Yet, that is exactly what policymakers do when they push coal-fired power plants into early retirement.

More than 250 coal-fired plants in the United States have been retired since 2010, taking more than 34,000 megawatts of power generation capacity offline.<sup>1</sup> Coal’s share of the electricity generation market fell from 50 percent in 2008 to around 31 percent in 2017.<sup>2</sup>

<b>Introduction</b> .....	1
<b>Part 1: Premature Coal-Plant Closures Increase Electricity Prices</b>	
Cost Advantages of Existing Generation Sources .....	4
Consequences for Coal-Reliant States .....	8
Importance of Competition and Fuel Switching.....	9
South Australia: A Cautionary Tale.....	11
<b>Part 2: Government Intervention Distorts Wholesale Power Markets</b>	
Auctioning of Power .....	16
Federal Subsidies .....	19
State-Level Subsidies and Mandates.....	23
Billions in Additional Transition Costs Due to Renewables .....	25
Case Study: Increasing Infrastructure Costs in Colorado .....	28
<b>Part 3: Premature Retirement of Coal Plants Harm Families, Enterprises, and Coal-Mining Communities</b>	
Low-Income Households Hurt the Most .....	30
Eroding the Manufacturing Base.....	32
Case Study: Manufacturing Suffers in California.....	35
Blackouts: Bad for Business .....	38
Impact on Coal-Mining Communities .....	41
<b>Part 4: Concluding Observations</b> .....	43
<b>About the Authors</b> .....	44

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<sup>1</sup> Trevor House, *et al.*, [Can Coal Make a Comeback?](#) Center on Global Energy Policy, April 2017.

<sup>2</sup> U.S. Energy Information Administration, [“Coal,” Short Term Energy Outlook](#), September 12, 2017.

Most of the retired plants, 88 percent, were older, smaller units with a generating capacity of less than 250 megawatts.<sup>3</sup> Recently, however, younger, more efficient plants with larger generation capacities have been slated for retirement before the end of their useful generating lives.

The average service life of a coal-fired power plant is between 35 and 50 years. Larger, more modern plants can be retrofitted to generate low-cost power with fewer emissions for decades beyond this lifespan.<sup>4</sup> The average age of the coal power plant fleet is currently 38 years, and these facilities have the potential to generate affordable electricity for decades to come.<sup>5,6</sup>

Prematurely retiring coal-fired power plants and replacing them with renewables and natural gas will cost consumers billions of dollars.

The premature retirements of many of the nation's coal-fired power plants were the result of increasing competition for electricity generation from natural gas power plants and Obama-era regulations, particularly rules limiting carbon dioxide emissions from power plants, the Mercury

and Air Toxics Standards, and New Source Review rules. Those regulations made operating coal-fired power plants more expensive.<sup>7</sup>

Other Obama-era policies also have contributed to the premature closure of coal-fired power plants. For example, federal subsidies for wind- and solar-powered electricity generation have distorted wholesale power markets and made it difficult for baseload power generators, such as coal and nuclear power plants, to remain competitive, even though they can produce the lowest-cost electricity when consistently generating large, steady quantities of electricity.

Part 1 of this *Policy Study* discusses how the premature retirement of coal-fired power plants increases electricity prices for consumers because on average, these plants generate electricity at lower cost than the electricity generators that would replace them. Premature retirement of coal-fired power plants will cost consumers billions of dollars in the form of higher electricity prices, high regulatory compliance costs, subsidies for renewable generation technologies, construction of unneeded electricity generation capacity and transmission lines, and lost economic opportunities, especially in energy-intensive industries like manufacturing.

Part 2 discusses how state renewable energy mandates (REMs) and federal subsidies to renewable energy sources, primarily wind and solar, distort wholesale power markets to the detriment of coal-fired power plants. These policies have played a significant role in the closure

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<sup>3</sup> Benjamin Storrow, "[Coal: Big, Younger Plants are Closing. Is it a New Trend?](#)" *E&E News*, April 27, 2017.

<sup>4</sup> Penny Hitchin, "[How Upgrades Can Make Old Plants Bloom.](#)" *Power Magazine*, October 1, 2011.

<sup>5</sup> U.S. Department of Energy, [Staff Report to the Secretary on Electricity Markets and Reliability](#), August 2017.

<sup>6</sup> U.S. Energy Information Administration, "[Coal Made Up More Than 80% of Retired Electricity Generation Capacity in 2015.](#)" *Today in Energy* (website), March 8, 2016.

<sup>7</sup> *Ibid.*

of these plants. In addition to distorting wholesale power markets, subsidies for renewables impose a substantial burden on taxpayers.

Part 3 discusses the real-life impact these policies have on families, businesses, manufacturers, and coal mining communities. Part 4 offers concluding observations.

## Part 1

### Premature Coal-Plant Closures Increase Electricity Prices

Electricity prices have risen approximately 36 percent since 2003, even while prices for natural gas were falling and prices for coal essentially remained flat. (See Figure 1.)<sup>8</sup>

Figure 1  
U.S. Residential Electricity Price



 Source: Short-Term Energy Outlook, July 2017

Electricity prices have increased nearly 36 percent since 2003, even though coal prices increased only slightly and natural gas prices have fallen by 71 percent since 2008. *Source:* U.S. Energy Information Administration, “[Coal Made Up More Than 80% of Retired Electricity Generation Capacity in 2015](#),” *Today in Energy* (website), March 8, 2016.

<sup>8</sup> U.S. Energy Information Administration, “[Electricity in the United States](#),” May 10, 2017.

One reason for the price jump is the premature retirement of existing power plants, particularly coal and nuclear power plants. Premature retirement refers to the closure of power plants that would otherwise continue to produce the lowest-cost electricity if not for regulatory burdens imposed by federal or state rules and regulations meant to drive these facilities out of business.

A second reason for increasing electricity prices is government policies that skew markets in favor of renewable energy: federal subsidies for renewables and state-level renewable energy mandates that require utilities to build renewable capacity and additional transmission infrastructure that is not needed to meet consumer demand.

## A. Cost Advantages of Existing Generation Sources

Prematurely retiring existing coal-fired power plants puts upward pressure on electricity prices because, on average, existing power plants generate electricity at significantly lower costs than do new plants.<sup>9</sup>

Existing power plants can generate electricity for less than new power plants because they have already paid off much or all of the up-front capital and financing costs needed to build them.

As Figure 2 shows, existing coal-fired power plants generate reliable electricity at an average cost of \$39.9 per megawatt-hour (MWh). Existing natural gas facilities generate electricity for about \$34.4/MWh; nuclear facilities for \$29.1/MWh; and hydroelectric resources for \$35.4/MWh.

Each of these existing resources generates electricity at approximately one-third the cost of new onshore wind facilities, which cost \$107.4/MWh, and at about one-fourth the cost of solar, which costs \$140.3/MWh.<sup>10</sup> Existing coal, nuclear, and natural gas resources also generate electricity at a cost that is, on average, approximately 28 percent less than new natural gas generating units.<sup>11</sup>

Existing power plants can generate electricity for less than new power plants because they have already paid off much or all of the up-front capital and financing costs needed to build them. Much like it is less expensive to live in a house after the mortgage has been completely paid off, existing power plants have less overhead and are able to reduce their prices and still make a profit on the electricity they sell. (See Figure 3.)

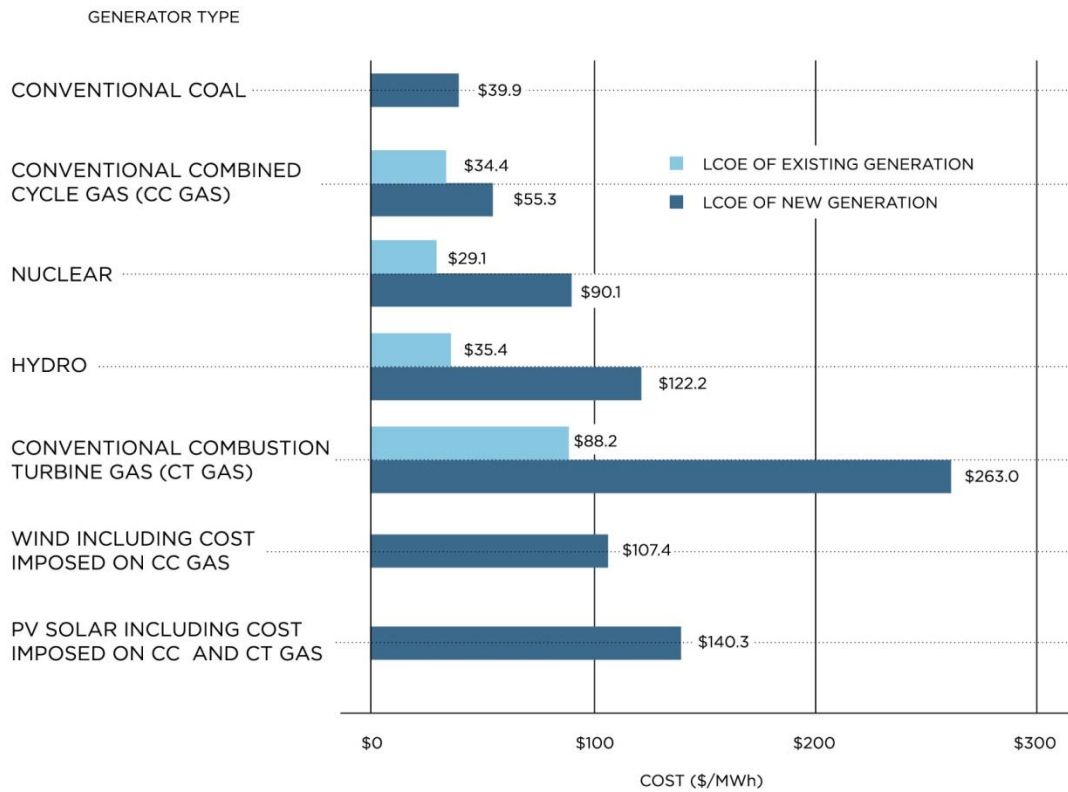
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<sup>9</sup> Tom Stacy and George Taylor, [The Levelized Cost of Electricity from Existing Generation Resources](#), Institute for Energy Research, July 2016.

<sup>10</sup> *Ibid.*

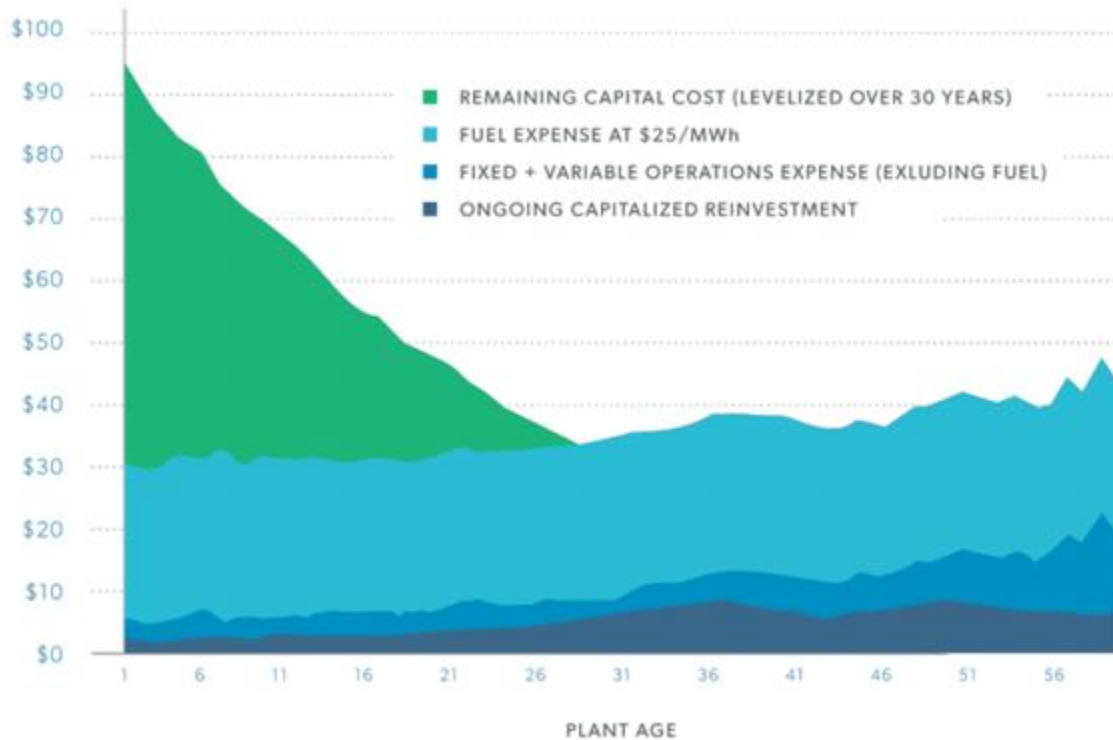
<sup>11</sup> *Ibid.*

**Figure 2**  
**Levelized Cost of Electricity**



Electricity generation from existing natural gas, coal, nuclear, and hydro power is significantly less expensive than new generating resources. In many cases, existing electricity resources can generate electricity for one-third of the cost of new wind power and one quarter of the cost of new solar. *Source:* Tom Stacy and George Taylor, [The Levelized Cost of Electricity from Existing Generation Resources](#), Institute for Energy Research, July 2016, page 5 (text color modified for readability).

**Figure 3**  
**LCOE from Coal in 2012 \$/MWh by Plant Age**  
**30-Year Outlook**

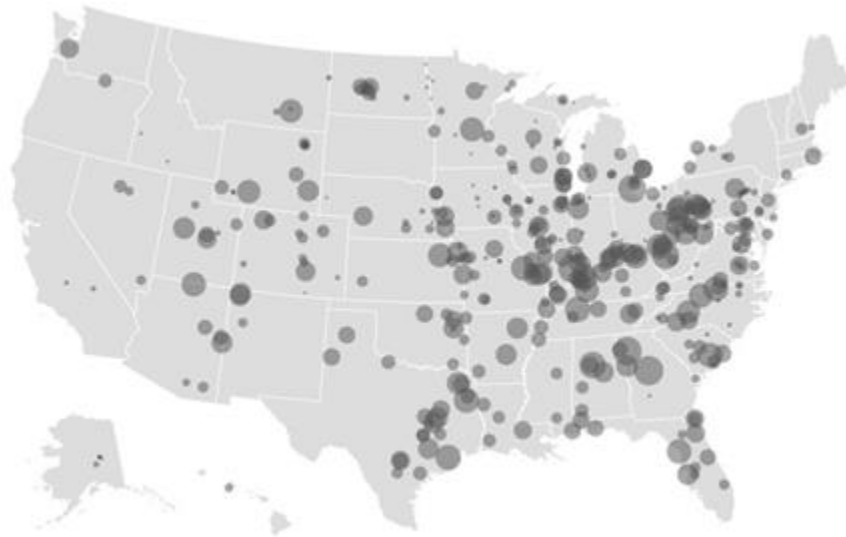


Analyses of the changes in going-forward costs for both coal and nuclear plants show these costs increase by less than 1 percent per year over the observed age distribution of existing plants. At an average age of 38 years, the typical existing coal-fired power plant will likely not be economic to retire and replace for another decade or more. *Source:* Tom Stacy and George Taylor, [The Levelized Cost of Electricity from Existing Generation Resources](#), Institute for Energy Research, July 2016, page 22.

