AMERICAN EXPERIMENT

THE HIGH COST OF 100 PERCENT CARBON FREE ELECTRICTY BY 2050

Governor Evers' Proposal Would Cost Wisconsin $248 Billion Through 2050 and Lead to Blackouts

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Executive Summary

- Wisconsin Governor Tony Evers' proposal for a 100 percent carbon-free electric grid by 2050 would cost Wisconsin families and businesses an additional $248 billion (in constant 2022 dollars) through 2050, compared to operating the current electric grid.
- Wisconsin electricity customers would see their electricity expenses increase by an average of $2,755 per year, every year, through 2050.
- The Muskego-Norway School District would see electricity costs increase by approximately $537,588 every year under the Evers Plan. This means the district would have to lay off 9 teachers making the average salary of $58,000 per year to pay these higher electric bills or raise property taxes to keep them on staff.
- Rising electricity prices would threaten jobs in energy intensive industries like manufacturing and agriculture. Jobs in the papermaking industry would be particularly at risk.
- The Evers Plan would reduce the reliability of the grid by making the state more vulnerable to fluctuations in electricity output from weather-dependent energy sources like wind and solar.
- Under the Evers Plan, the electric grid would experience capacity shortfalls, which means there is not enough electricity on the grid to prevent blackouts, in half the years studied due to weather-driven fluctuations in electricity generation from wind and solar facilities.
- Shockingly, Wisconsin would experience devastating 8-hour and 20-hour blackouts in late January 2050 if electricity demand and wind and solar output are the same as they were in the year 2020.
- In contrast, utilizing Wisconsin's existing coal, natural gas, and nuclear plants would reduce electricity costs by using almost fully depreciated power plants while maintaining a reliable grid.
- Blackouts would be far less likely if Wisconsin continued utilizing reliable power plants because they are not dependent on the weather for electricity generation.
- Wisconsinites would benefit most from keeping their reliable power plants running as long as possible to bring down energy costs and prevent blackouts.

Authors' Note: This report is a continuation of the work performed by Center of the American Experiment modeling the cost of energy portfolios in states throughout the country. Portions of this report have been repurposed and modified to reflect the result of Governor Evers' proposal of reaching 100 percent carbon-free electricity in Wisconsin by 2050.

Policy Recommendations

Our research leads us to five common-sense policy recommendations that would reduce the costs of electricity and maintain the reliability of the electric grid that Wisconsin families rely on every day. If adopted, these recommendations would save Wisconsin electricity consumers billions of dollars in the coming decades.

1. **Issue a moratorium on coal, nuclear, and natural gas plant closures:** The 15-state electric grid to which Wisconsin belongs, the Midcontinent Independent Systems Operator (MISO), currently has a 1,200-megawatt (MW) capacity shortfall, which means there is not enough reliable power plant capacity online to meet expected peak electricity demand, plus a margin of safety.

   For context, 1,200 MW is equivalent to the amount of power plant capacity needed to supply roughly half of the homes in Wisconsin with electricity on an average hour. The shortfall could grow to 2,600 MW by 2023 and 10,900 MW by 2027.[1]

   Alliant Energy and the WEC Energy Group are to be applauded for their decisions to temporarily delay the closure of three coal-fired power plants to ensure grid reliability, but these actions should be codified by policymakers in the form of moratorium on closing existing coal, nuclear, and natural gas plants until these assets have reached the end of their useful service lives and the reliability problems on the regional electric grid have been resolved.[2]

"Our research leads us to five common-sense policy recommendations that would reduce the costs of electricity and maintain the reliability of the electric grid that Wisconsin families rely on every day."

2. **Require utility companies to get approval from the Public Service Commission before retiring their facilities:** Wisconsin's system for utility regulation is currently broken. Wisconsinites are forced to purchase their electricity from government-approved monopoly utilities in exchange, but they are not getting reasonable rates and reliable service in return.

   But unlike in other states across the country, utilities in Wisconsin can close down their reliable power plants without needing final approval from regulators at the Public Service Commission (PSC). As a result, Wisconsin's electricity system is the worst of both worlds, featuring no regulatory oversight and no consumer choice.

   Wisconsin lawmakers must strengthen the oversight powers of the PSC and allow the PSC to deny proposed power plant closures from Investor-Owned Utilities (IOUs) based on cost and reliability metrics. Otherwise, Wisconsin's electricity supply will continue to become less reliable and more expensive.

3. **Require utility companies to factor into their Integrated Resource Plans the "All-In Cost" of wind and solar:** Utilities like We Energies must make the case to utility regulators that wind and solar are low cost and will not impair grid reliability. Currently, these companies are not required to attribute to new wind and solar facilities the massive costs associated with integrating these intermittent resources on to the electric grid.

   This must change, and utilities should be required to attribute the cost of additional transmission, additional state taxes, utility profits, load balancing costs, and overbuilding and curtailment costs to the wind and solar facilities that necessitate them. Our research finds that when these factors are accounted for, wind would cost more than $218 per megawatt hour (MWh), and solar would cost more than $321 per MWh, under the Evers Plan.

4. **Enact the "Get What You Pay For" Act:** A fundamental problem with the monopoly utility model is that utilities can recover the full cost of an asset, plus a rate of return, regardless of whether that asset contributes to the grid's reliability. We believe ratepayers should only pay for the reliable portion of energy sources.

   For example, MISO gives wind turbines a 15.5 percent capacity accreditation, which assumes wind will produce 15.5 percent of its potential output when needed most.[3]

   Under this legislation, a Wisconsin company would recover from ratepayers only 15.5 percent of the wind turbine cost – the portion of the wind project MISO deems as reliable for Wisconsin consumers – with the remainder paid by shareholders. This would protect ratepayers from large cost increases stemming from wind and solar construction by shifting costs to company shareholders.

5. **Acknowledge that increasing Wisconsin's renewable energy mandate would be repeating California's energy mistakes and expecting different results:** Mandating that 100 percent of Wisconsin's electricity come from carbon-free resources by 2050 would cost Wisconsinites $248 billion—a cost of nearly $2,755 per customer per year—and potentially cause a 20-hour blackout in January.

   This is an enormous price to pay in exchange for potentially averting 0.00092° C of warming by 2100, an amount too small to measure with even the most sophisticated scientific equipment.

Introduction

Wisconsin stands at an energy crossroads. The Badger State can either choose to prioritize reliable, low-cost electricity, or it can pursue the same policies as California, which have resulted in skyrocketing costs and rolling blackouts. Unfortunately, it appears Governor Tony Evers and some utility companies in the state have opted for the latter.

The situation is urgent, because the electricity that powers Wisconsin homes and factories is already becoming more expensive and less reliable.

Data from the U.S. Energy Information Administration (EIA) shows that Wisconsin's electricity prices are the third-highest in the Midwest, and our research concludes that building the wind turbines, solar panels, and battery storage facilities needed to meet the energy mandates put forward by the Evers Administration would cause Wisconsin to have the highest electricity prices in the country, compared to 2020 electricity rates.[4,5]

These policies would also reduce the reliability of the electric grid at a time when it is already stressed. This summer, the North American Electric Reliability Corporation (NERC) issued a dire report concluding the Upper Midwest, including Wisconsin, does not have enough reliable power plants online to meet its peak electricity demand with a margin of safety.[6]

"The Badger State can either choose to prioritize reliable, low-cost electricity, or it can pursue the same policies as California, which have resulted in skyrocketing costs and rolling blackouts. Unfortunately, it appears Governor Tony Evers and some utility companies in the state have opted for the latter."

This shortfall of reliable power plants exists because too many electric companies, including companies in Illinois, are following in California's footsteps by shuttering their reliable coal, natural gas, and nuclear power plants and are becoming increasingly reliant on weather-dependent wind and solar power, increasing the risk of rolling blackouts.[7,8,9]

Blackouts hit California in the summer of 2020, and it almost experienced them again in September 2022 because the Golden State shuttered too many nuclear and natural gas plants and is too reliant upon intermittent solar, wind, battery storage, and imports of electricity from neighboring states.[10]

Adding insult to injury, California's electricity prices have increased four times faster than the national average since 2008, when then-Governor Arnold Schwarzenegger signed an executive order requiring 33 percent of California's electricity to be renewable by 2020.[11,12] In 2018, California passed a law mandating that 100 percent of its electricity come from carbon-free resources by 2045, further causing prices to increase and reliability to falter.[13]

Many people seem to believe that replacing coal and natural gas-fired power plants with wind turbines, solar panels, and battery storage technologies will be easy to accomplish and reduce electricity prices. That belief is not supported by the physics of the electrical system or the real-world experience of states with high penetrations of wind and solar power.

The biggest problem with relying on wind and solar is their electricity generation is erratic. Wind turbines and solar panels can produce electricity only when the wind is blowing or the sun is shining but our demand for electricity must be met regardless of weather conditions.

It is a common misconception that the grid is a device that stores electricity for later use, like a giant bathtub that fills with power that can be accessed when needed at a later time. This misguided understanding of the grid leads people to believe that wind and solar can increase the availability of electricity on the grid and improve reliability.[14] They cannot.

Solving the challenges of erratic power generation would require enormous amounts of battery storage, which our research shows would be cost prohibitive. These physical realities mean that enacting California-style energy policies in Wisconsin will yield California-style results.

This study assesses how Governor Evers' proposal to make Wisconsin's electricity grid 100 percent carbon-free by 2050 (the "Evers Plan") would greatly increase energy costs for Wisconsin families and businesses and make the grid more fragile.

Section I: What is the Evers Plan?

Photo Courtesy: Wisconsin Watch/Flickr.com

In August of 2019, Governor Evers signed Executive Order 38, requiring the establishment of the Wisconsin Office of Sustainability and Clean Energy (SCE) and it also established an executive action to require 100 percent of Wisconsin's electricity be generated by carbon-free electricity sources by 2050.[15]

In April 2022, the SCE issued its *Wisconsin Clean Energy Plan (CEP)*, which established carbon dioxide reduction schedule of at least 60 percent by 2030 and 100 percent by 2050. The CEP also offered suggestions for how to reduce these emissions, including the possibility that Wisconsin impose a carbon tax on energy, and enact government mandates for carbon-free energy systems.[16,17]

Governor Evers' report shows two potential energy pathways to obtaining 100 percent of our electricity from sources that do not emit carbon dioxide.[18] One of these scenarios employs high amounts of wind, the other solar. Neither scenario appears to add appreciable quantities of new nuclear power plants in Wisconsin. As a result, the Evers Plan is almost entirely a wind, solar, and battery storage mandate, a policy that will cause electricity prices to increase substantially and reduce the reliability of the grid.[19]

"This analysis examines the cost and reliability implications of complying with the Evers Plan and compares it to operating the current electric grid, which would provide the lowest cost, and most reliable electricity for Wisconsin families and businesses."

This analysis examines the cost and reliability implications of complying with the Evers Plan and compares it to operating the current electric grid, which would provide the lowest cost, and most reliable electricity for Wisconsin families and businesses. We conclude that complying with the Evers Plan will make maintaining a reliable electricity grid exponentially more expensive and more difficult.

Readers should note that this analysis does not account for federal subsidies paid to wind and solar facilities. This methodology is appropriate because federal subsidies would not reduce the cost of producing energy using these resources; they would simply shift who pays for it.

This analysis also assumes that electricity consumption in Wisconsin will remain constant at approximately 75.1 million MWhs from 2021 through 2050.[20,21] This assumption is conservative because proponents of renewable energy mandates often promote the widespread adoption of electric vehicles and the broader electrification of the energy sector for purposes such as home and water heating. Doing so would dramatically increase the need for electricity generation and would require even more capacity additions to comply with the Evers Plan.

The additional costs associated with rising levels of electrification are not analyzed in this study because it seeks to provide an apples-to-apples comparison of the cost of electricity in Wisconsin with and without, the Evers Plan.

The appendix explains the assumptions and factors considered by our model.

Is the Evers Plan realistic?

The Evers Plan will require a massive buildout of new power plant capacity on an aggressive timeline that may not even be possible.

For example, the Evers Plan would require Wisconsin to have 48,081 megawatts (MW) of wind capacity, 35,726 MW of solar capacity, 41,702 MW of four-hour battery storage capacity, and 385 MW of small modular nuclear reactors (SMRs) online by 2050. In 2020, Wisconsin had just 724 MW of wind, 208 MW of solar, zero MW of battery storage, and zero MW of SMRs.

While we can model the theoretical cost of attempting to power a grid with wind, solar, battery storage, and SMR technologies under the Evers Plan, it does not mean that this plan will materialize in the real world. The most realistic read of the situation is that eliminating greenhouse gas emissions from Wisconsin's electricity sector is unlikely to be technically or economically feasible by 2050.

Section II: Wisconsin's Electricity Mix Before and After the Evers Plan

In 2019, Wisconsin derived 35.2 percent of its electricity from coal, 27.2 percent from natural gas, 13.4 percent from nuclear, 16.2 percent from imports of electricity from other states, 3.5 percent from hydroelectric, 2.5 percent from wind, 1.8 percent from biomass, 0.2 percent from petroleum, 0.1 percent from solar, and 0.1 percent from "other" sources (see Figure 1).[22,23]

Under the Evers Plan, this electricity mix would be required to shift dramatically.

> **"Under the Evers Plan, this electricity mix would be required to shift dramatically."**

In our analysis, we assumed the Evers Plan would allow existing nuclear power plants to continue operating through 2050, and that electricity generated from these plants would be counted as carbon-free under the 100 percent carbon-free mandate.

Additionally, in May of 2022 Dairyland Power Cooperative announced a memorandum of understanding (MOU) with NuScale Power to build an SMR in the state of Wisconsin, which is possible because Wisconsin lifted its moratorium on building new nuclear power plants in 2016.[24,25] While this project is in the preliminary phases and may not come to fruition, this analysis assumes Dairyland will build a 385 MW SMR to replace the coal-fired John P. Madgett Generating Station on their system entering service in 2039.

To achieve 100 percent carbon-free electricity by 2050, all utility companies will be required to replace electricity currently generated with coal, natural gas, and oil with carbon-free energy sources such as wind turbines, solar panels, battery storage facilities, or SMRs by 2050.[26]

Maintaining grid reliability would be much less costly if natural gas were used instead of battery storage to provide electricity when the wind is not blowing or the sun is not shining, but these plants would need to be shut down by 2050 under the Evers Plan. This analysis excludes the possibility of natural gas additions because the Evers CEP document states that natural gas generation in Wisconsin will likely plunge after 2040, due to carbon dioxide reduction goals.

Consistent with the goals of the Evers Plan,

FIGURE 1

2019 Wisconsin Electricty Consumption by Source

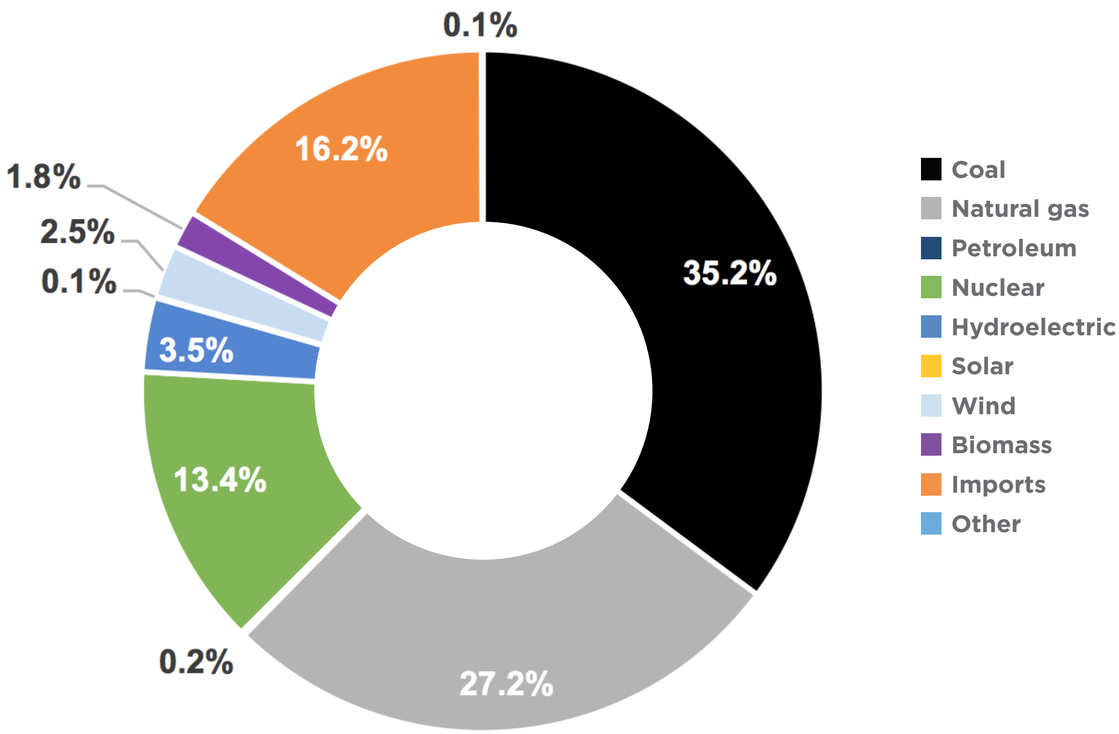


Figure 1. Coal, nuclear, natural gas, and electricity imports accounted for 92 percent of the electricity consumed in Wisconsin in 2019. Wind accounted for 2.5 percent, solar for 0.1 percent, and biomass for 1.8 percent.

this report calculates the cost of using battery storage technology to provide electricity to the grid during periods of low wind and solar output.