Some four hundred coal-fired power plants currently generate electricity in the United States. (See Figure 4.) Coal-fired plants historically have been the largest source of electricity generation in the United States and are currently responsible for approximately one-third of U.S. electricity generation. Prematurely shuttering these facilities will have the largest impact on the electricity sector, causing electricity prices to increase significantly while reducing reliability.

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**Figure 4**  
**Coal-Fired Power Plants in the United States**



Coal use in the United States is concentrated most heavily east of the Mississippi River. Shuttering these coal-fired power plants will require them to be replaced with higher-cost sources of electricity, causing electricity prices to rise. Source: John Muyskens, Dan Keating, and Samuel Granados, "[Mapping How the United States Generates its Electricity](#)," *Washington Post*, March 28, 2017.

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As existing power plants are shut down before the end of their useful lives, they will be replaced with newer power plants that are inherently more expensive to build and operate because they must repay the debt used to finance their construction. These higher costs will be passed on to ratepayers: residential consumers, businesses, and manufacturers.

Ratepayers will benefit from the lowest possible electricity rates only if existing generating resources are kept in operation until the cost of operating those facilities exceeds the cost of replacing them.<sup>12</sup> Power plant owners must be permitted to make those cost calculations on a level playing field, without government penalties on existing plants or subsidies to renewable energy sources that distort energy markets.

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<sup>12</sup> Tom Stacy and George Taylor, *supra* note 9.





According to research conducted by Roger Bezdek and Frank Clemente, if all coal-fired power plants in these states were retired, electric rates would increase by:

- 50 percent or more in Indiana;
- 35 to 40 percent in Iowa;
- 30 to 40 percent in Michigan;
- 50 percent or more in Missouri;
- 40 to 50 percent in Ohio;
- 50 percent or more in West Virginia; and
- 30 to 40 percent in Wyoming.<sup>14</sup>

Electricity price increases have a two-fold impact on ratepayers. First, families are harmed directly because they must pay higher prices for the electricity they use. This is especially burdensome for low-income families, who spend a higher portion of their incomes on necessities, including electricity.

Second, increasing electricity prices hurt employers and businesses, ultimately hurting their employees and customers. This harm will be discussed in detail in a later section of this paper.

Low electricity prices are especially vital for American manufacturers. They compete in a global marketplace with businesses in other countries, most of which have lower labor costs and fewer regulations than the United States. The importance of low electricity prices to the manufacturing sector will be discussed in greater depth later in this paper.

Competition unfettered by irresponsible regulation will allow consumers, businesses, and families to benefit from the most efficient resource mix providing the lowest-cost electricity.

### **C. Importance of Competition and Fuel Switching**

Those who wish to eliminate coal-fired power plants claim they are no longer necessary for electricity generation because hydraulic fracturing has made natural gas cheap and abundant. They point to lower natural gas prices as a key reason retail electricity prices fell in 2016 for the first time in 14 years.<sup>15</sup>

However, electricity prices are expected to be 3 percent higher in 2017 than they were in 2016. The cost of natural gas delivered to electric generators rose to an average of \$3.53 per million

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<sup>14</sup> Roger Bezdek and Frank Clemente, [Protect the American People: Moratorium on Coal Plant Closure Essential](#), June 2014.

<sup>15</sup> Energy Information Administration, "[U.S. Residential Electricity Prices Decline for the First Time in Many Years](#)," *Today in Energy* (website), October 6, 2016.

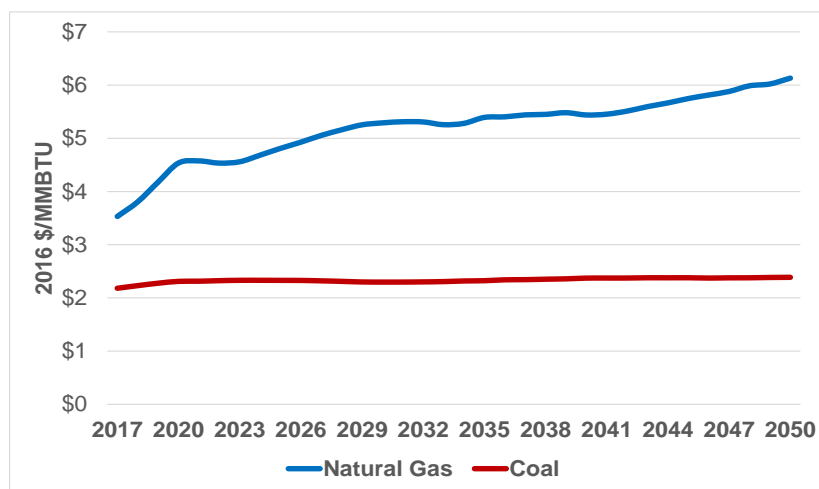
British thermal units (BTU) in the first half of 2017, an increase of 37 percent compared to the approximately \$2.23 per BTU paid for natural gas in the first half of 2016.<sup>16</sup>

As a result, the share of electricity generated from natural gas in the United States is expected to fall from 34 percent in 2016 to 31 percent in 2017. Coal's share of the electricity generation portfolio is expected to inch up from 30 percent in 2016 to 31 percent in 2017 due to higher natural gas prices and a 2 percent decrease in coal costs in 2017 compared to 2016.<sup>17</sup>

Historically, natural gas prices have been more volatile than coal prices. In recent years, fracking has led to low, more stable prices. That may change in the near future; as the United States becomes a net exporter of natural gas, there is reason to believe natural gas prices may increase.

The Energy Information Administration (EIA) projects natural gas costs to the utility sector will increase much more rapidly than coal costs through 2050.<sup>18</sup> (See Figure 6.) EIA expects natural gas costs to increase (in 2016 dollars) at an annual average rate of 2.1 percent, while coal costs will increase just 0.3 percent a year. Natural gas is currently 60 percent more expensive than coal; by 2050, EIA projects natural gas will be 2.6 times as expensive as coal. Over time, this increasing price difference will tend to shift demand to coal power generation.<sup>19</sup>

**Figure 6**  
**Costs to the Utility Sector**



Source: U.S. Energy Information Administration, [Annual Energy Outlook 2017](#), January 5, 2017.

<sup>16</sup> U.S. Energy Information Administration, "[Residential Electricity Prices up 3% in First Half of 2017](#)," *Today in Energy* (website), September 25, 2017.

<sup>17</sup> U.S. Energy Information Administration, *supra* note 2.

<sup>18</sup> U.S. Energy Information Administration, [Annual Energy Outlook 2017](#), January 5, 2017.

<sup>19</sup> Management Information Services Incorporated, [Analyzing and Estimating the Economic and Job Benefits of U.S. Coal](#), prepared for the U.S. Department of Energy, September 2017.

Low natural gas prices in recent years have resulted in low electricity costs for consumers and industry, but those benefits might disappear if lawmakers and regulators do not permit coal and natural gas to continue to compete for market share in electricity markets. Market conditions for these fuels are always changing, and regulations must not prevent the market from responding appropriately.

For example, new liquefied natural gas (LNG) capacity coming online in the near future could allow the country to export as much as 40 percent of current natural gas production by 2020.<sup>20</sup> If not balanced by an increase in production, those exports could lead to an increase in domestic

Market conditions for coal and natural gas are always changing, and regulations must not prevent the market from responding appropriately.

natural gas prices. Increasing natural gas prices would drive up electricity prices, especially if electricity generators do not have the option to use coal when market conditions dictate it would be the lowest-cost producer of electricity.

Additionally, coal is primarily used for electricity generation, while natural gas is also used for heating. Approximately half of the homes in the United States use natural gas for heating.<sup>21</sup> By law, utilities must prioritize natural gas delivery for heating.<sup>22</sup> If demand for natural gas for home heating spikes, residential consumers are given first priority over electricity generators for the natural gas. This causes large price swings for natural gas in the winter months, making coal a more cost-stable choice for electricity generation.

EIA projects the price advantage favoring coal over natural gas will increase every year through 2050, yet the organization also forecasts natural gas will increase its market share compared to coal every year through 2050. The projected decline in coal's share of the electricity market is entirely due to government policies that hamper its use for electricity generation.

## D. South Australia: A Cautionary Tale

South Australia offers a cautionary tale about the damage that can be done by government policies that force coal-fired power plants into early retirement. Policies adopted by the government of that Australian state resulted in the closure of all its coal-fired power plants and mandated the use of renewable energy for 50 percent of electricity generation. Those policies have resulted in skyrocketing electricity prices: In 2017 the price for electricity (in Australian

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<sup>20</sup> Jude Clemente, "[The Importance of U.S. Oil and Natural Gas Exports](#)," *Forbes* (website), March 19, 2017.

<sup>21</sup> U.S. Energy Information Administration, "[Natural Gas Explained: Use of Natural Gas](#)," October 26, 2017.

<sup>22</sup> PJM, "[Natural Gas and Electricity Market Coordination Issues](#)," Learning Center, accessed December 1, 2017.

dollars) in South Australia was 47.13¢ per kWh compared to 15.75¢ per kWh in the United States.<sup>23</sup>

South Australia also has experienced severe reliability problems, including power outages, requiring it to import power from the neighboring state of Victoria. These self-inflicted wounds have been exacerbated by increased exporting of Australian liquefied natural gas to Asian markets, where prices are higher, leaving the domestic market undersupplied.

Residential power prices nearly doubled throughout Australia from 2008 to 2014 as a result of government policies that forced coal plants to retire and mandated the use of wind.

The problems are not confined to one Australian state. The national government also has promoted renewable power and penalized coal-generated electricity. Residential power prices nearly doubled throughout Australia from 2008 to 2014 as a result of government policies that forced coal plants to retire and mandated the use

of wind. Increasing reliance on wind energy has required utilities across the country to invest in additional infrastructure to connect power markets among states and ensure reliable electricity service. The cost of this infrastructure was passed on to consumers in the form of higher electricity prices. (See Figure 7.)<sup>24,25</sup>

Prior to shuttering its coal-fired power plants and increasing its reliance on renewables and natural gas, Australia had some of the lowest power prices in the world. Now households across that country pay much higher prices; in South Australia, households pay the highest electricity prices in the world.<sup>26</sup>

The United States may face similar damage as state and federal policies force the premature retirement of nuclear and coal-fired power plants and mandate the use of renewable resources. These destructive policies, in addition to the rapidly growing liquefied natural gas export industry in the United States, have the potential to hurt the reliability of the power grid and drive up the cost of electricity in the United States.

Because natural gas is heavily used in domestic manufacturing and home heating and will soon be exported in large quantities, lawmakers should not mandate that it also become the primary source of electricity generation. Instead, they should preserve the current flexibility in electricity

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<sup>23</sup> Ben Potter and Andrew Tillett, "[Australian Households Pay Highest Power Prices in the World](#)," *Financial Review*, August 5, 2017.

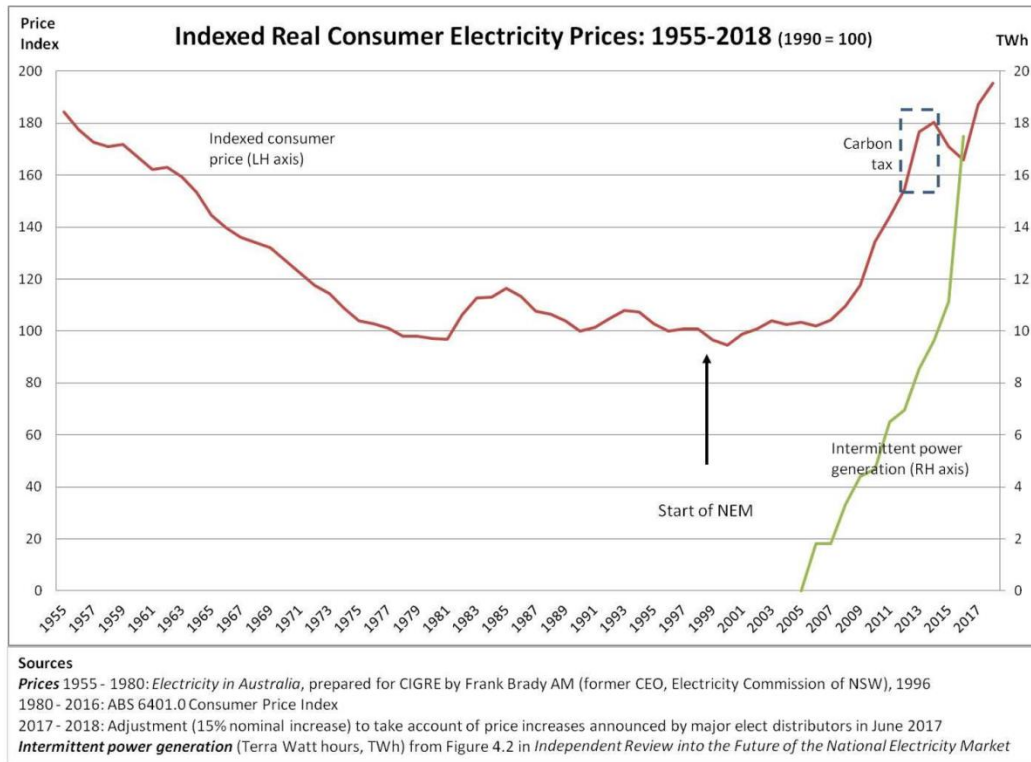
<sup>24</sup> Department of Industry, Innovation and Science, [Australian Energy Update](#), Australian Government, October 2016.

<sup>25</sup> Charis Chang, "[Why South Australia's Blackouts are a Problem for Us All](#)," news.com.au, February 10, 2017.

<sup>26</sup> Ben Potter and Andrew Tillett, *supra* note 23.

markets and allow for fuel switching by power plant owners when market forces favor one source of fuel over another.

**Figure 7**  
**Indexed Real Consumer Electricity Prices in Australia**  
**1955–2018 (1990=100)**



The National Electricity Markets (NEM) were established to introduce competitive elements to wholesale electricity markets in Australia and drive down prices. However, electricity prices in Australia have increased dramatically since 2005, when intermittent sources of electricity (wind and solar) were beginning to be incorporated into the national electricity supply. There is a strong correlation between increasing quantities of wind and solar and higher prices. *Source: Dr. Michael Crawford, “An Open Letter to Dr. Alan Finkel RE Review of Future Security of the National Electricity Market,”* June 23, 2017.