Generation mix under the Evers Plan

Our model calculates the generation mix resulting from compliance with the Evers Plan in Wisconsin using wind and solar generation with battery storage, and SMRs. Figure 2 shows Wisconsin's electricity mix in 2050 under the Evers Plan, and Figure 3 shows the annual share each source of electricity contributes to the state's total electricity consumption.

Under the proposal, we project that Wisconsin electric companies would be required to invest heavily in wind, solar, battery storage technologies, and SMRs. As a result, by 2050, 48.4 percent of Wisconsin's electricity would come from wind, 20.1 percent would come from solar, 13.2 percent would come from existing nuclear plants, 4.2 percent from new nuclear SMRs, 8.6 percent would be supplied by battery storage, 3.6 percent from hydroelectric power, and 1.8 percent from biomass. None of the state's electricity would come from coal, natural gas, or oil.

FIGURE 2

Evers Proposal Electricty Consumption by Source in 2050

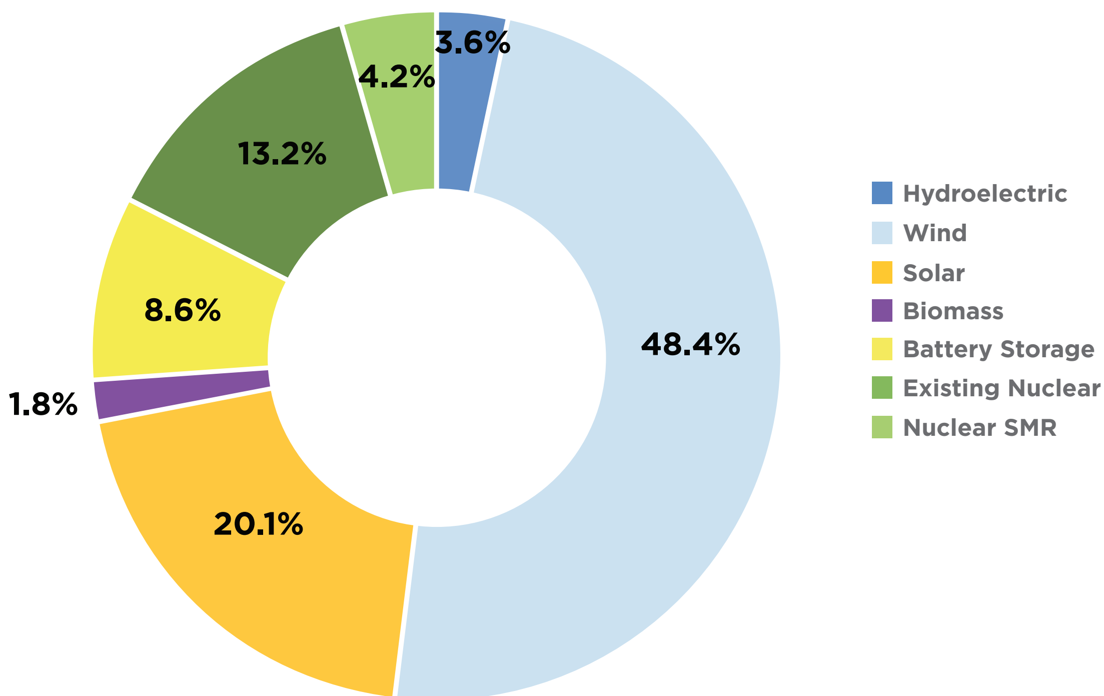


Figure 2. Wind power will become the largest source of electricity in Wisconsin by 2050, followed by solar as the second largest and nuclear as the third. Battery storage will provide 8.6 percent of Wisconsin's electricity consumption. This is drastically different than the current Wisconsin grid, which is comprised of mostly coal, natural gas, and nuclear power.

FIGURE 3

Evers Plan Share of Annual Electricity Consumption

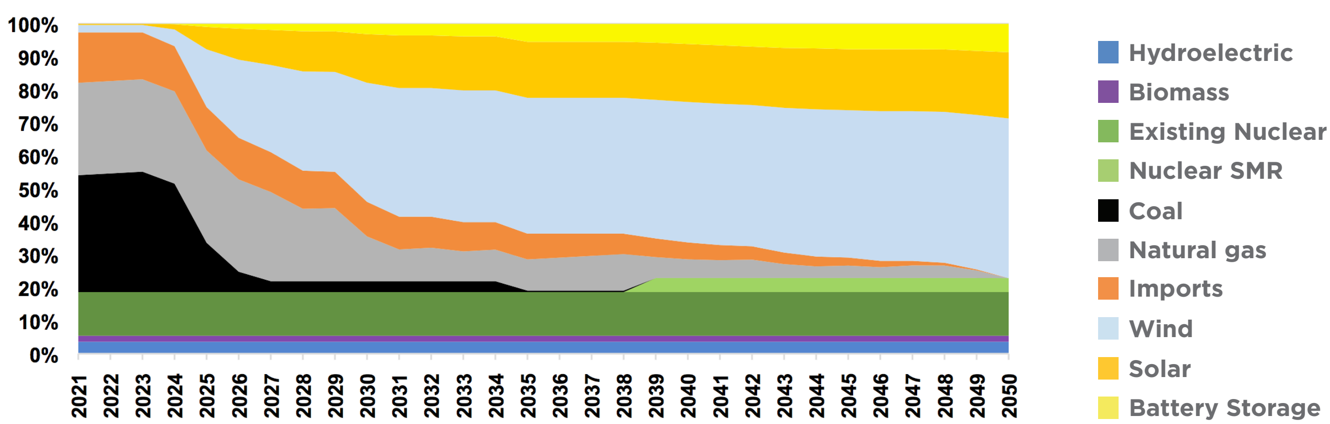
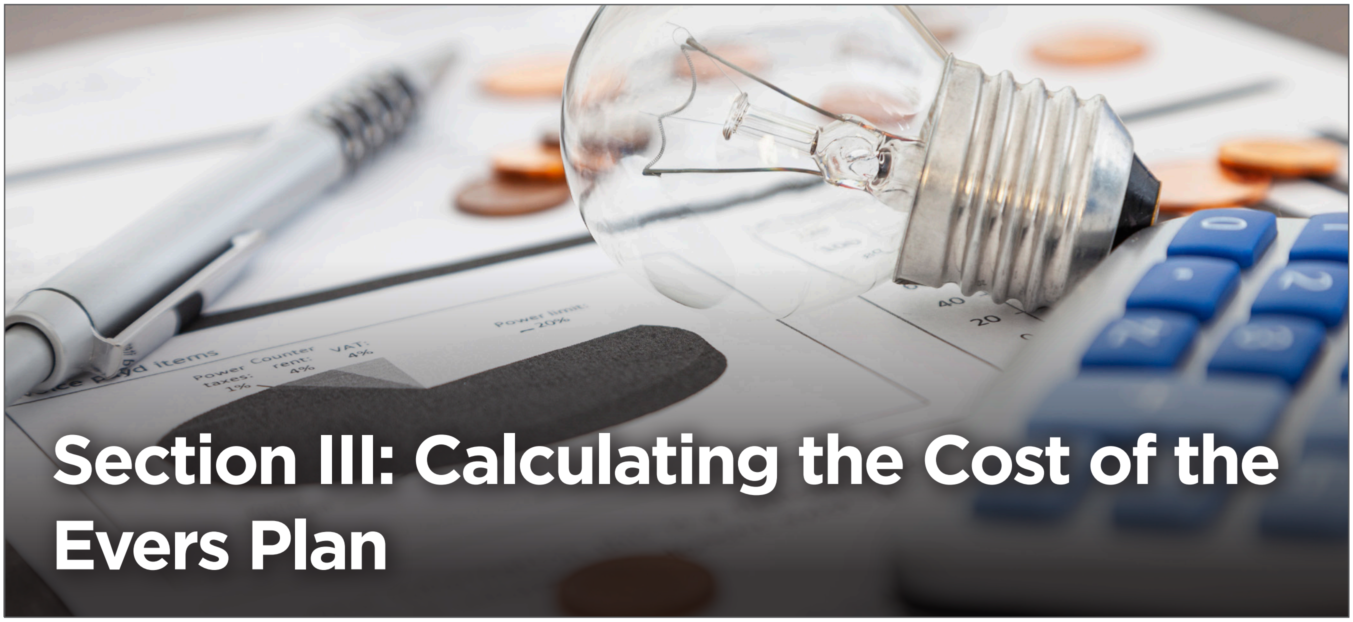