## **Part 2**

### **Government Intervention**

### **Distorts Wholesale Power Markets**

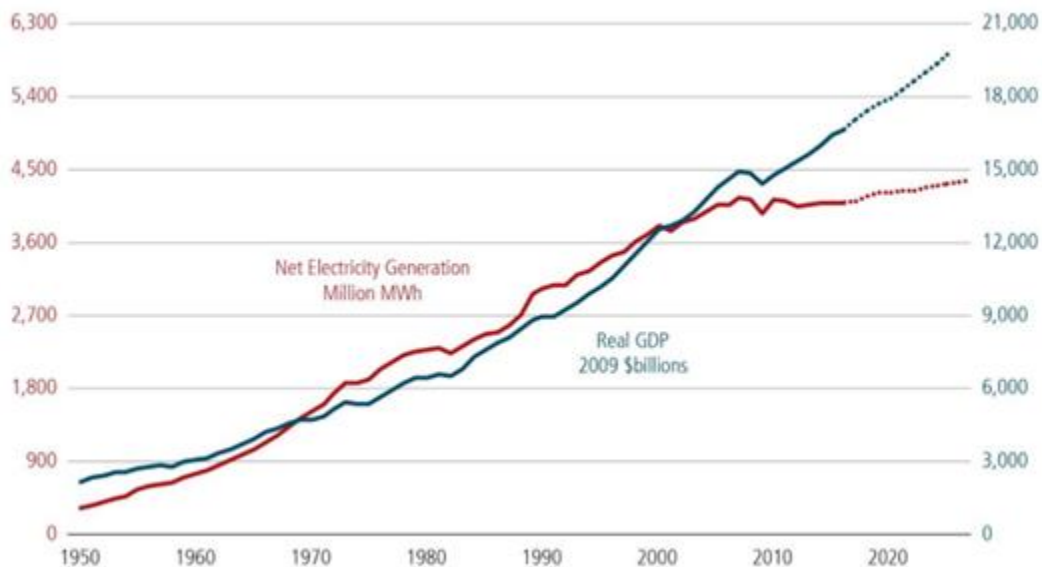
A well-functioning wholesale marketplace for electricity provides price signals that encourage the kind of investment decisions needed to produce a reliable, resilient, and efficient supply of electricity for all consumers.

Many government policies distort market price signals and encourage over-investment in renewable generation.<sup>27</sup> Most harmful at the federal level are the wind Production Tax Credit (PTC), which pays wind producers 23 cents per kilowatt hour (\$23 per MWh) of electricity produced, and the solar Investment Tax Credit, which equals 30 percent of the cost of purchasing and installing solar panels. At the state level, electricity markets are distorted by renewable energy mandates, subsidies, and policies such as net metering.

These distortions are more pronounced in the current wholesale market because electricity demand has been essentially flat since 2006 (see Figure 8).

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**Figure 8**  
**Gross Domestic Product and Net Electricity Production**  
**Historical (1950–2016) and Projected (2017–2027)**



Electricity generation in the United States has been essentially flat since 2006. The lack of growth, coupled with increasing electricity generation capacity from renewable resources, has caused wholesale electricity prices to fall which has eroded the business model of low-cost baseload power generators. Source: U.S Department of Energy, [Staff Report to the Secretary on Electricity Markets and Reliability](#), August 2017.

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The lack of growth in electricity demand has resulted in more generation sources vying for market share in a fixed-pie scenario. State and federal policies promote generation from renewables like wind and solar, resulting in more renewable generation capacity being built than

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<sup>27</sup> Lawrence Makovich and James Richards, [Ensuring Resilient and Efficient Electricity Generation](#), IHS Markit, September 2017.

is needed to satisfy consumer demand. Building more electricity capacity than is needed has resulted in an oversupply of electricity on the market, causing wholesale electricity prices to fall.

In some cases, tax credits have incentivized wind producers to sell their power for below the cost of producing it. Wind producers are encouraged to overproduce because the wind PTC guarantees they will secure a tax credit of \$23 per MWh for the electricity they generate—regardless of whether the electricity is needed to satisfy consumer demand. The tax credit effectively allows wind producers to profit even at prices as low as -\$22 per MWh.

In some areas of the country, state policies promoting renewables have resulted in markets with *almost double* the excess capacity needed to reliably supply electricity to their customers. The cost of building this excess capacity is added to the monthly utility bill paid by families and businesses. Renewable energy mandates and state policies supporting nuclear power—such as “zero emission credits” in Illinois and New York that subsidize nuclear power generators because they do not emit carbon dioxide—are perpetuating this oversupply and suppressing electricity prices.<sup>28</sup>

Policies that artificially suppress wholesale electricity prices cause disproportionate loss of revenue for coal and nuclear power plants, which act as baseload power generators. Coal and nuclear plants have high fixed costs, but they can generate electricity at low prices when selling a large volume of electricity to the grid. They must operate at a steady, constant output to recoup their fixed costs.

In some areas of the country, state policies promoting renewables have resulted in markets having *almost double* the amount of excess capacity needed to reliably supply electricity.

As intermittent renewable energy sources are increasingly imposed on the electricity supply, baseload coal plants are being forced to increase or decrease their output based on how much electricity the renewable sources are generating. The process of ramping up or ramping down electricity generation at coal plants is called “load following.”

Coal plants are ramped up when renewable sources are not generating electricity because of a lack of wind or sunlight, and they are ramped down during periods of high electricity generation from renewables. Coal plants are ramped down because renewable energy sources are given preference on the grid, and coal plants must reduce their electricity output during periods of high electricity generation from renewables to prevent the damage that can occur to a power grid when it is overloaded with electricity.

All of this ramping causes coal plants to operate inefficiently, because they were not designed to “follow the load.” Baseload coal plants are being forced to operate at inefficient levels, producing less energy per unit of cost. Operating baseload plants this way reduces the amount of revenue the plants can earn but does not reduce their fuel costs enough to offset their high fixed

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<sup>28</sup> Robbie Orvis, [“The State of the US Wholesale Power Markets: Is Reliability at Risk From Low Prices?”](#) *Utility Dive* (website), May 22, 2017.

costs. The result is lower profitability, which affects decisions made by their owners to retire the plants early.<sup>29</sup>

Said simply: Introducing intermittent resources into the electricity mix causes baseload power generators to run below full capacity. As a result, these power generators cannot pay their high fixed costs, and their owners feel compelled to retire them. State and federal policies exacerbate this trend.

## A. Auctioning of Power

In wholesale electricity markets, power plants bid in forward capacity markets (FCMs) operated by public utilities. The utilities need to contract for future delivery of electricity from various sources—coal, natural gas, renewables—to keep their costs low and to offer consumers reasonable prices and reliable service. Suppliers bid based not only on their costs of producing electricity but also on other revenue or concessions they might be receiving, notably government subsidies and preferential tax treatment.

Government policies can distort forward capacity markets for whole sale electricity in two ways.

Government policies can distort FCMs in two ways. First, power plants receiving state subsidies can bid into the auction at a lower price (even sometimes negative) because they have

additional revenue. These subsidized facilities are therefore selected more often in the auctions than they otherwise would have been, given their lower bids (see Figure 9).

Government policies also affect capacity auctions, illustrated in Figure 10. In this example, a total of 550 MW (the red horizontal line) is needed to meet customers' electricity demands.

At the far left of Figure 10, one wind turbine is shown offering a bid of \$30 per MW to provide 50 MW of capacity. The next offer is from another wind operator bidding \$50 per MW to provide the next 50 MW of capacity. Two natural gas plants bid in to bring the total supplied up to 300 MW.

Next up the cost curve, you can see an “efficiency bid” into the auction at \$130 per MW. Efficiency is also sometimes called “demand response.” In this situation, retail electricity customers will reduce their electricity consumption by 100 MW. In return, the public utility pays customers who volunteer to reduce their electricity usage during periods of high electricity prices.<sup>30</sup>

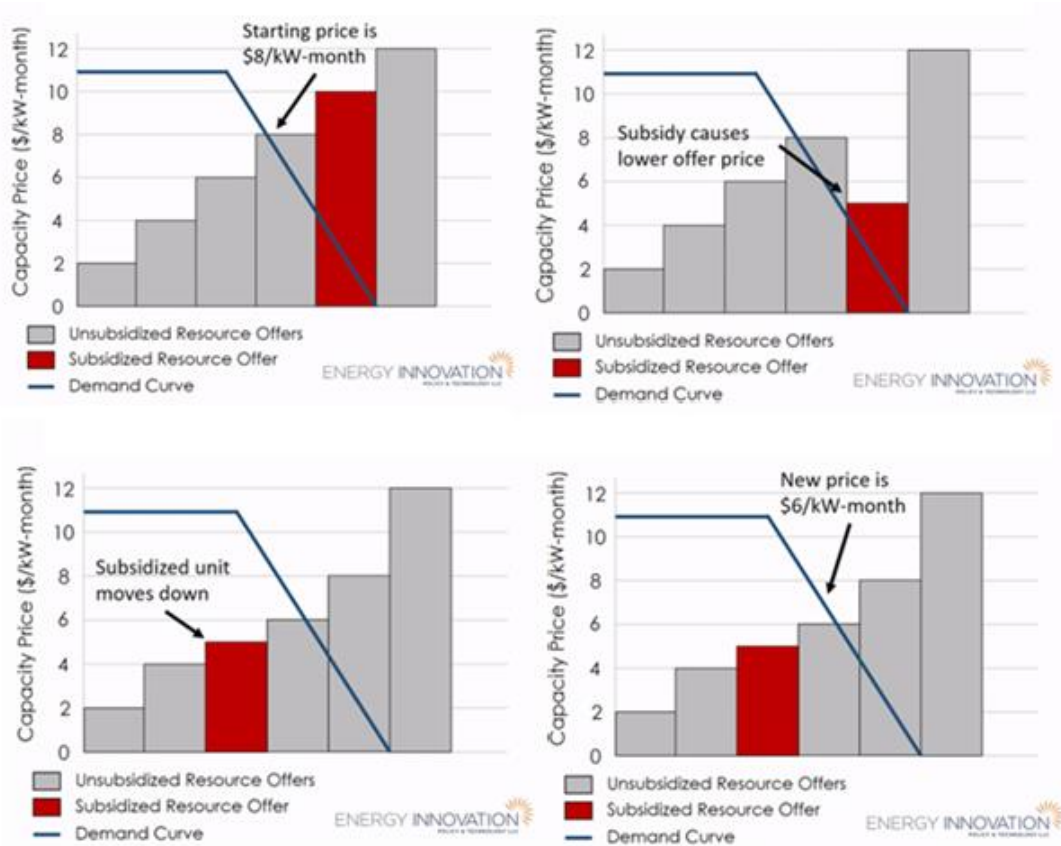
A coal plant bid into the auction at \$150 per MW to provide 150 MW of capacity, bringing the total supplied to the 550 MW needed. The second coal plant, bidding in at \$160 per MW, won't be given a contract in the auction because its 100 MW of power isn't needed.

<sup>29</sup> U.S Department of Energy, *supra* note 5.

<sup>30</sup> PJM, “[Market FAQ's](#),” Learning Center, accessed December 1, 2017.

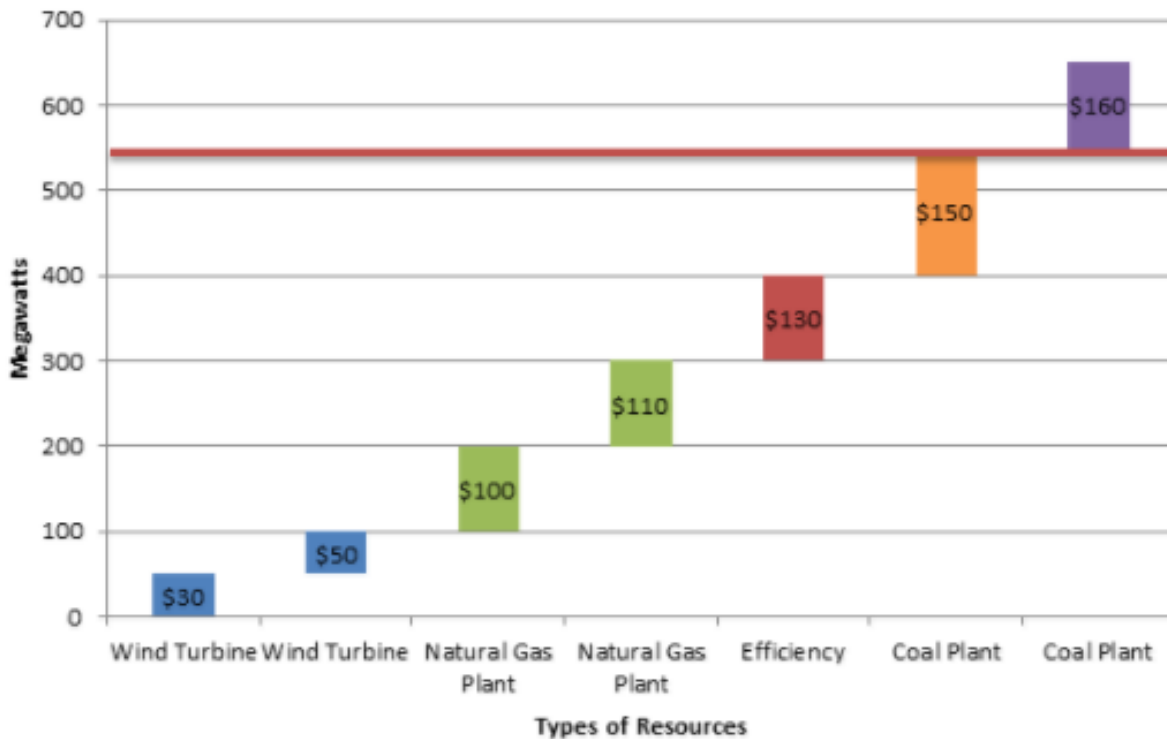


**Figure 9**  
**How Subsidized Resources Can Drop Capacity Prices**



Prices start at \$8 per Kw-month (top left) before subsidies are incorporated into the bidding price. Subsidies allow wind or solar facilities to reduce their bid offer and still reap a profit (top right). These subsidized sources are then incorporated into the grid at a reduced price (bottom left), and the new price for electricity is \$6/kW-month (bottom right). *Source:* Robbie Orvis, "[The State of Wholesale Power Markets: What's Wrong with Proposed Changes in Eastern RTOs?](#)" *Utility Dive* (website), June 20, 2017.

**Figure 10**  
**How a Capacity Auction Works**



Source: Adam James, "[Explainer, How Capacity Markets Work](#)," *Midwest Energy News*, June 17, 2013.

*And now the distorting effect of government policies becomes readily apparent.* Even though the wind turbines have bid \$30 and \$50 to supply power, they will be compensated at the same rate as the coal plant (\$150), the last of the bids needed to meet the desired capacity. In capacity auctions, the most expensive power plant selected in the auction sets payments for all plants. In this example, all of the resources will receive \$150 per MW. This is called the “clearing price,” and it is set by the most expensive unit needed to meet demand. All electricity generators are paid the clearing price because it incentivizes them to bid in at their lowest operating costs. Otherwise, electricity generators would be incentivized to inflate their bids to capture more revenue, increasing costs to consumers.

It is not difficult to see how government policies tilt the playing field. In Figure 9 above, for example, the subsidized power generator was able to reduce the maximum bid, lowering the price for all generators. In Figure 10, the wind turbines were able to come into the auction at especially low prices at least in part because the wind PTC pays them \$23 per MWh produced—they don’t need to cover their own costs as other power plants do. In fact, wind producers can make a profit selling power to the grid even when prices are negative, as can happen on very windy days when there is so much electricity available that there is too much on the grid. The wind PTC pays them to produce power even when it’s not needed.

Declining prices for power, depressed by subsidies to renewables, exert outsized financial pressure on coal and nuclear units. Coal-fired power plants make less revenue per unit of electricity generated as prices drop, and they also generate less electricity overall as cheaper natural gas units and subsidized renewables bid below them in capacity auctions. Natural gas, wind, and solar have effectively lowered the amount of revenue flowing to all power generators, making coal and nuclear power plants less economical.<sup>31</sup>

The oversupply in generation capacity will continue to grow as more states mandate the use of increasing amounts of renewable energy. The result will be continued suppression of wholesale electricity prices and the continued retirement of reliable baseload power plants.<sup>32</sup>

While low wholesale electricity prices may appear to be good for electricity consumers, the savings are short-lived.

While low wholesale electricity prices may appear to be good for electricity consumers, the savings are short-lived. The retirement of generation capacity will reduce the oversupply of electricity, ultimately causing prices to increase. The retiring low-cost baseload power plants will be replaced by higher cost generators. In the long run, market-distorting policies will leave the power grid more vulnerable to price increases, and to higher risks related to reliability and resiliency challenges in the future.<sup>33</sup>

Policymakers must understand the long-term consequences of the decisions they make. Utility planning occurs on the scale of decades, not years. Prioritizing short-term benefits while ignoring the long-term negative consequences will lead to fewer economic opportunities and increased economic risk for Americans in the coming years and decades.

## B. Federal Subsidies

Renewable power is costly for electricity consumers. As explained above, subsidizing renewables erodes the underlying economics for baseload coal-fired power plants, and consumers will pay higher long-term electricity prices as those power plants are prematurely retired.

Renewable power is also costly for taxpayers. Subsidies do not reduce the cost of producing electricity; they merely change who pays, shifting some of the costs to taxpayers.<sup>34</sup> For example, the federal wind PTC shifts as much as 50 percent of wind power costs from utility bills to tax

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<sup>31</sup> Robbie Orvis and Eric Gimon, "[The State of Wholesale Power Markets: What's Wrong with Proposed Changes in Eastern RTO's?](#)" *Utility Dive* (website), June 20, 2017.

<sup>32</sup> *Ibid.*

<sup>33</sup> Lawrence Makovich and James Richards, *supra* note 27.

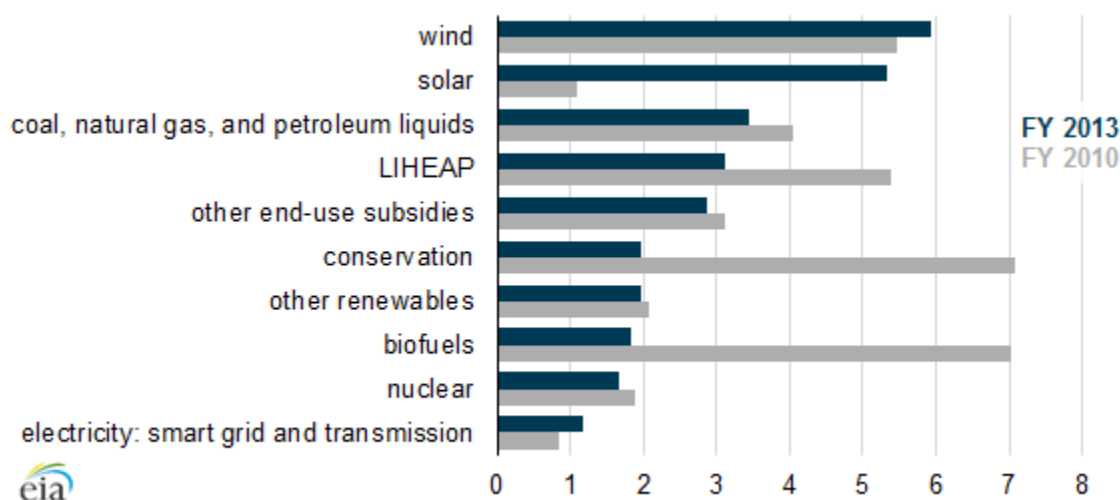
<sup>34</sup> *Ibid.*

bills.<sup>35</sup> The subsidies given to wind producers must be paid by increasing taxes on individuals or businesses, or by increasing the budget deficit.

According to the Energy Information Administration, wind and solar receive more subsidies than any other source of energy, both in absolute terms and on a per-unit-of-energy-generated basis.<sup>36</sup>

In 2013, the last year for which data are available, wind received more subsidies than any other energy source at \$5.9 billion (see Figure 11). Solar was the second largest with \$5.3 billion. By contrast, nuclear energy received \$1.66 billion, coal received \$1.07 billion, and oil and natural gas received \$2.35 billion.<sup>37</sup> In recent years, federal renewable energy incentives have totaled more than three times the incentives paid for all fossil fuels and nuclear energy combined.<sup>38</sup>

**Figure 11**  
**Quantified Energy-Specific Subsidies and Support by Type**  
**Fiscal Years 2010 and 2013**  
 in billion 2013 dollars



Government subsidies supporting wind and solar combined for \$11.2 billion in 2013, while coal received \$1.07 billion in incentives. LIHEAP is the Low Income Home Energy Assistance Program, which helps families pay their energy bills among other initiatives. *Source:* U.S. Energy Information Administration, [“Total Energy Subsidies Decline Since 2010, With Changes in Support Across Fuel Types,”](#) *Today in Energy* (website), March 13, 2015.

<sup>35</sup> *Ibid.*

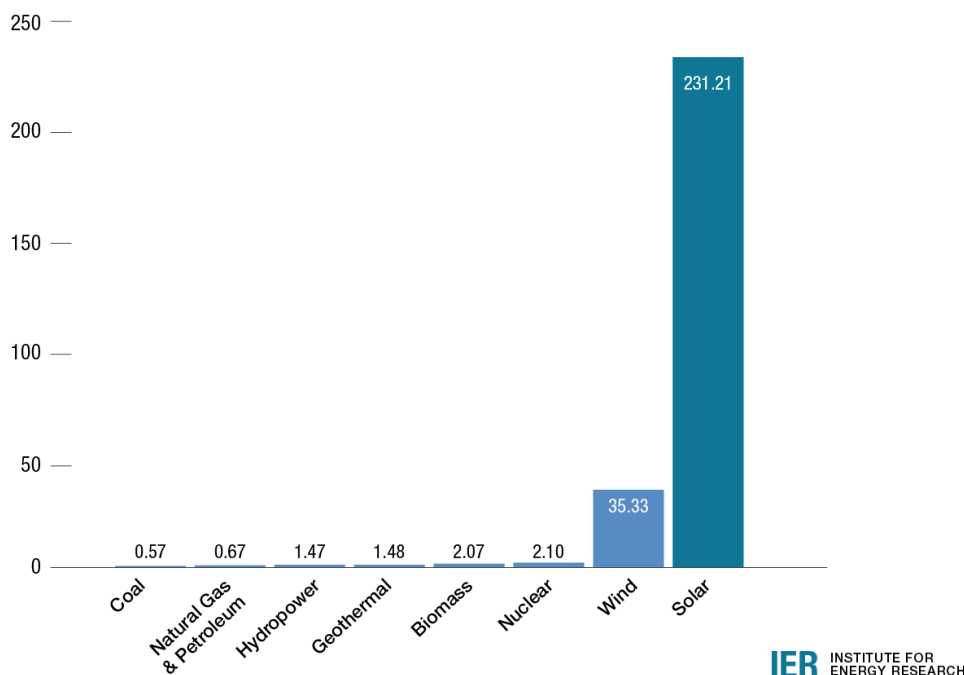
<sup>36</sup> U.S. Energy Information Administration, [“Direct Federal Financial Interventions and Subsidies in Energy in Fiscal Year 2013,”](#) *Analysis and Projections*, March 23, 2015.

<sup>37</sup> U.S. Energy Information Administration, [“Total Energy Subsidies Decline Since 2010, With Changes in Support Across Fuel Types,”](#) *Today in Energy* (website), March 13, 2015.

<sup>38</sup> Management Information Services, Inc. [“Two Thirds of a Century and \\$1 Trillion+ U.S. Energy Incentives Analysis of Federal Expenditures for Energy Development, 1950–2016,”](#) prepared for the Nuclear Energy Institute, May 2017.

Subsidies to wind and solar are large in absolute terms and even larger when considered in terms of per unit of energy produced. When viewed in these terms, wind received \$35.33 per MWh and solar received \$231.21/MWh, while coal received only \$0.57/MWh and natural gas and petroleum received only \$0.67/MWh. Wind and solar received 52 times and 345 times more subsidies than coal, respectively (see Figure 12).<sup>39</sup>

**Figure 12**  
**Federal Electric Subsidies**  
**Per Unit of Production, FY 2013**  
 2013 dollars per megawatt hour



Federal subsidies for wind and solar grew dramatically from 2010 to 2013. On a per unit of energy basis, wind and solar received 52 times and 345 times more subsidies than coal, respectively. *Source:* Institute for Energy Research, “[EIA Report: Subsidies Continue to Roll In For Wind and Solar](#),” March 18, 2015.

Recent data suggest very few wind power facilities would be built without the federal wind PTC (see Figure 13). Without federal, state, and local government incentives and mandates, the renewable energy industry would not survive in the United States. As Warren Buffet, CEO of Berkshire Hathaway and “one of the most successful investors of all time,”<sup>40</sup> stated, “We get a

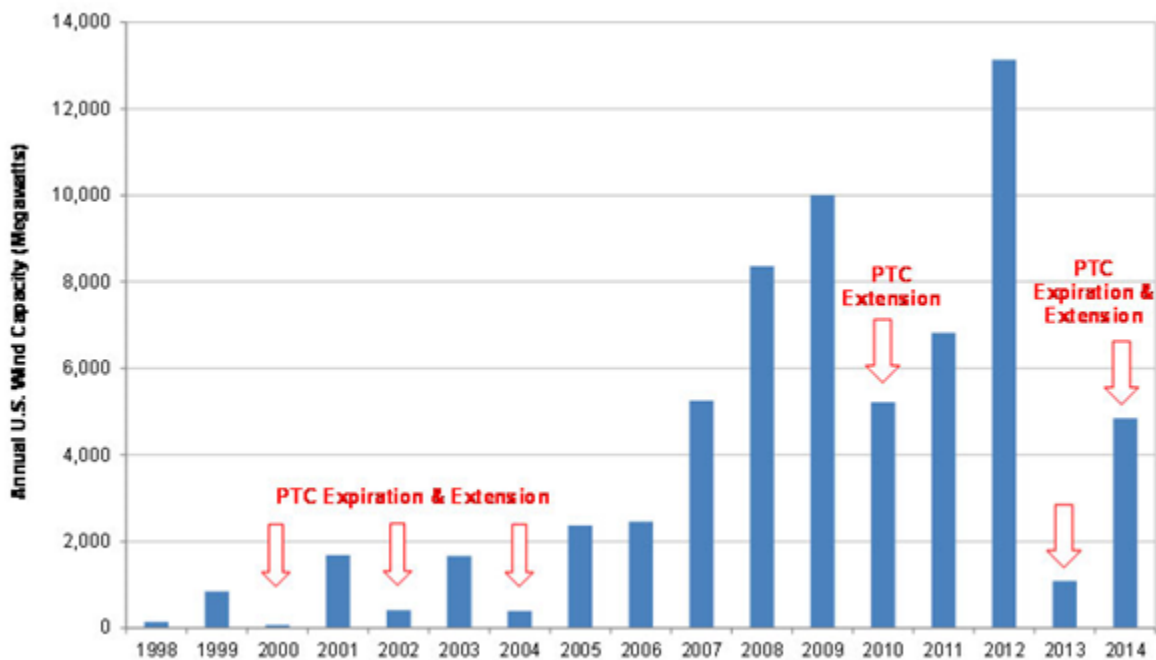
<sup>39</sup> Institute for Energy Research, “[EIA Report: Subsidies Continue to Roll In For Wind and Solar](#),” March 18, 2015.

<sup>40</sup> [Profile: Warren Buffet](#), *Forbes* (website), accessed November 28, 2017.

tax credit if we build a lot of wind farms. That's the only reason to build them. They don't make sense without the tax credit."<sup>41</sup>

Federal subsidies distort wholesale power markets by artificially increasing the amount of wind and solar generation on the grid. Although wind and solar receive more subsidies in absolute terms and on a per-unit-of-energy basis than any other source of energy, they account for just 6.5 percent of electricity generation. It is difficult to argue this money has been well spent.

**Figure 13**  
**Impact of Production Tax Credit Expiration and Extension**  
**On U.S. Annual Installed Wind Capacity**



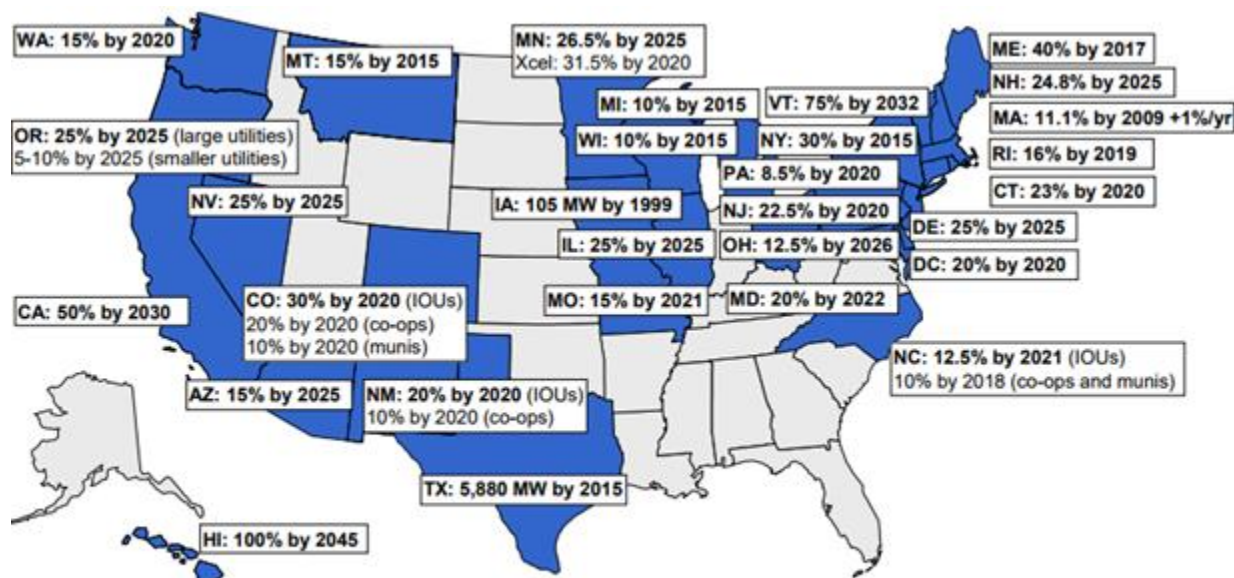
In the years following expiration of the wind PTC, wind power installations dropped between 76 and 93 percent, suggesting wind installations are not competitive without federal subsidies. *Source:* Union of Concerned Scientists, "[Production Tax Credit for Renewable Energy](#)" (website), accessed September 27, 2017.

<sup>41</sup> Grant Kidwell, "[Iowa Wind Farm Generates More Tax Credits than Electricity](#)," *The Hill*, October 6, 2016.