Figure 3. Coal and natural gas generation are phased out by 2039 and 2050, respectively. Wind and solar generation increase to 48 percent and 20 percent, respectively, making them the two largest sources of electricity in Wisconsin.



Section III: Calculating the Cost of the Evers Plan

Our modeling indicates that complying with the Evers Plan will cost an additional $248 billion (in constant 2022 dollars) compared to operating the current electric grid. This would more than double electricity prices, with rates rising from 10.82 cents per kilowatt hour (kWh) in 2020 to 28.61 cents per kWh in 2050 – an increase of 17.79 cents per kWh.

As a result, the average annual cost for each Wisconsin utility customer would increase by $2,755 per year, the equivalent of paying an additional $230 per month. Costs would rise to $4,961 per customer in 2050 (see Figure 4).[27]

Figure 4 shows the average additional cost of complying with the Evers Plan from 2021 through 2050, compared to the current cost of electricity. This number is obtained by dividing the annual cost of the mandate among all Wisconsin utility customers, including residential, commercial, and industrial electricity users. The Evers Plan immediately increases electricity costs as wind and solar facilities are built.

"Our modeling indicates that complying with the Evers Plan will cost an additional $248 billion (in constant 2022 dollars) compared to operating the current electric grid."

Residential customers

Under the Evers Plan, residential electricity prices would more than double by 2050, causing Wisconsin families to see their annual electricity costs increase by an average of $1,089 per year through 2050, an increase of over $90 per month (see Figure 5). Families would see their yearly electricity costs increase by $1,960 in 2050.

Commercial customers

Under the Evers Plan, commercial customers like small businesses, grocery stores, and other retailers would see their electricity costs increase by an average of $6,108 per year through 2050, an increase of over $500 per month (see Figure 6). In 2050, these businesses would pay an additional $11,000 for their yearly supply of electricity.

FIGURE 4

Evers Plan Annual Additional Cost per Customer

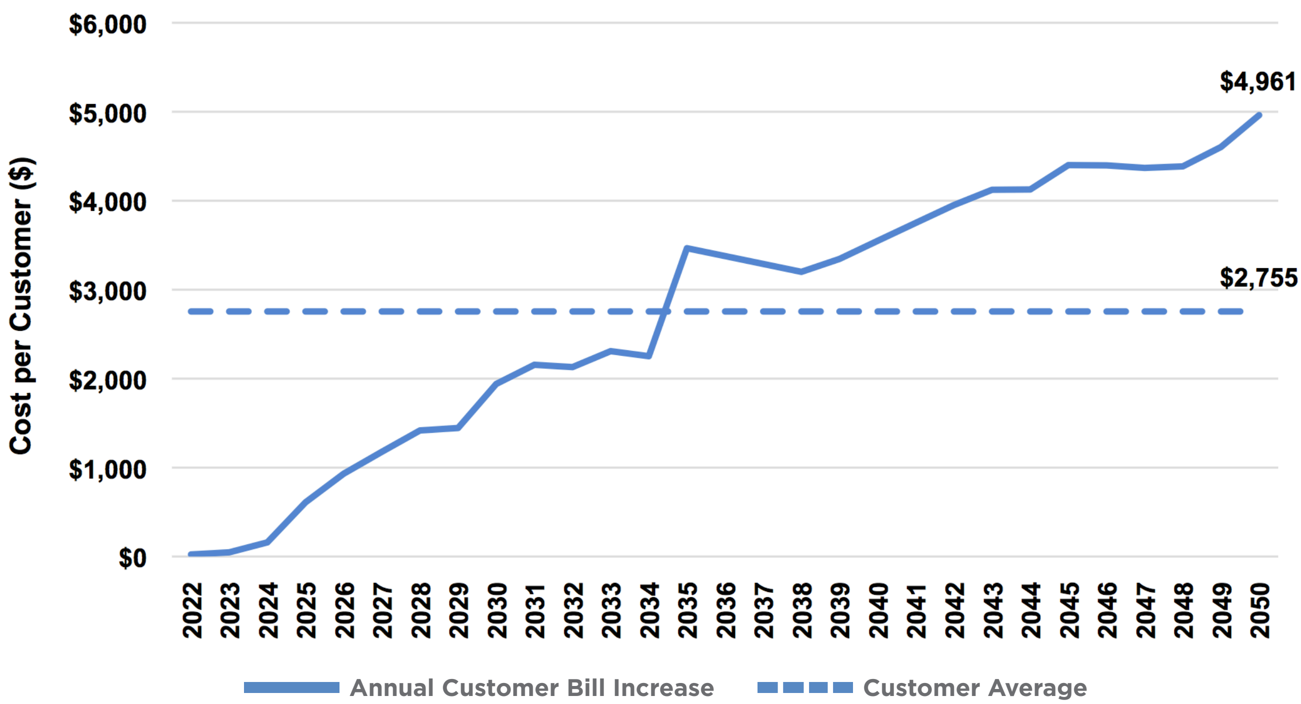


Figure 4. Annual costs for Wisconsinites increase by an average of $2,755 per year under the Evers Plan. Costs peak at $4,961 in 2050.

Industrial customers

Industrial companies in Wisconsin, such as manufacturers used roughly 32.9 percent of the electricity consumed in the Badger State in 2020. Under the Evers Plan, these firms would be hit hard, seeing electricity costs increase by an average of $262,292 per year, an increase of $21,857 per month. These costs would peak at $472,367 in 2050 (see Figure 7).

Evers Plan compliance costs are driven by the need to build enough wind turbines, solar panels, battery storage facilities, transmission lines and SMRs to meet the proposal's stipulation that the Wisconsin electric grid be 100 percent carbon-free by 2050.

"Under the Evers Plan, [industrial companies] would be hit hard, seeing electricity costs increase by an average of $262,292 per year, an increase of $21,857 per month."

Other factors that increase costs include rising state taxes as a result of having 7.7 times more capacity on the system than in 2020, and utility profits that would result from the state-approved rate of return on undepreciated assets for government-approved investor-owned utilities.

FIGURE 5

Evers Plan Annual Additional Cost per Residential Customer

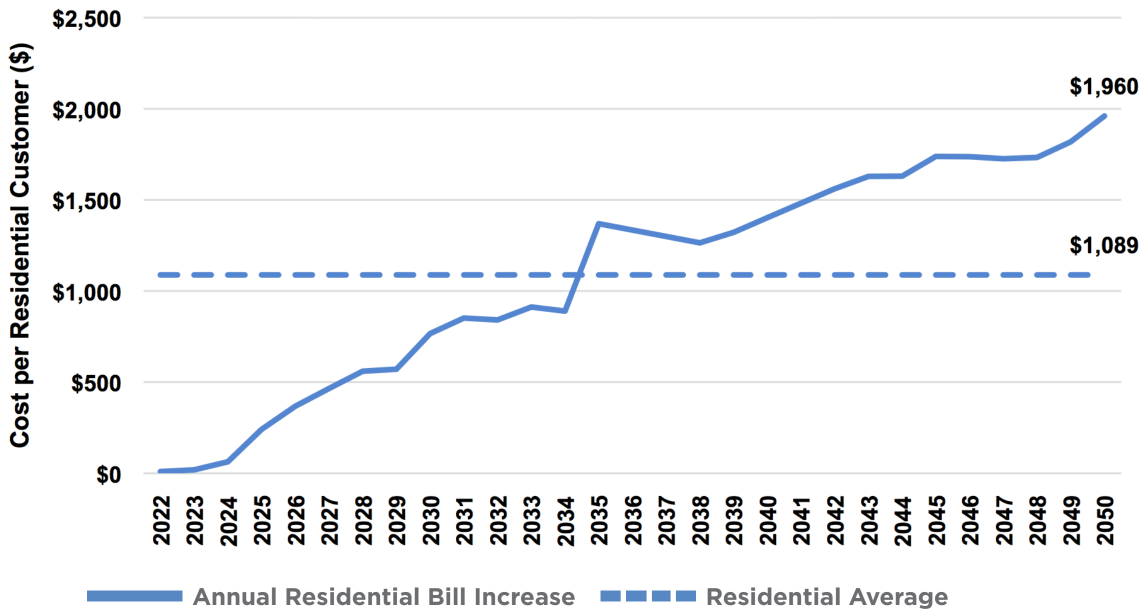


Figure 5. Wisconsin families would see their electric bills increase by an average of $1,089 per year.