## C. State-Level Subsidies and Mandates

Twenty-nine states and the District of Columbia have renewable energy mandates (REMs), also known as renewable portfolio standards (RPSs), which require the use of renewable energy resources for some portion of the electricity generation mix. (See Figure 14.) The mandate varies from state to state, from Pennsylvania’s relatively low mandate requiring 8.5 percent of its electricity come from renewables by 2020, to California’s high mandate, which requires the state get 50 percent of its total electricity from renewables by 2030.<sup>42</sup>

**Figure 14**  
**RPS Policies Exist in 29 States and Washington, DC**  
**Apply to 54% of Total U.S. Retail Electricity Sales**



Source: Berkeley Lab

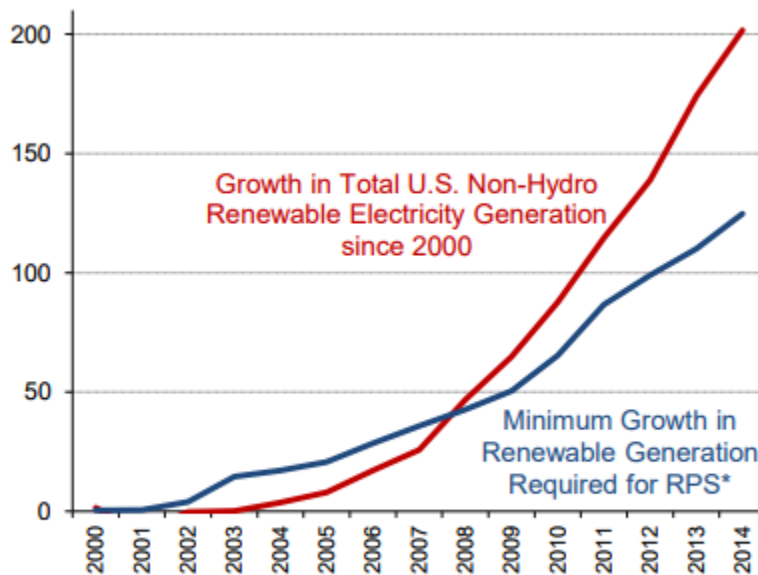
Notes: Compliance years are designated by the calendar year in which they begin. Mandatory standards or non-binding goals also exist in US territories (American Samoa, Guam, Puerto Rico, US Virgin Islands)

Twenty-nine states have enacted renewable energy mandates, and these mandates apply to 54 percent of total U.S. retail electricity sales. While these mandates initially had limited impacts on electricity prices, the growing number of increasingly high mandates implemented by some states will have severe negative consequences for consumers and businesses. *Source:* Galen Barbose, [U.S. Renewable Portfolio Standards: Overview of Status and Key Trends](#), Lawrence Berkeley National Laboratory, November 5, 2015.

<sup>42</sup> Galen Barbose, [U.S. Renewable Portfolio Standards: Overview of Status and Key Trends](#), Lawrence Berkeley National Laboratory, November 5, 2015.

REMs were initially intended to encourage a minimum level of investment needed to bring renewable technologies up to scale and reduce their costs. Today, these mandates are increasingly being used to force an uneconomic transition to 50 percent or even 100 percent renewable electricity generation within 13 to 23 years, a timetable that cannot be met. Approximately 62 percent of the growth in all U.S. non-hydro renewable generation and 58 percent of renewable capacity additions since 2000 are the result of mandates for renewable energy (see Figure 15).<sup>43</sup>

**Figure 15**  
**Growth in U.S. Renewable Electricity Generation (TWh)**



\* Min. Growth Required for RPS accounts for the use of pre-2000 vintage facilities in meeting RPS obligations, where it occurs

State-level REMs have been a major driver of renewable energy installations in the United States with 62 percent of installed renewable capacity used to satisfy REM demands. *Source:* Galen Barbose, [U.S. Renewable Portfolio Standards: Overview of Status and Key Trends](#), Lawrence Berkeley National Laboratory, November 5, 2015.

<sup>43</sup> *Ibid.*



REM goals already have resulted in costly power system operating challenges. These mandates reduce the efficiency of the power grid by promoting intermittent renewable resources over more reliable and cost-effective sources.<sup>44</sup> In addition, utilities paid \$2.6 billion in 2014 to comply with REMs, averaging \$12 per MWh, roughly 1.3 percent of average retail electricity bills.<sup>45</sup> These costs will increase dramatically in the next decade as most state REMs are scheduled to reach their mandatory compliance deadlines between 2020 and 2030.

## D. Billions in Additional Transmission Costs Due to Renewables

Increasing the share of electricity provided by wind and solar energy requires constructing new transmission infrastructure to deliver the electricity to consumers.<sup>46</sup> The U.S. Energy Information Administration's Levelized Cost of Energy (LCOE) and similar estimates do not take into account the cost of building additional transmission infrastructure.

That cost can be substantial. Wind and solar facilities are typically located farther away from consumers than coal, natural gas, or nuclear power plants, and therefore longer transmission lines are required to connect renewable sources to the grid.<sup>47</sup>

Texas spent \$7 billion—roughly \$950 for every household—to construct more than 3,600 miles of transmission lines needed to connect remote wind resources to major population centers.

Transporting electricity long distances also results in significant power loss. Transmission and distribution of electricity on power lines can result in the loss of 2 percent to 6 percent in energy.<sup>48</sup> Such losses must be taken into account when comparing the difference between how much power is generated and how much power is actually delivered.

Additionally, wind turbines and solar panels are smaller and more geographically dispersed than traditional electricity generators, and they require more linkages to the grid. These transmission lines could impose up to \$100 billion in additional costs on consumers if just 15 percent of U.S. electricity generation came from renewable energy resources.<sup>49,50</sup>

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<sup>44</sup> Lawrence Makovich and James Richards, *supra* note 27.

<sup>45</sup> U.S. Department of Energy, *supra* note 5, page 123.

<sup>46</sup> U.S. Energy Information Administration, "[Investment in Electricity Transmission Infrastructure Shows Steady Increase](#)," *Today in Energy* (website), August 26, 2014.

<sup>47</sup> Lawrence Makovich and James Richards, *supra* note 27.

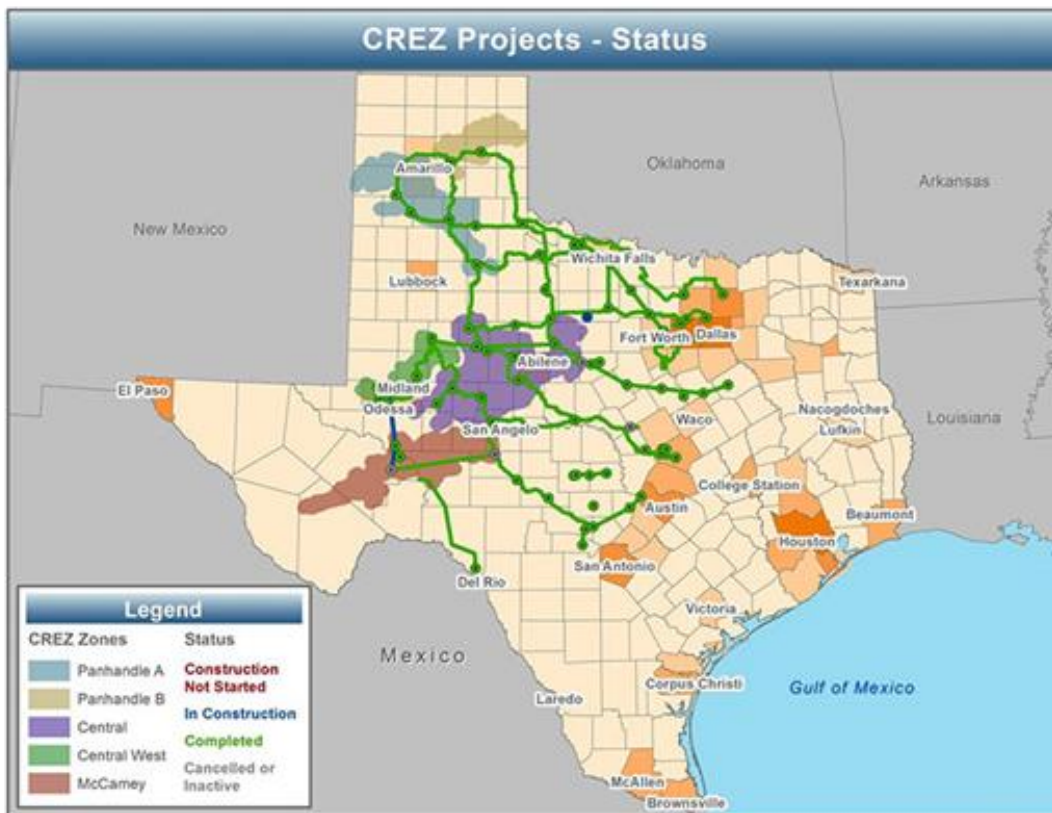
<sup>48</sup> Jordan Wirfs-Brock, "[Lost in Transmission: How Much Electricity Disappears Between A Power Plant and Your Plug?](#)" *Inside Energy* (website), November 6, 2015.

<sup>49</sup> Christopher Blansett, "Solar Energy," J.P. Morgan, September 1, 2009.

<sup>50</sup> Management Information Services, Inc., "[Not-So-Green Superhighway](#)," *Public Utilities Fortnightly*, February 2012.

Consider Texas, which generates more electricity from wind than any other state. Most of the wind turbines are in remote regions of the state, far from the major population centers of Austin, Dallas, Houston, and San Antonio (see Figure 16). Texas spent \$7 billion—roughly \$950 for every household in the state and nearly \$2 million per mile—to construct more than 3,600 miles of transmission lines needed to connect remote wind resources to major population centers.<sup>51</sup> For comparison, the average household in Texas spends \$1,500 for electricity in an entire year.<sup>52</sup>

**Figure 16**  
**Transmission Lines for Renewable Projects in Texas**



As part of Texas's Competitive Renewable Energy Zones (CREZ) project, more than 3,600 miles of transmission lines were constructed to connect distant wind generators to major population centers. The construction of these transmission lines cost approximately \$7 billion, about \$950 per household in Texas. *Source:* U.S. Energy Information Administration, "[Fewer Wind Curtailments and Negative Power Prices Seen in Texas After Major Grid Expansion](#)," *Today in Energy*, June 24, 2014.

<sup>51</sup> U.S. Energy Information Administration, "[Fewer Wind Curtailments and Negative Power Prices Seen in Texas After Major Grid Expansion](#)," *Today in Energy* (website), June 24, 2014.

<sup>52</sup> Electricity Local, "[Residential Electricity Rates and Consumption in Texas](#)" (website), accessed September 27, 2017.

The cost of constructing the transmission lines in Texas was passed on to the state's utility customers, who paid higher electricity fees as a result. And despite the price tag of \$950 per household, wind accounted for just 10 percent of electricity generation in Texas in 2015.<sup>53</sup>

In California, it is estimated the state will need to spend up to \$5.8 billion to upgrade its current power system and build new transmission facilities as it attempts to meet a mandate of 50 percent from renewable sources by 2030.<sup>54</sup>

The large capital costs associated with building transmission lines to connect renewable energy sources to the grid are one reason the cost of delivering electricity to consumers increased 31 percent between 2006 and 2016, from 2.2 cents per kilowatt hour (kWh) in 2006 to 3.2 cents per kWh in 2016, in 2016 dollars.<sup>55</sup> Growing transmission costs and declining fuel prices caused delivery's share of total electricity costs to grow from 22 percent in 2006 to 36 percent in 2016. (See Figure 17.)<sup>56</sup> The need for new transmission infrastructure to deliver electricity from distant renewable energy sources to customers has caused electricity prices to be higher than the prices consumers would have otherwise paid.

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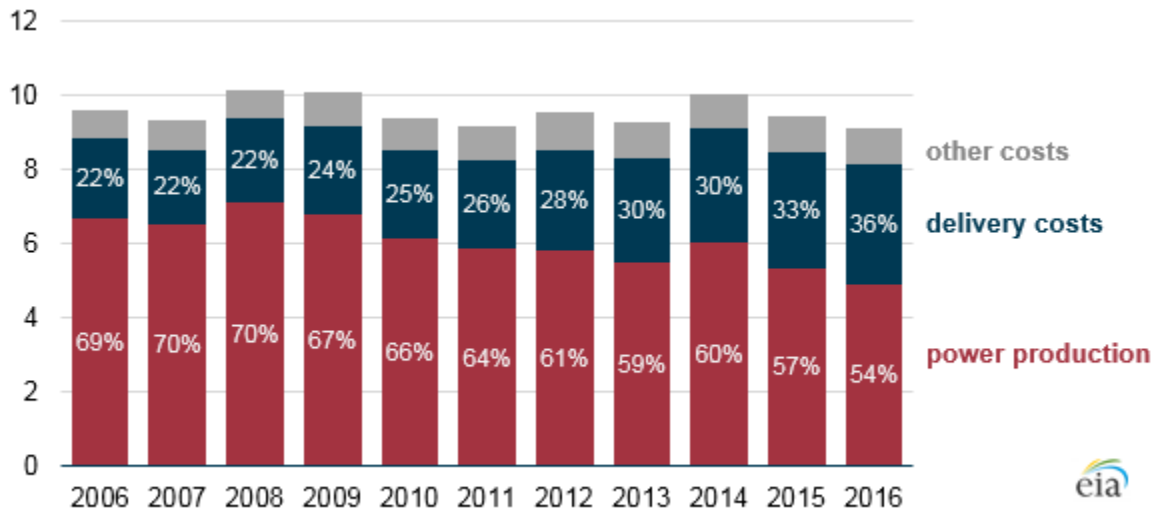
<sup>53</sup> U.S. Energy Information Administration, "[Texas](#)," *State Profile and Energy Estimates*, January 19, 2017.

<sup>54</sup> California Natural Resources Agency, [Renewable Energy Transmission Initiative 2.0 Plenary Report](#), Public Review Draft, December 16, 2016.

<sup>55</sup> U.S. Energy Information Administration, "[Electricity Prices Reflect Rising Delivery Costs, Declining Power Production Costs](#)," *Today in Energy* (website), September 7, 2017.

<sup>56</sup> *Ibid.*

**Figure 17**  
**Federal Energy Regulatory Commission-Regulated Utility Spending**  
**in Cents per Kilowatthour (\$2016)**



Delivery costs for electricity have grown 31 percent since 2006, resulting in the cost of delivering electricity growing from 22 percent of the total cost of electricity in 2006 to 36 percent in 2016. *Source:* U.S. Energy Information Administration, [“Electricity Prices Reflect Rising Delivery Costs, Declining Power Production Costs,”](#) *Today in Energy*, September 7, 2017.

## **E. Case Study: Increasing Infrastructure Costs in Colorado**

In addition to paying for new generation and transmission facilities, electricity consumers and ratepayers must also pay for prematurely retired coal-fired power plants, even though these plants are not generating electricity.

In Colorado, Xcel Energy announced it would retire 660 MW of coal-fired power plant capacity before the end of its useful life and replace the plants with new natural gas and renewable energy.<sup>57</sup> Even after the two coal-fired power plants are shuttered, ratepayers will have to pay the remaining capital costs for building and upgrading the facilities, which were built in the 1970s.

As is true of other major capital investments, the cost of building and upgrading coal-fired power plants is spread over decades into the future under the expectation these plants will generate electricity for 50 years or more. If the Colorado plants are shut down before the end of their useful lives, ratepayers will still have to pay the \$297 million that is owed on the plants.