FIGURE 6

Evers Plan Annual Additional Cost per Commercial Customer

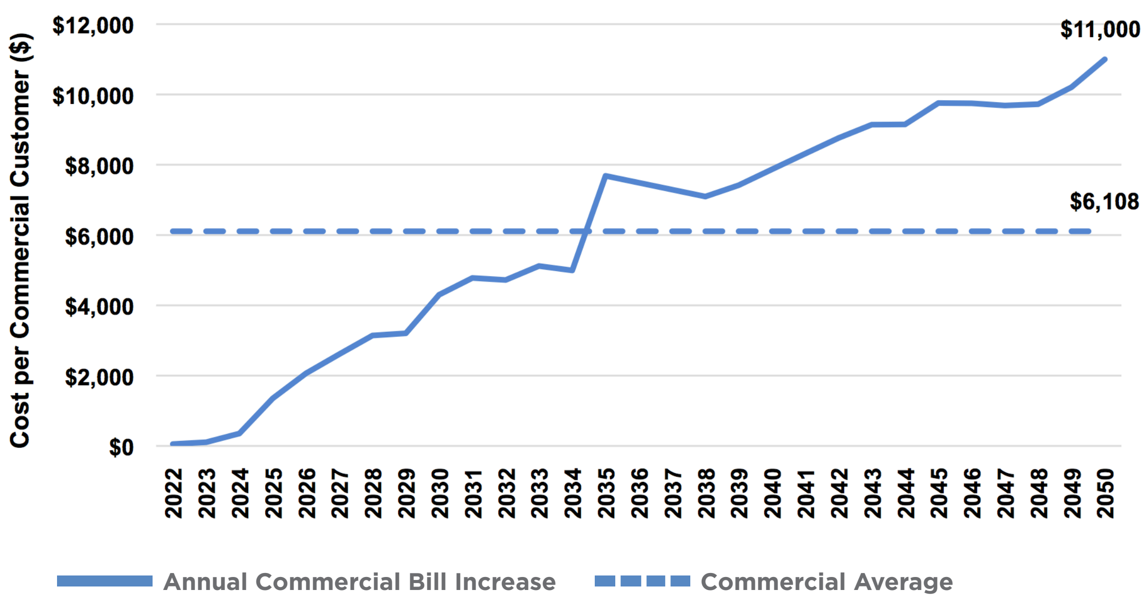


Figure 6. Costs for commercial customers, such as small businesses, rise quickly, peaking at $11,000 in 2050.

FIGURE 7

Evers Plan Annual Additional Cost per Industrial Customer

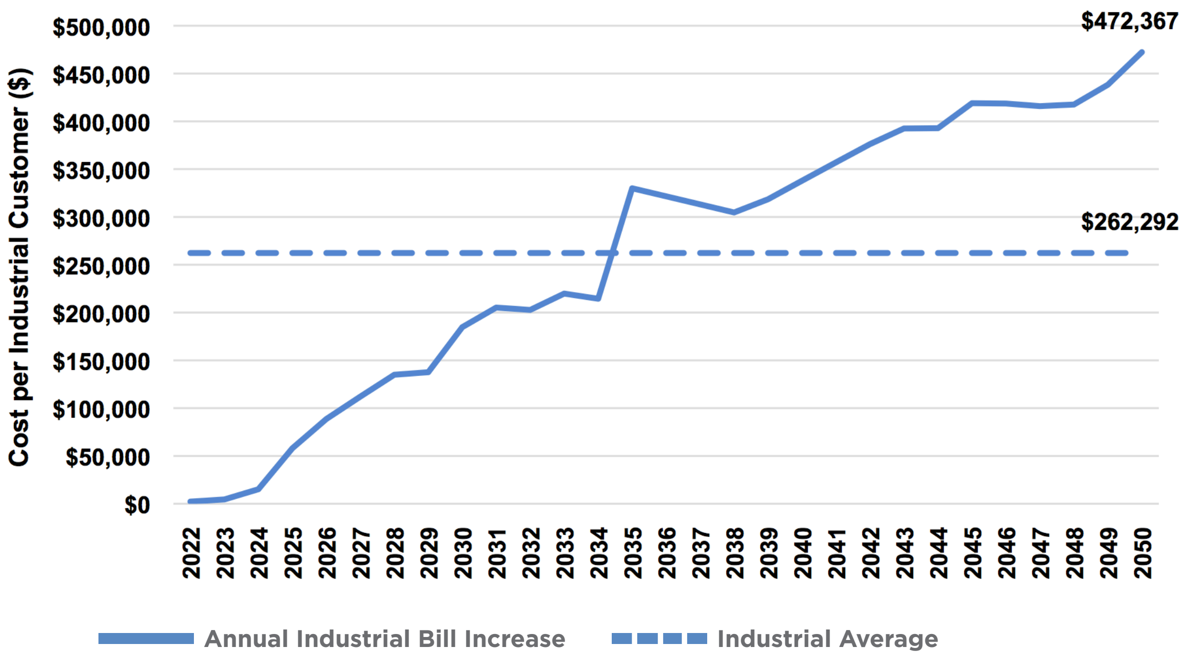


Figure 7. Industrial electricity consumers would experience cost increases of over $262,292 per year under the Evers Plan, an increase of nearly $22,000 per month.

Section IV: How Wind, Solar, and Battery Storage Drive Up Costs Compared to Reliable Power Plants

Thus far, this report has summarized the cost difference between the Evers Plan and using Wisconsin's existing power plants. In this section, we will discuss how attempting to run a reliable electric grid using mostly wind, solar, and battery storage drives up costs to a much greater extent than building a grid using reliable power plants.

The most important thing to know about the electric grid is that the supply of electricity must be in perfect balance with demand at every second of every day.[28] If demand rises as Wisconsinites turn on their air conditioners or heaters, an electric company must increase the supply of power to meet that demand. If companies are unable to increase supply to meet demand, grid operators are forced to cut power to consumers—i.e. initiate brownouts or blackouts— to keep the entire grid from crashing.

> **"The most important thing to know about the electric grid is that the supply of electricity must be in perfect balance with demand at every second of every day."**

Generating more electricity is relatively easy with dispatchable power plants—plants that can be turned up or down on command—like those powered with coal, natural gas, and nuclear fuel. But adjusting to second-by-second fluctuations in electricity demand is much more difficult with wind and solar, whose electricity production is dependent on second-by-second fluctuations in the weather. As a result, it is much more difficult to provide reliable power as we become more reliant upon wind and solar to meet our energy needs.

It is possible to mitigate some of the inherent unreliability of wind and solar by vastly increasing the amount of wind and solar capacity on the grid (known as "overbuilding" wind and solar installations) to allow electricity demand to be met even on cloudy or low-wind days, and curtailing, or turning off, much of this capacity when wind and solar production is higher. Other mitigation strategies include building more transmission lines and battery storage facilities. Each of these mitigation strategies, however, is a major driver of cost for the entire electric system.

These mitigations come with other

FIGURE 8
Evers Plan Total Installed Capacity in 2050 vs. Current Grid

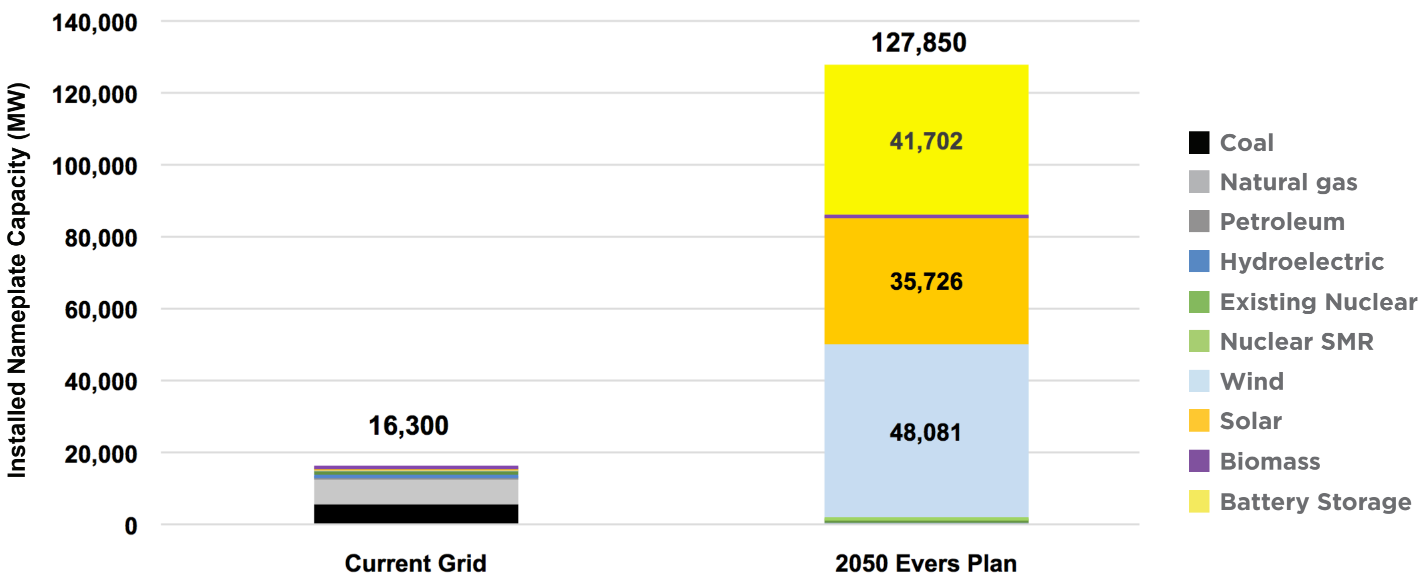


Figure 8. Complying with the Evers Plan would require 7.7 times more installed capacity on the electric grid Wisconsin relies upon to maintain a reliable system. This massive buildout of capacity would drive significant cost increases for families and businesses.

additional costs, including higher profits for government-approved monopoly utilities like We Energies, Alliant Energy, Wisconsin Public Service, and Xcel Energy and higher state taxes. Each of these additional costs will be discussed in greater detail below.

Increasing electricity generation capacity

Building and operating new power plants is expensive. The Evers Plan would greatly increase the amount of new power plant capacity on Wisconsin's electric grid, which is why it is so costly.

In 2020, Wisconsin had roughly 16,300 MW of installed power plant capacity on the grid and relied upon at least 1,300 MW of import capacity—supplying 11.4 million MWh of electricity—to meet electricity demand. These imports come from other states on the regional grid.[29]

Under the Evers Plan, the amount installed power plant capacity in Wisconsin would increase from 16,300 MW in 2020 to 127,850 MW by 2050. This means the Evers Plan would require nearly 7.75 times more in-state power plant capacity than is currently used to meet Wisconsin's electricity demand (see Figure 8).

While adding power plant capacity to the grid may sound like a good thing, increasing capacity merely to meet green energy mandates rather than meeting electricity demand is an unnecessary cost that will harm Wisconsin families and the state's economy.

Wind installations under the Evers Plan

FIGURE 9

Evers Plan Hourly Electricity Supply During Peak Load 6/4/2050-6/11/2050

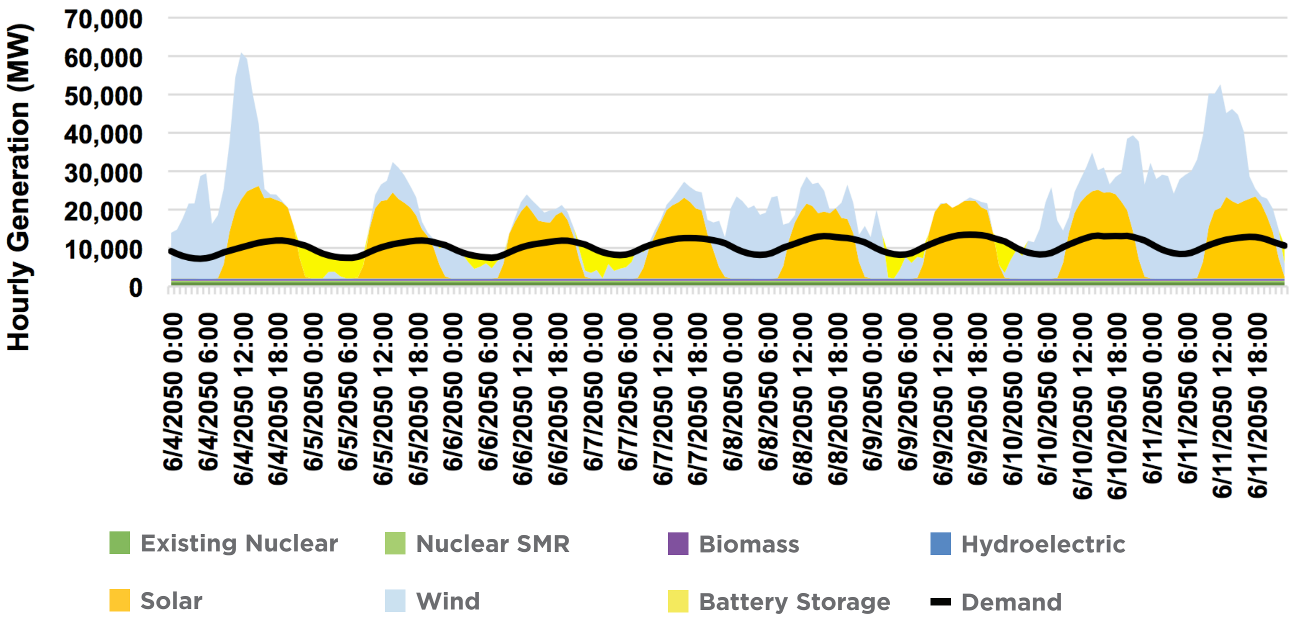


Figure 9. Battery storage is needed to help meet electricity needs during periods where wind and solar generation is insufficient to meet demand. The batteries are charged by the solar panels and wind turbines when their generation exceeds the black demand line and discharged when wind and solar are unavailable.

would increase from 724 MW of installed capacity in 2020 to 48,081 MW of capacity in 2050. Solar capacity would grow from 208 MW in 2020 to 35,726 MW in 2050, and battery storage would increase from zero MW in 2020 to 41,702 MW, with four hours of storage per MW, SMR capacity would grow from zero MW in 2020 to 385 MW by 2050 (See Figure 8).[30]

It is important to note that our model selected these quantities of solar, wind, and battery storage resources because they were the most cost-effective portfolio for meeting the carbon-free energy mandates proposed by Governor Evers and maintaining grid reliability under 2021 electricity demand and wind and solar generation conditions.