<sup>57</sup> William Yeatman and Amy Oliver Cooke, [“The Math Behind Xcel ‘Colorado Energy Plan’ Defies Reality and History,”](#) *The Greeley Tribune*, September 19, 2017.

Replacing this retired capacity with a 400 MW combined cycle natural gas power plant would add another \$400 million in expenses for ratepayers.<sup>58</sup>

In addition to paying for the remaining balance on the retired coal plants and the cost of a new natural gas plant, ratepayers will also pay higher costs for electricity because natural gas is more than twice as expensive as coal on Xcel Colorado's power grid: \$3.79 for gas versus \$1.79 for coal on a per-unit-of-energy basis.<sup>59</sup>

The costs to Colorado ratepayers will increase further when the cost of renewables is factored into the equation. Xcel Energy has not released the details of its plan to replace these power plants with renewables, but the Colorado Public Utilities Commission recently approved the construction of a \$1 billion industrial wind project with 49 MW of capacity. By way of comparison, a small natural gas plant with the same capacity could be built for \$80 million—8 percent as much.<sup>60</sup> If it didn't retire the coal-fired plants, the utility could get 49 MW from existing coal at near zero price.

The cost of prematurely retiring just two coal-fired power plants in Colorado and replacing them with a mix of natural gas and renewables could reach more than \$1.7 billion.

All told, the cost of prematurely retiring just two coal-fired power plants in Colorado and replacing them with a mix of natural gas and renewables could reach more than \$1.7 billion, without taking into account the higher fuel costs that will be paid for burning natural gas rather than coal.

Electricity prices in Colorado increased by 67 percent, double the rate of inflation, between 2001 and 2014, even though the costs of fuel generating that electricity fell during that period.<sup>61</sup> Replacing all of Colorado's coal-fired generation units, which accounted for 55 percent of electricity generation in the state in 2016, with a mixture of natural gas and renewable energy would of course increase these costs even more.

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<sup>58</sup> *Ibid.*

<sup>59</sup> *Ibid.*

<sup>60</sup> *Ibid.*

<sup>61</sup> Aldo Svaldi, "[Coal's Future As a Power Source in Colorado Is Flickering](#)," *The Denver Post*, April 7, 2017.

## Part 3

# Premature Retirement of Coal Plants Harms Families, Enterprises, and Coal Mining Communities

Policies that artificially increase the cost of electricity harm consumers in two ways. First, increasing electricity costs result in higher electricity bills, leaving consumers and families with less money to spend (or save) on other goods and services.

Policies that drive up the cost of electricity disproportionately hurt low-income Americans, including minority groups and elderly people living on fixed incomes.

Second, electricity is an important component of everything we buy on a daily basis, so higher electricity prices also cause the price of goods and services to increase. Businesses saddled with increasing electricity costs will raise their prices and fees in an attempt to offset some of those rising costs by passing them

on to consumers. The end result is higher prices and fewer economic opportunities.

The Energy Information Administration estimates the typical U.S. residential customer will spend \$1,350 for electricity in 2017. The premature retirement of nuclear and coal-fired power plants will increase power prices by 27 percent—meaning the annual electricity bill paid by consumers will grow to \$1,714. Consumers also will pay higher prices for the goods and services they buy, and studies show there will be 1 million fewer job opportunities as increasing electricity prices are expected to reduce U.S. gross domestic product by 0.8 percent, equal to \$158 billion (2016 chain-weighted dollars).<sup>62</sup> The combination of these factors will reduce the average U.S. household’s annual income by \$850.

### A. Low-Income Households Hurt the Most

Energy costs make up a larger share of spending by the average low-income household than spending by higher-income households. Being forced to spend more to pay the electric bills means less to spend on food, rent, and other essentials. Policies that drive up the cost of electricity disproportionately hurt low-income Americans, including minority groups and elderly people living on fixed incomes.

The threshold beyond which experts believe energy ceases to be “affordable” is 6 percent of a household’s income. Households that spend 10 percent or more of their income on energy are considered to live in “energy poverty.”<sup>63</sup>

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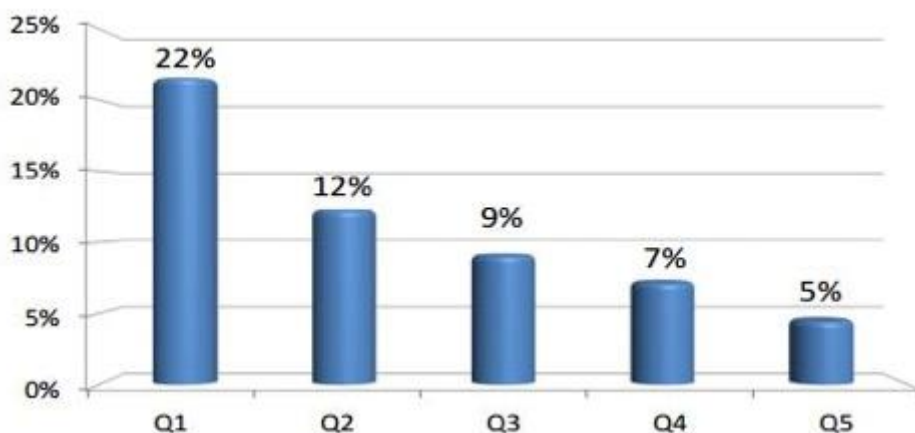
<sup>62</sup> Lawrence Makovich and James Richards, *supra* note 27. [Chain-weighted dollars](#) is an alternative measurement to the Consumer Price Index.

<sup>63</sup> Adam Chandler, “[Where the Poor Spend More than 10 Percent of Their Income on Energy](#),” *The Atlantic*, June 8, 2016.

According to data from the Bureau of Labor Statistics, the 20 percent of U.S. households in the lowest income bracket had after-tax incomes of \$11,155, while the second-lowest 20 percent had after-tax incomes of \$28,283. Figure 18 below shows the percentage of after-tax income spent on energy services. According to the data, 44 percent of U.S. households live in energy poverty.<sup>64</sup> That is nearly half the U.S. population at present, and if current trends persist, more than half of the country's households will live in energy poverty in the very near future.

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**Figure 18**  
**Energy Expenditures as Percentage of**  
**Household After-Tax Income**  
by Income Quintile



The lowest-earning households spend more than 20 percent of their after tax-income on energy services, and 40 percent of Americans live in energy poverty. "Energy expenditures" include expenditures for electricity, natural gas, other household fuels, and motor gasoline. *Source:* Bureau of Labor Statistics, *Consumer Expenditure Survey*, April 2016.

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Clearly, policies that increase electricity prices hurt low-income households financially. Less-often discussed but no less important are the social and human costs of policies that make it more difficult for low-income families to keep the lights on.

For example, parents in low-income households may need to work longer hours or get a second job to pay food, housing, and energy costs. This leaves them less time to spend with their children. This is significant for many reasons. For example, studies have shown reading aloud to children at an early age is the single most important activity for future reading and educational success.<sup>65</sup>

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<sup>64</sup> American Council for Clean Coal Electricity, [Energy Expenditures By American Families](#), June 2016.

<sup>65</sup> Derry Koralek, [Reading Aloud with Children of All Ages](#), *Reading Is Fundamental* (website), 2001.

Additionally, a study published in *Proceedings of the National Academy of Sciences* found 25 percent of teenage children in low-income households were obese in 2010, whereas only 7 percent of teenage children with college-educated parents were obese.<sup>66</sup> Studies have found people who cook at home tend to have healthier overall diets, but home-cooked meals are difficult to manage for low-income families whose parents are working long hours just to make ends meet.<sup>67</sup>

## B. Eroding the Manufacturing Base

Manufacturing is an energy-intensive sector, with industrial uses consuming approximately 23.8 percent of electricity generation in the United States.<sup>68</sup> Because manufacturing is such a large

If policymakers in the United States want to increase domestic manufacturing and increase the number of manufacturing jobs available, they must ensure the country's energy marketplace is free and unfettered by irresponsible regulations.

consumer of electricity, increases in electricity prices can have severe consequences for that sector. If policymakers in the United States want to increase domestic manufacturing and increase the number of manufacturing jobs available, they must ensure the country's energy marketplace is free and unfettered by irresponsible regulations.

The United States has among the lowest industrial electricity rates in the world, averaging 6.81 cents per kWh in 2013 (see Figure 19).<sup>69</sup> That is an important competitive advantage policymakers must strive to maintain.

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<sup>66</sup> Carl B. Fredericka, Kaisa Snellmana, and Robert D. Putnama, "[Increasing Socioeconomic Disparities in Adolescent Obesity](#)," *Proceedings of the National Academy of Sciences* 111, no. 4 (November 2013): 1338–42; see also Melissa Healy, "[Among Kids in the U.S., The Rich Get Thinner and the Poor Get Fatter](#)," *The Los Angeles Times*, January 13, 2014.

<sup>67</sup> Arpita Tiwari, "[Cooking at Home Tonight? It's Likely Cheaper and Healthier, Study Finds](#)," *Science Direct*, March 14, 2017.

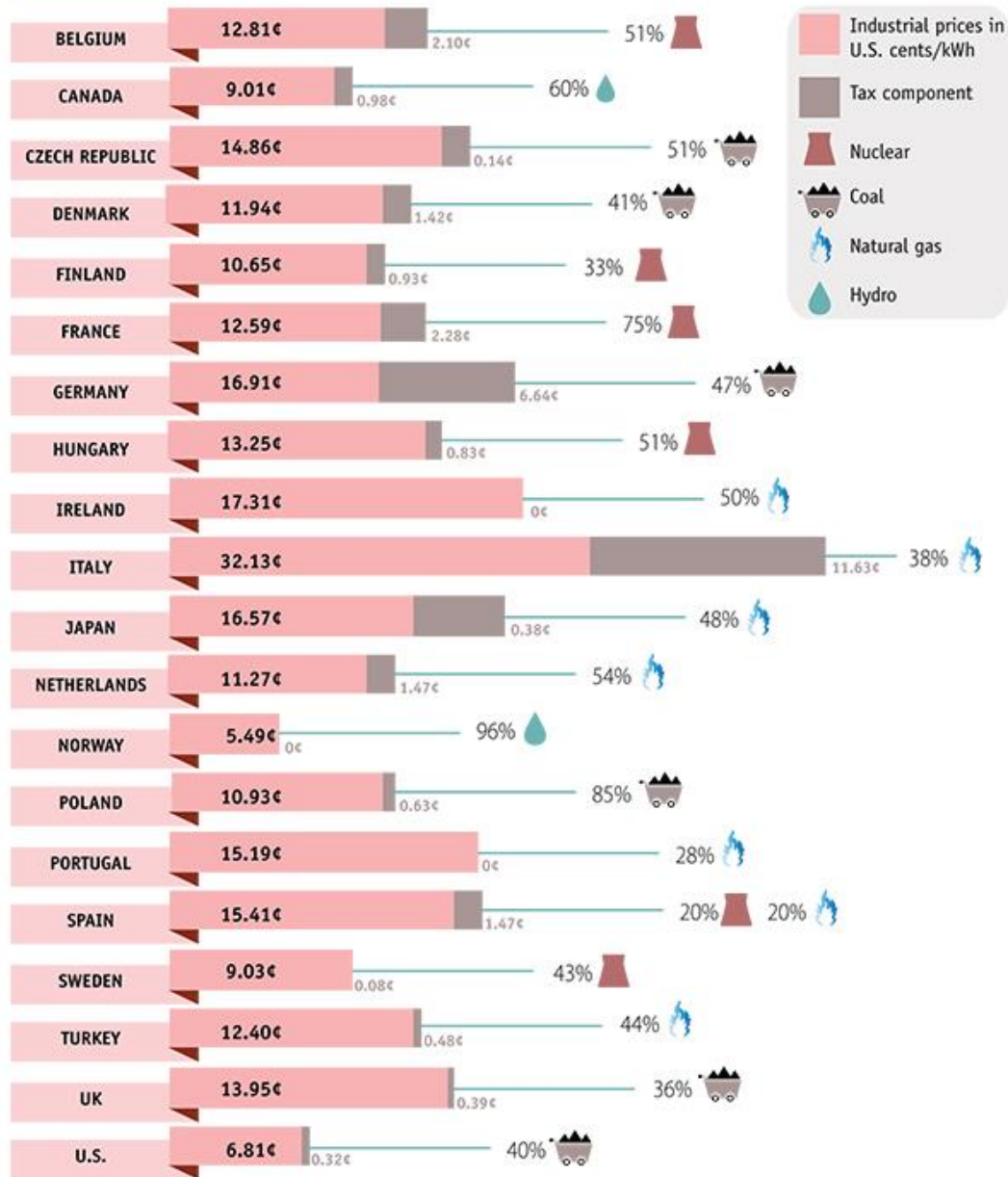
<sup>68</sup> U.S. Energy Information Administration, "[Electric Power Annual 2015 Files](#)" (website), accessed September 28, 2017.

<sup>69</sup> Sonal Patel, "[The Big Picture: World Industrial Power Prices](#)," *Power Magazine*, May 1, 2015.



**Figure 19**  
**Industrial Energy Prices in 2013**

How much industry pays for power varies tremendously by country, owing to variations in generation costs, network costs, and taxes, fees, and surcharges. This comparison shows average industrial electricity prices in 2013, with each nation's tax component. Also shown is the fuel source that dominated each nation's power mix in 2013. *Source: UK Department of Energy and Climate Change, Eurostat, International Energy Agency —Copy and artwork by Sonal Patel, associate editor*



The United States has among the lowest industrial electricity prices in the world largely because of the use of coal to generate electricity. This competitive advantage will be put at risk if the United States increases its reliance on natural gas and renewables, jeopardizing the potential for creating additional manufacturing jobs. *Source: Sonal Patel, "The Big Picture: World Industrial Power Prices," Power Magazine, May 1, 2015.*

Manufacturing generates high-skilled, high-wage jobs: The average U.S. manufacturing worker earns \$80,000 per year, including benefits, compared to \$57,000 per year for the average U.S. worker.<sup>70</sup> Manufacturing benefits non-college-educated workers: According to the Economic Policy Institute, on average for 2012–2013, non-college-educated workers in manufacturing made 10.9 percent more than similar workers in the rest of the economy.<sup>71</sup>

The ability to create high-paying jobs for low-skilled workers is an underappreciated hallmark of the manufacturing sector. These are the workers whose livelihoods are most at risk as coal-fired power plants are prematurely closed and replaced by high-cost renewables and new natural gas generation. If the Trump administration is going to achieve its goals of increasing manufacturing jobs, low-cost coal will be an indispensable component of making U.S. manufacturing firms competitive with global competitors.

In competition with the United States for manufacturing, China has an advantage in labor costs but is at a distinct disadvantage with respect to energy costs. (See Table 1.) For the United States to remain competitive with China and similar low-labor-cost countries, industrial electricity prices in the United States must remain low.