Building these solar panels, wind turbines, and battery storage facilities would cost $47 billion, $73.5 billion, and $43 billion, respectively. Eventually repowering these facilities at the end of their 20- to 25-year useful lives would cost an additional $59.7 billion, however, most of these costs would be paid for beyond 2050.[31]

Figure 9 shows the electricity provided by each resource from June 4 through June 11 in 2050. These dates were selected because they show the period in time where electricity demand is the highest, which is commonly referred to as peak electricity demand. Electric grids must be built to accommodate this peak demand plus a margin of safety—called a "reserve margin"—much in the same way a bridge must be built to handle its maximum capacity plus a factor of safety, making it

FIGURE 10

New Transmission Capacity Requirements for Wind and Solar Integration

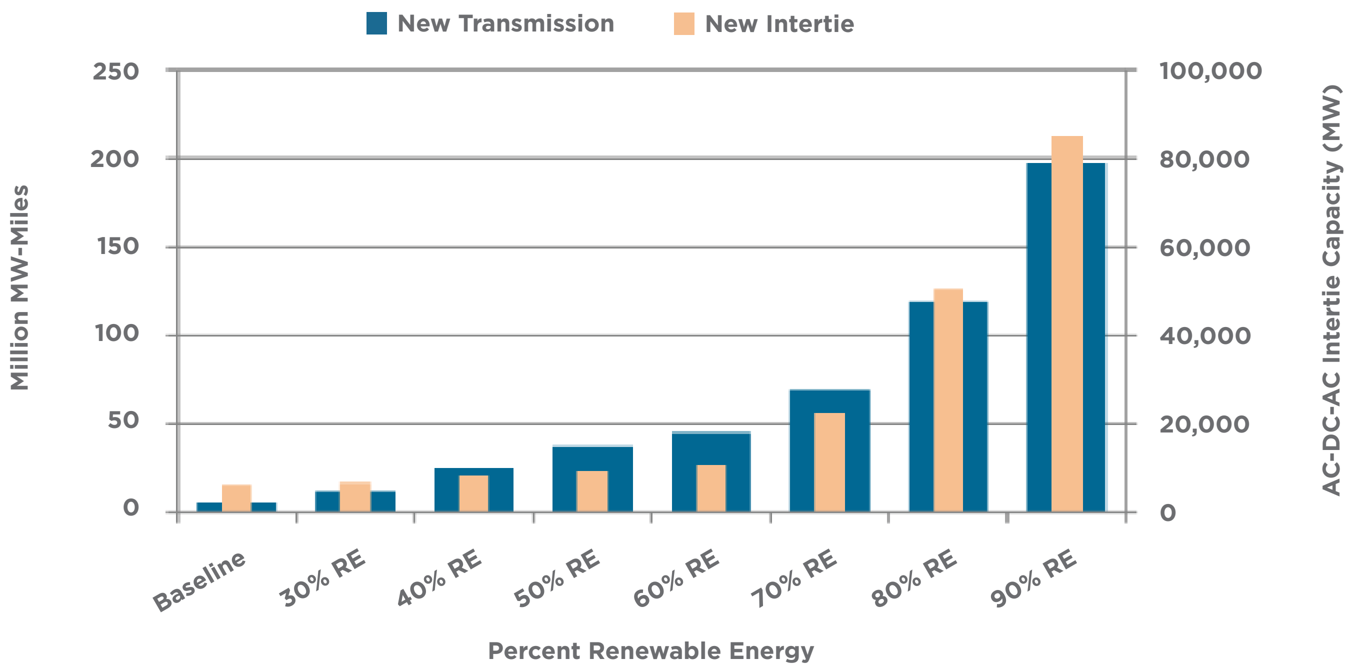


Figure 10. NREL estimates show the amount of transmission needed increases dramatically as the percentage of electricity being provided by intermittent renewable energy sources grows.

stronger than its expected maximum load.

This graph, which is based on actual 2021 federal data for electricity demand and generation from solar power plants in the Midcontinent Independent Systems Operator (MISO) region, and wind generation from the National Renewable Energy Laboratory (NREL) System Advisor Model (SAM) database, shows a hypothetical week in 2050 under the Evers Plan.

The black line shows electricity demand throughout the week. Solar generation, shown in orange, increases in the morning, peaking in mid-afternoon, before falling off in the early evening.[32] Wind generation is shown in light blue, and it varies considerably based on wind speeds. Battery storage, shown in yellow, provides electricity during the hours when wind and solar generation is insufficient to meet electricity demand.

A portion of the extra wind and solar power must be used to charge the batteries. Once the batteries are fully charged, any additional solar or wind power that is generated is curtailed, or turned off. Curtailment is expected to become increasingly common as more wind and solar facilities are placed into service on the grid.[33]

It is important to remember that this methodology is generous to the Evers Plan because Wisconsin's solar resources are not as good as those in neighboring areas on the MISO system, meaning it would likely require more capacity to meet electricity demand using Wisconsin-based solar panels.[34]

Transmission costs

Transmission lines are important: It does no good to generate electricity if it cannot be transported to the homes and businesses that rely upon it.

Transmission costs are driven by the need to build new infrastructure to connect wind turbines and solar panels to the rest of the electric grid. These facilities are oftentimes located in other states with superior wind resources.[35] Additionally, wind facilities in Wisconsin are frequently located far away from the population centers in the state.[36]

The Electricity Futures Study published by NREL shows the amount of transmission required to accommodate more wind and solar increases as they supply ever-greater quantities of electricity. The amount of transmission needed grows exponentially as wind and solar market share increase beyond 60 percent (see Figure 10).[37]

Powering a grid with 80 percent solar and wind in the United States would require the construction of approximately 115 million MW miles of transmission lines. For context, NREL estimates there are currently between 150 and 200 million MW miles of transmission lines in the United States, meaning a grid powered by 80 percent renewable energy would require a 58 to 76 percent increase in transmission infrastructure.[38]

Assuming similar increases in transmission lines would be needed for each state, Wisconsin's grid—which would be powered by 68 percent solar and wind, and 9 percent by batteries charged using wind and solar, under the Evers Plan—would require the amount of existing transmission lines to increase by approximately 58 to 76 percent to accommodate higher penetrations of intermittent renewable energy.

A Renewable Integration Impact Assessment (RIIA) study by MISO suggests most of the required increases in transmission capacity would occur in high voltage transmission lines, meaning those over 230 kilovolts (kV) or higher, with the largest increases needed for lines over 345 kV.[39]

"Transmission lines in Wisconsin routinely cost $3.2 million per mile for 230 kV lines and $5.2 million per mile for 345 kV lines. We estimate building enough transmission lines to comply with the Evers Plan would cost $6.6 billion."

Wisconsin currently has approximately 68 miles of 230 kV lines, and 2,101 miles of 345 kV lines.[40] According to our assumptions based on NREL estimates, these transmission line miles would increase by 58 percent—the low end of NREL estimates—under the Evers Plan.

Transmission lines in Wisconsin routinely cost $3.2 million per mile for 230 kV lines and $5.2 million per mile for 345 kV lines.[41,42] We estimate building enough transmission lines to comply with the Evers Plan would cost $6.6 billion.

Utility returns

In Wisconsin, investor-owned electric companies constituted 83 percent of total electricity sales in 2020, while municipal electric companies made up 10 percent, and electric co-ops provided 6.2 percent.[43]

Because investor-owned utilities (IOUs) in Wisconsin, such as We Energies, Wisconsin Public Service, Xcel Energy, and Alliant Energy are regulated monopolies in Wisconsin, they are not allowed to make a profit on the electricity they sell.

Instead, they are guaranteed a 10 percent profit, or rate-of-return on equity, when they spend money on capital assets such as power plants, transmission lines, and even new corporate offices, if the Wisconsin PSC approves those expenses. This report utilizes the capital structure of We Energies to estimate utility returns.[44]

The Evers Plan would require utilities to spend $223.2 billion on new infrastructure. As a result, additional corporate profits for investor-owned utilities under the Evers Plan would cost Wisconsin families and businesses an additional $110.8 billion through 2050. This makes the utility returns the second-largest expense in the Evers Plan.

"The Evers Plan would require utilities to spend $191 billion on new infrastructure. As a result, additional corporate profits for investor-owned utilities under the Evers Plan would cost Wisconsin families and businesses an additional $110.8 billion."

The government-approved rate of return on new power plants, regardless of their reliability, gives IOUs a powerful incentive to build unreliable wind and solar facilities with battery backup to maximize utility profits. This system places the interests of the utility in direct competition with those of the ratepayers, who would benefit most from the company utilizing its existing fleet of natural gas, coal, and nuclear power plants. Municipal utilities and co-ops, on the other hand, earn no government approved profits for building new infrastructure.

The perverse incentives of IOUs could be remedied if these companies were only allowed to recoup the portion of their costs based on the reliability of the asset in question, which is why we urge Wisconsin policymakers to adopt the "Get What You Pay for Act."

Additional state taxes

Most utility companies in Wisconsin are exempt from property taxes and are instead subject to a state tax based on their wholesale revenues, in the amount of 1.59 percent.[45]

Additional state taxes increase by $3.9 billion under the Evers Plan because building additional capacity increases required revenues for utility companies, compared to operating the current grid.