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**Table 1**  
**Industrial Energy Prices**  
**China and United States**  
**2014, in US \$k/MWh**

	<b>Industrial Electricity Price</b>	<b>Coal Price for Generation</b>	<b>Gas Price for Generation</b>	<b>Residential Electricity Price</b>
China	0.1068	0.0384	0.0778	0.0908
United States	0.0710	0.0241	0.0159	0.1252
China minus U.S.	0.0358 (50% higher)	0.0143 (60% higher)	0.0619 (389% higher)	-0.0344 (27% lower)*

Industrial electricity prices in the U.S. are lower than in China. Lower energy costs in the United States help offset the low wages paid to Chinese workers. \*Only in this category are real energy prices lower in China. Source: Michael G. Pollitt, *et al.*, [Reforming the Chinese Electricity Supply Sector: Lessons from International Experience](#), University of Cambridge Energy Policy Research Group, March 2017.

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<sup>70</sup> Jessica R. Nicholson and Regina Powers, [The Pay Premium for Manufacturing Workers as Measured by Federal Statistics](#), U.S. Department of Commerce, October 2, 2015.

<sup>71</sup> Robert E. Scott, [The Manufacturing Footprint and the Importance of U.S. Manufacturing Jobs](#), Economic Policy Institute, January 2015.

## C. Case Study: Manufacturing Suffers in California

Although the United States as a whole has among the lowest industrial electricity rates in the world, as shown in Figure 19 above, there is significant variation among states. California, New York, and other states that have mandated high levels of renewable energy and greatly reduced the use of coal for electricity generation have experienced higher electricity prices and a loss of manufacturing jobs.

In California, for example, utilities are under a mandate to produce 50 percent of their electricity from so-called clean energy by 2030. Some lawmakers want the mandate raised to 60 percent by 2030 and 100 percent by 2045.<sup>72</sup> Other state mandates in California set limits on greenhouse gas emissions and force companies to buy permits—“low carbon fuel credits”—to emit carbon dioxide into the atmosphere.

From 2006 through July 2016, 3,463 megawatts of capacity from imported and in-state coal-fired power plants were removed from California’s resource portfolio to reduce greenhouse gas emissions.<sup>73</sup> California’s aggressive regulation of greenhouse gas emissions nearly eliminated in-state generation of coal-fired electricity. However, California still imports approximately 4 percent of its total electricity from coal-fired generation units in neighboring states.

Shuttering most of the state’s coal-fired power plants and building out renewables has caused California to have some of the highest electricity prices in the country.

Shuttering most of the state’s coal-fired power plants and building out renewables has caused California to have some of the highest electricity prices in the country, behind only Alaska, Hawaii, New York, and the Northeastern Region and far above the national average (see Figure 19, above).<sup>74</sup>

Between March 2012 and March 2015, California added 52,447 manufacturing jobs, a 3.5 percent increase. And then in a single year, from March 2015 to March 2016, it lost 10,393 manufacturing jobs, approximately 20 percent of the jobs created in the prior three years.<sup>75</sup> Soft global demand for products, a tightening labor market, and stringent regulations all played a role in the loss of jobs in California’s manufacturing sector.

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<sup>72</sup> Makeda Easter and Ivan Penn, “[Elon Musk Said Tesla Could Build Australia a Power Storage System in 100 Days. Now We’ll See](#),” *The Los Angeles Times*, July 7, 2017.

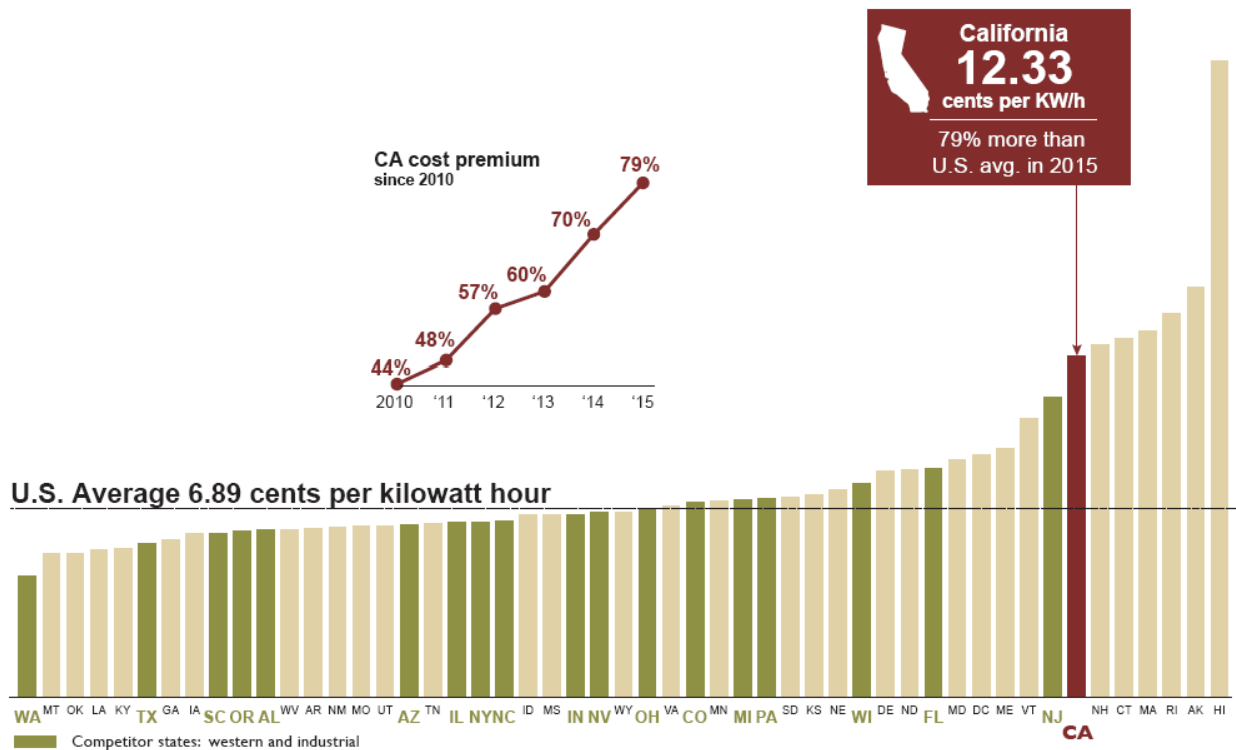
<sup>73</sup> California Energy Commission, [Actual and Expected Energy From Coal in California](#), November 3, 2016.

<sup>74</sup> U.S. Energy Information Administration, “[Average Price of Electricity to Ultimate Customers by End-Use Sector](#),” August 24, 2017.

<sup>75</sup> Jennifer Ratcliff, “[California Manufacturing Employment Growth Stalls](#),” *Manufacturers News Incorporated*, May 23, 2016.

California’s dramatic loss of manufacturing jobs in 2016 coincides with industrial electricity prices more than 79 percent above the national average (as shown in Figure 20) and high levels of renewable energy generation (Figure 21).

**Figure 20**  
**California Manufacturers Paid 79%**  
**More than U.S. Average for Electricity in 2015**  
 industrial rates by state, annual average



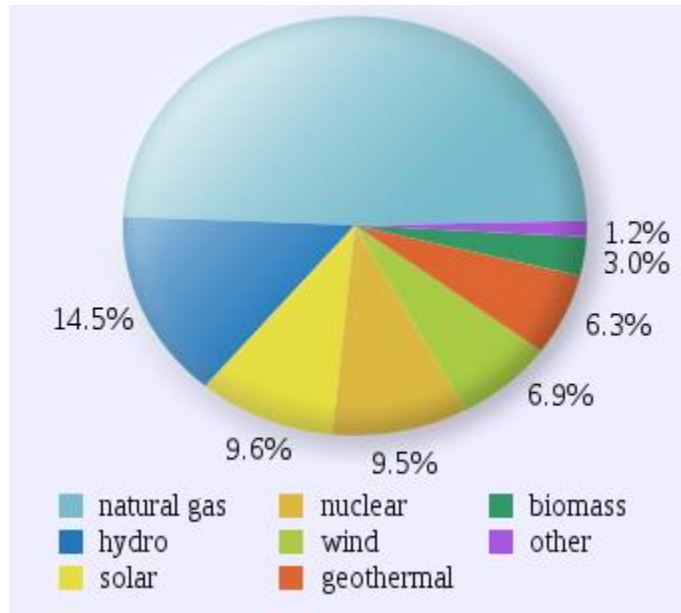
Source: U.S. Energy Information Administration Chart: CA Manufacturers & Technology Association www.cmta.net @cmta as of June 10, 2016

Electricity prices in California have risen dramatically since 2010 and in 2015 exceeded the national average by 79 percent.<sup>76</sup> This is partially due to poor planning, causing the state to build too many power plants: 500 of them between 2001 and 2016. Continued investment in renewable power generation continues to oversupply California markets. *Source:* Ivan Penn and Ryan Menezes, “[Californians Are Paying Billions for Power They Don’t Need](#),” *The Los Angeles Times*, February 5, 2017.

<sup>76</sup> California Manufacturing and Technology Association, [CA Electricity Cost Premiums Since 2010](#), accessed September 28, 2017.

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**Figure 21**  
**In-State Sources of Electricity Generation**  
**in California, 2016**



Wind and solar power accounted for 6.9 percent and 9.5 percent of electricity generation in California, respectively. By 2016 California had nearly eliminated all in-state electricity generation using coal. The figure focuses on in-state sources; about 4 percent of the electricity used in the state was generated by importing coal-fired electricity from other states. *Source:* California Energy Commission, "[Total System Electric Generation](#)" (website), accessed September 14, 2017.

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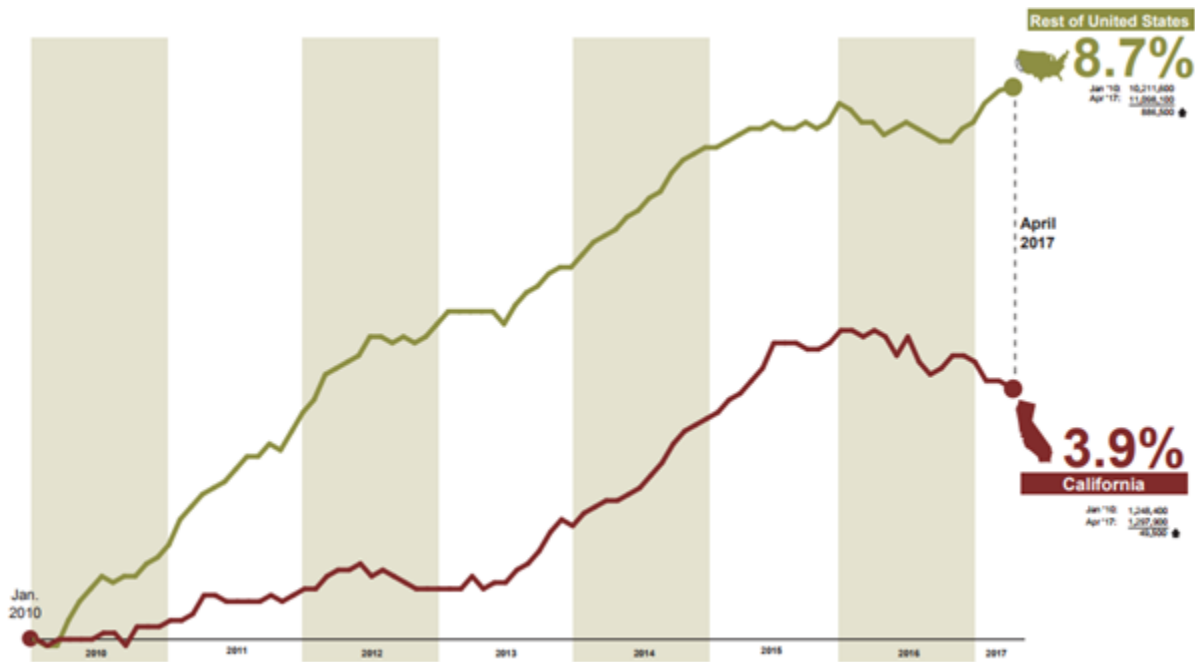
It should therefore come as little surprise the state's manufacturing job losses were concentrated in energy-intensive industries.<sup>77</sup> (See Figure 22.) Jobs in printing and publishing were down 5 percent; in the paper products industry, down 2.6 percent; in primary metals, down 2 percent; in stone, glass, and clay manufacturing, down 1.4 percent; and in other heavy manufacturing sectors, such as furniture, fabricated metals, and transportation, down 1 percent.

Manufacturing is an energy-intensive industry, consuming nearly a quarter of all electricity generated in the United States. While several factors determine where companies invest capital and employ workers, energy costs are important. The United States is currently a destination for manufacturing jobs because it has among the lowest industrial electricity prices in the world. This advantage will be lost if the rest of the United States follows in California's footsteps and prematurely retires its coal-fired power plants in favor of renewables and natural gas.

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<sup>77</sup> California Energy Commission, "[Total System Electric Generation](#)" (website), accessed September 14, 2017.

**Figure 22**  
**California Manufacturing Job Growth**  
**Continues to Lag the Country**  
 percent change since 2010



Sources: Labor Market Information Dept, U.S. Bureau of Labor Statistics. Chart: CA Manufacturers & Technology Assn. As of June 1, 2017

California has lagged behind the national average in creating manufacturing jobs since 2010. This is due to a variety of factors, including stringent regulations and high energy costs. *Source:* California Energy Commission, “[Total System Electric Generation](#)” (website), accessed September 14, 2017.

## D. Blackouts: Bad for Business

The government policies driving premature closure of coal-fired power plants have caused electricity prices in state such as California to skyrocket, as candidate Barack Obama promised in January 2008: “Under my plan, of a cap and trade system, electricity rates would necessarily skyrocket.”<sup>78</sup> In addition, those policies force into the power grid increasing amounts of intermittent renewable energy, putting the United States at greater risk of power outages.

Power outages, frequently referred to as blackouts, have severe economic and social consequences. While the United States has for the most part avoided blackouts, they plague the state of South Australia, which has closed all of its coal-fired power plants and relies on wind for

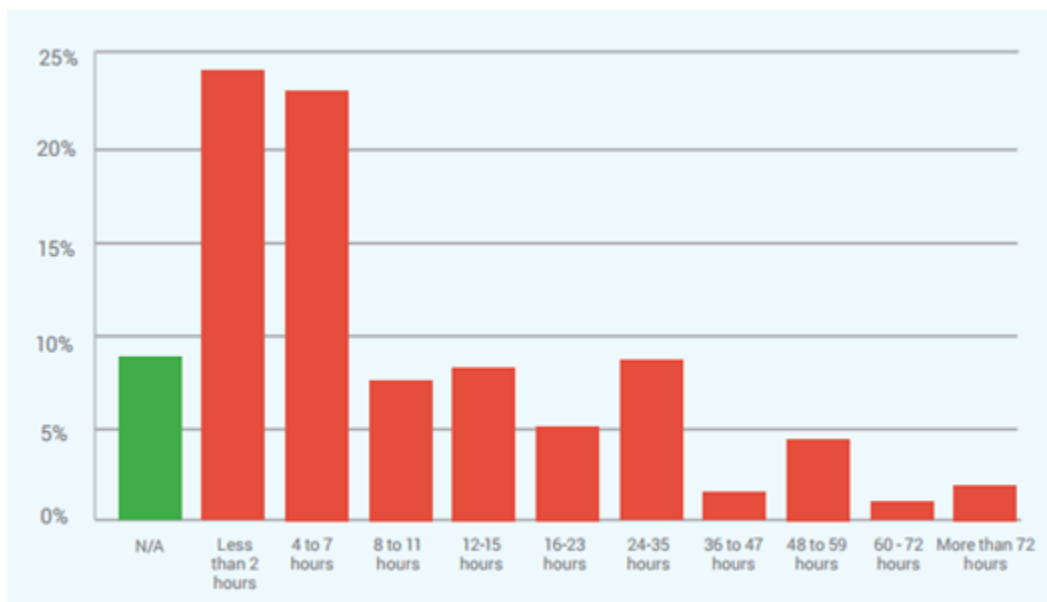
<sup>78</sup> Barack Obama, [interview with the San Francisco Chronicle](#), January 2008.

more than 50 percent of its power. Those blackouts have come at great cost to businesses and consumers. (Further discussion of South Australia appears in the first *Policy Study* in this series.<sup>79</sup>)

For example, in September 2016, a state-wide blackout occurred in South Australia, leaving 1.7 million households without access to electricity. The blackout, which started around 4:00 pm on Wednesday, September 28, lasted from a few hours in some parts of the state to several days in other parts (see Figure 23).

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**Figure 23**  
**How Long Businesses Were Unable to Operate**  
**as a Result of the September 2016 Blackout**  
**in South Australia**



Businesses reported power outages lasting less than two hours to more than 72 hours, with most businesses experiencing less than two hours without power. These statistics may be influenced by the fact the blackout happened near the end of the business day. *Source:* Renato Castello, “[Business SA Calculates September’s Massive Blackout Cost the State \\$367 Million](#),” news.com.au, December 9, 2016.

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The power outage cost businesses an estimated \$367 million. Business SA—the South Australia Chamber of Commerce—noted the losses would have been significantly higher if the blackout had started earlier in the business day.<sup>80</sup> After conducting a survey of its members, Business SA

<sup>79</sup> Isaac Orr and Fred Palmer, “How the Premature Retirement of Coal-Fired Power Plants Affects Energy Reliability, Affordability,” *Heartland Policy Study* No. 145, February 2018.

<sup>80</sup> Nick Harmsen, “[South Australian Blackout Costs Business \\$367m, Fears Summer Outages on Way, Lobby Group Says](#),” Australian Broadcasting Company, December 8, 2016.

issued the following statement: “Considering 70 percent of respondents had power restored within 24-hours, we are looking at a cost of close to \$120,000 per minute for all businesses in the state.”<sup>81</sup>

According to the Business SA survey results, the median cost borne by businesses due to the power outage was \$5,000, a figure that includes the loss of production, trading, and the cost of paying wages to employees. The vast majority of those losses were absorbed by business owners and consumers; only 37 percent of businesses had business interruption insurance and more than half of those with insurance were not covered for losses associated with blackouts. Only 12 percent of businesses had a backup generator.<sup>82</sup>

In today’s energy environment, increasing renewable capacity at the expense of reliable coal-fired power plants puts the United States at greater risk of experiencing costly power outages.

Since the state-wide blackout, South Australia has experienced two more load-shedding events—power outages caused by grid operators cutting power to certain areas so power plants are not overloaded and damaged—on December 1, 2016 and February 9, 2017. The December blackout caused the electricity distributor to make

compensation payments of more than \$20 million to about 75,000 customers.<sup>83</sup>

Power outages could be even more devastating if they were to occur in the United States, given our larger population and economy. For example, in mid-August 2003, an electric power blackout lasted up to four days in parts of the American Northeast and Midwest and in Canada, adversely affecting 50 million people and shutting down 62,000 megawatts of electricity load. The blackout cost an estimated \$4 billion to \$10 billion in economic losses due to food spoilage, lost production, overtime wages, and power line damages.<sup>84</sup> In response to the need for a more reliable energy system, Congress passed legislation in 2005 directing the Federal Energy Regulatory Commission (FERC) to develop incentive-based rate treatments for interstate transmission.<sup>85</sup>

The 2003 blackouts in the United States were not caused by an overreliance on intermittent renewable resources. But in today’s energy environment, increasing renewable capacity at the expense of reliable coal-fired power plants puts the United States at greater risk of experiencing costly power outages. One analysis found:

Comparing the expected electric industry performance in the less efficient diversity portfolio case with the actual industry performance in recent years quantifies what is at

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<sup>81</sup> Renato Castello, “[Business SA Calculates September’s Massive Blackout Cost the State \\$367 Million](#),” news.com.au, December 9, 2016.

<sup>82</sup> *Ibid.*

<sup>83</sup> Charis Chang, *supra* note 25.

<sup>84</sup> U.S. Energy Information Administration, *supra* note 46.

<sup>85</sup> *Ibid.*



stake if nothing is done to arrest the erosion in the cost-effectiveness, resilience, and reliability of the current US power supply mix. A comparison of the current US electric supply portfolio outcomes from 2014 to 2016 with analyses of the expected outcome from the less efficient diversity portfolio case indicates that ... [p]reventing the erosion in reliability associated with a less resilient electric supply portfolio mitigates an additional cost of \$75 billion per hour associated with more frequent power supply outages that add to the current US average expected outage rate of 2.33 hours per year.<sup>86</sup>

The fully allocated cost of power disruptions—including lost workdays, foregone business sales, time spent waiting in gas lines, the life-or-death strains on hospitals and other health care facilities, and more—is far higher than

The National Academy of Sciences found the economic cost of blackouts is about 50 times higher than the price of the actual electricity lost.

generally recognized. The National Academy of Sciences found the economic cost of blackouts is about 50 times higher than the price of the actual electricity lost, even without taking into account deaths or other human tragedies.<sup>87</sup> It is estimated that power outages already cost the U.S. economy nearly \$200 billion a year.<sup>88</sup>

## E. Impact on Coal-Mining Communities

The premature closure of coal-fired power plants has caused significant harm to coal-mining communities and coal-producing states, leading to jobs losses and falling coal production.

U.S. employment in coal mining peaked in 1923 at 863,000. Since then, mechanization has greatly improved productivity in coal mining, and employment has declined (see Figure 24)<sup>89,90</sup> even as coal production increased.

More than 80 percent of the coal jobs in the United States support electricity production. Between 2011 and September 2016, increased regulation, low natural gas prices, mechanization, and a shift to western coal resulted in the loss of 36,000 coal-mining jobs, of which nearly 90 percent were in Appalachia.<sup>91</sup> Jobs in the coal industry have an average salary of \$82,000 per year, making the loss of these jobs a significant problem for the region.

<sup>86</sup> Lawrence Makovich and James Richards, *supra* note 27, page 42.

<sup>87</sup> "[Hurricane Sandy Alters Utilities' Calculus on Upgrades](#)," *New York Times*, December 29, 2012.

<sup>88</sup> Neil Hodge, "[Power Trip](#)," *Special Topic – Emerging Risks*, Allianz Global Corporate & Specialty, 2012. Other studies estimate power interruptions cost the U.S. economy about \$150 billion each year, or 4 cents/kWh; see [Electric Reliability: Problem, Progress, and Policy Solutions](#), Galvin Electricity Initiative, February 2011.

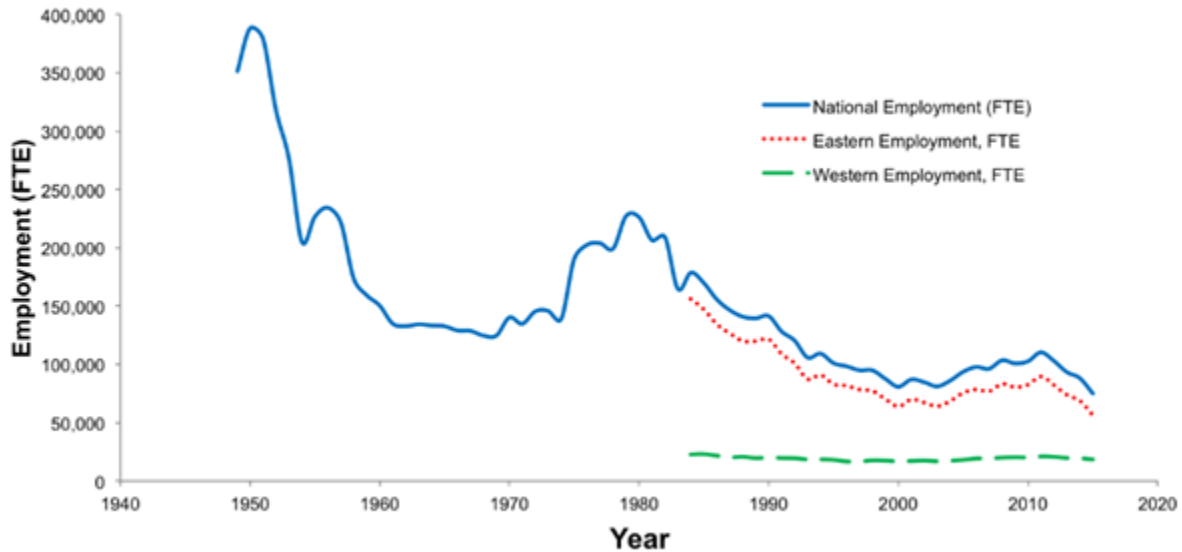
<sup>89</sup> Management Information Services Incorporated, *supra* note 19.

<sup>90</sup> Charles Kolstad, "[What Is Killing the Coal Industry?](#)" Stanford Institute for Economic Policy Research, March 2017.

<sup>91</sup> U.S. Department of Energy, *supra* note 5.

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**Figure 24**  
**Employment in Coal Mining, National, Western U.S. and Eastern U.S.**  
(FTE: Full-Time Equivalent)



Employment in the coal industry has been declining for decades as productivity gains allow fewer workers to mine more coal. However, coal mining jobs fell dramatically during the Obama administration. *Source:* Charles Kolstad, [“What Is Killing the Coal Industry?”](#) Stanford Institute for Economic Policy Research, March 2017.

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A recent study commissioned by the U.S. Department of Energy found the number of coal jobs in the country has been seriously underestimated, because official estimates do not include contractor employment, which constitutes 30 to 40 percent of the mining jobs in states such as Kentucky and West Virginia. The study concluded Appalachia lost more than 36 percent of its coal mining employment between 2011 and 2015. More than 70 percent of the Appalachian coal job losses were concentrated in Kentucky and West Virginia.<sup>92</sup>

Including contractor jobs, the Appalachian coal industry employed more than 95,000 people in 2009, and that total grew to 102,000 in 2011. Between 2011 and 2015, however, the number of people employed in the Appalachian coal-mining industry fell to 65,600 jobs, a decline of 36 percent.<sup>93</sup>

Job losses due to productivity gains are a net positive for the economy, although individuals and their families are still hurt by such job losses. Job losses due to distortions in the energy market

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<sup>92</sup> Management Information Services Incorporated, *supra* note 19.

<sup>93</sup> *Ibid.*

caused by scientifically unjustified regulations and uneconomic renewable energy subsidies hurt individuals, families, consumers, businesses, and the economy overall.

## **Part Four Concluding Observations**

Electricity prices have risen approximately 36 percent since 2003 despite falling prices for natural gas and essentially flat prices for coal. The increase can be attributed at least in part to the premature retirement of coal-fired power plants, because existing coal plants generate electricity for half the cost of new wind generation and one-third the cost of new solar generation.

Federal subsidies for wind and solar generation sources exceeded \$11 billion in 2013; extension of the wind Power Tax Credit and solar Investment Tax Credit will likely impose additional high costs on taxpayers. Moreover, the reported costs of wind and solar energy do not take into account the expensive, extensive transmission lines needed to transport the electricity to population centers. In Texas, 3,600 miles of transmission lines were built at the cost of \$7 billion—nearly \$2 million per mile and \$950 per household in the state.

The United States has among the lowest industrial electricity rates in the world, but this competitive advantage is threatened by policies that prioritize intermittent renewables over affordable baseload power.

Failing to act to preserve the existing coal-fired generation fleet will impact all U.S. citizens and enterprises, hurting families, businesses, and manufacturers. Low-income households are especially harmed because they pay the largest share of their income in energy bills. Businesses are harmed by increasing commercial electricity prices and the potential for power outages if the reliability of the grid is undermined. Businesses in South Australia have already suffered this fate.

The United States has among the lowest industrial electricity rates in the world, but this competitive advantage is threatened by policies that prioritize intermittent renewables over affordable baseload power. The United States risks sluggish growth in energy-intensive industries if it continues to follow in California’s renewable energy footsteps. Already, coal communities have been decimated by overregulation, low natural gas prices, and renewable energy subsidies and mandates.

The final report in this *Heartland Policy Study* series, “How to Prevent the Premature Retirement of Coal-Fired Power Plants,” will help policymakers correct imbalances in regulated and unregulated power markets to ensure the United States has access to affordable, reliable electricity for decades to come.

# # #

## About the Authors

**Isaac Orr** is a research fellow for energy and environment policy at The Heartland Institute. Orr is a speaker, researcher, and writer specializing in hydraulic fracturing, frac sand mining, agricultural, and environmental policy issues. He graduated from the University of Wisconsin Eau Claire with studies in political science and geology, winning awards for his undergraduate geology research before taking a position as an aide in the Wisconsin State Senate, where he served as lead-office writer and as a policy advisor on frac sand mining and agricultural issues.

Since joining Heartland, Orr has written a *Heartland Policy Study* on fracking titled “[Hydraulic Fracturing: A Game-Changer for U.S. Energy and Economies](#)” and has coauthored multiple policy studies on frac sand mining, including “[Environmental Impacts of Industrial Silica Sand \(Frac Sand\) Mining](#)” and “[Economic Impacts of Industrial Silica Sand \(Frac Sand\) Mining](#).”

Orr’s writing has appeared in *The Wall Street Journal*, *USA Today*, the *New York Post*, *The Hill*, *Orange County Register*, and *Washington Times*. His work on fracking is also featured in *Alternative Energy and Shale Gas Encyclopedia*, published by John Wiley & Sons, Inc. He has recorded dozens of podcasts on energy and environment topics for Heartland.

**Frederick D. Palmer** is a senior fellow for energy and climate at The Heartland Institute. He served from 2001 through June 2015 as Peabody Energy’s senior vice president of government relations. He was Peabody’s representative on the Board of Directors of the World Coal Association and served as its chairman from November 2010 to November 2012. He also represented Peabody on the Board of the FutureGen Alliance from its formation until June 2015.

Prior to joining Peabody Energy, Palmer served as general counsel and chief executive officer of Western Fuels Association, Inc. He served on the Board of Directors of the National Mining Association and served as chair of the NMA Legal Committee. He began his career in 1969 in Washington, DC on the staff of Arizona Congressman Morris K. Udall and was a partner in a Washington, DC-based law firm. He was the 2004 recipient of the Erskine Ramsay Medal Award from the Society for Mining, Metallurgy and Exploration. He is a member of the National Coal Council, Executive Committee, and chairman of the Coal Policy Committee. He is a member of the California and DC Bar Associations.

Palmer attended the University of Arizona, where he earned a Bachelor of Arts degree in 1966 and Juris Doctorate with honors in 1969. He was inducted into the Order of the Coif honor society there in 1969 and served as Symposium Editor of the *Arizona Law Review*.

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