Section V: The Levelized Cost of Energy for Different Generating Resources

Almost all studies that examine the cost of renewable energy use a methodology called the Levelized Cost of Energy, or LCOE, to assess the cost of wind and solar compared to different technologies.[46] LCOE estimates reflect the cost of generating electricity from different types of power plants, on a per-unit of electricity basis (generally megawatt hours), over an assumed lifetime and quantity of electricity generated by the plant.

In other words, LCOE estimates are essentially like calculating the cost of your car on a per-mile-driven basis after accounting for expenses like initial capital investment, loan and insurance payments, fuel costs, and maintenance.

Wind and solar advocates often misquote LCOE estimates from Lazard or EIA to claim that wind and solar are now lower cost than other sources of energy. However, Lazard and EIA show the cost of operating a single wind or solar facility at its maximum reasonable output; they do not convey the cost of *reliably operating an entire electricity system* with high penetrations of wind and solar, which costs exponentially more.[47]

> **"LCOE estimates reflect the cost of generating electricity from different types of power plants, on a per-unit of electricity basis (generally megawatt hours), over an assumed lifetime and quantity of electricity generated by the plant."**

For example, Lazard and EIA do not account for the expenses incurred to build new transmission lines, additional state taxes, utility profits, or the cost of providing "backup" electricity with natural gas or battery storage when the wind is not blowing or the sun is not shining, referred to as a "load balancing" cost in this report.[48]

Even more importantly, the LCOE estimates generated by Lazard and EIA do not account for the massive overbuilding and curtailment that must occur to ensure that grids with high reliance on wind, solar, and battery storage meet electricity demand.[49]

It is important for the reader to understand that the costs associated with load balancing, overbuilding, and curtailment increase

FIGURE 11

Wisconsin LCOE: Existing Plants vs. New Wind, Solar, and Nuclear SMR

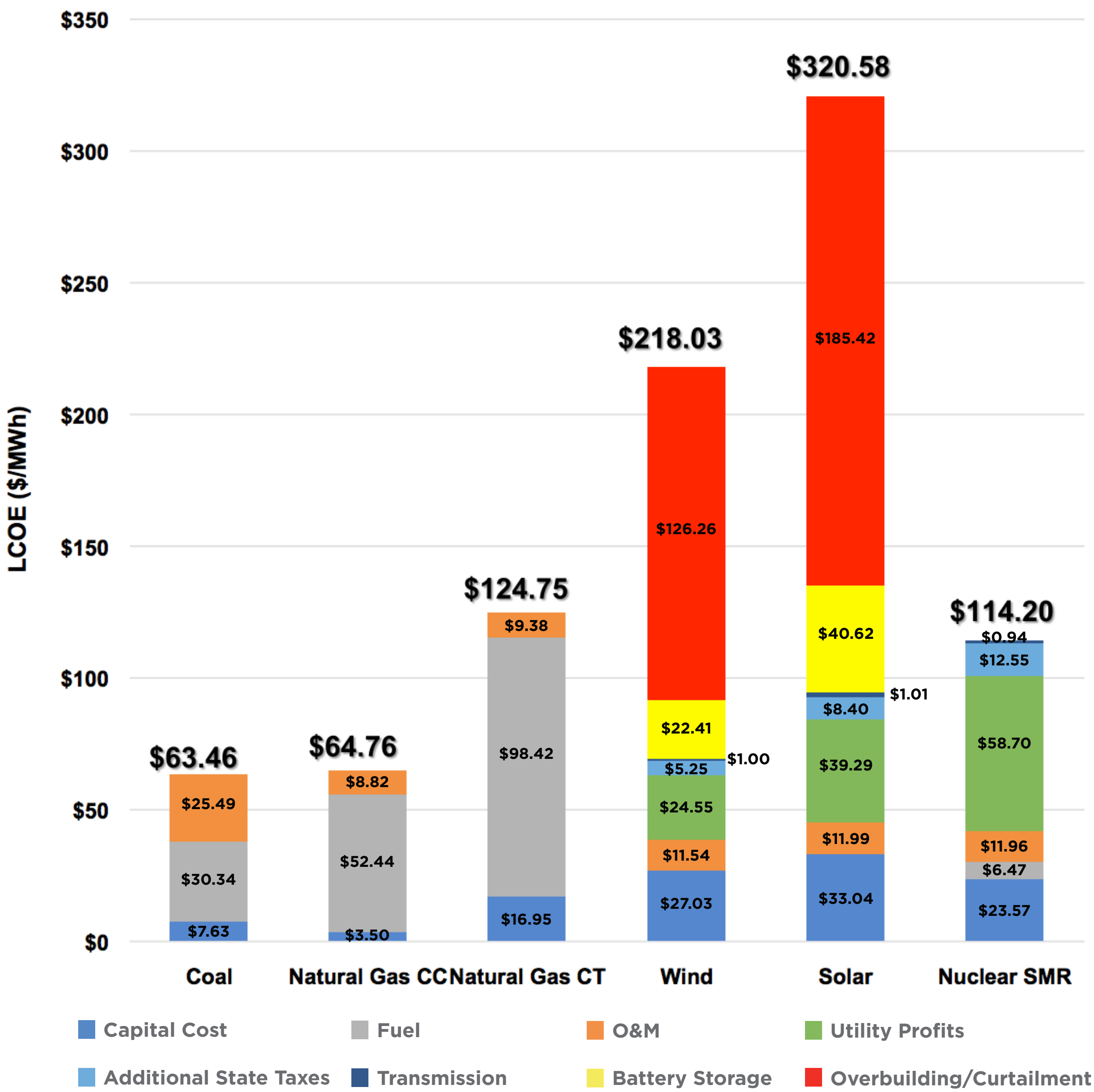


Figure 11. New solar facilities are the most expensive form of new electricity generation built under the Evers Plan. Once costs such as state taxes, transmission, utility returns, battery storage, and overbuilding and curtailment are accounted for new wind costs $218 per MWh, and new solar costs $321 per MWh. SMRs require no backup generators and do not need to be curtailed, which is why they produce electricity for a much lower price.

dramatically because the amount of wind, solar, and battery storage must be "overbuilt" to account for the intermittency of wind and solar, which is why the Evers Plan has an installed capacity of 127,851 MW by 2050 to meet Wisconsin's peak demand of 13,493 MW.

American Experiment's model accounts for all of these additional expenses and attributes them to the cost of wind and solar to get an "All-In" LCOE value for these energy sources. Our All-In LCOE represents the cost of delivering the same reliability value of other generating technologies, allowing for an apples-to-apples comparison of the cost of reliably meeting electricity demand with existing nuclear, natural gas, and coal plants operating in Wisconsin, with new plants built under the Evers Plan.

Data from the Federal Energy Regulatory Commission (FERC) show Wisconsin's natural gas plants were some of the lowest-cost sources of electricity in the state in 2020, generating electricity at a cost of $29 per MWh. Wisconsin's nuclear plants generated electricity for $54 per MWh, and coal plants in the state generated electricity for $54 per MWh, on average in 2020.

However, these values are based on outdated fuel prices. This study adjusts fuel prices for existing resources to match current prices. As a result, the cost of coal used in this study is $63 per MWh and $65 per MWh for combined cycle natural gas plants (see Figure 11).

Under the Evers Plan, these low-cost, reliable coal and natural gas plants would be replaced with wind, solar, battery storage, and SMRs by 2050. Figure 11 shows the All-In LCOE of new wind and solar reaches approximately $218 and $321 per MWh, respectively, in 2050, whereas SMRs cost $114 per MWh.

"Costs are higher for wind and solar facilities because grids powered with large concentrations of intermittent wind and solar require much more total capacity and transmission to meet electricity demand than systems consisting largely of dispatchable power systems such as traditional fossil fuel and nuclear plants."

Because curtailment rates reach 70 percent by 2050, overbuilding and curtailment costs are the primary drivers of wind and solar LCOEs due to the need to build 7.7 times more capacity than would be needed to meet peak demand with dispatchable power plants.[50] As a result, the cost of battery storage, overbuilding, and curtailing in Figure 11 can be thought of as a levelized cost of intermittency, or unreliability.

Costs are higher for wind and solar facilities because grids powered with large concentrations of intermittent wind and solar require much more total capacity and transmission to meet electricity demand than systems consisting largely of dispatchable power systems such as traditional fossil fuel and nuclear plants.

Section VI: Implications for Reliability

Reliability is the most crucial function of the electric grid. Our lives have never been more dependent upon electronic devices, and it is highly unlikely that we will be less dependent upon them in the future.

The Evers Plan will seriously undermine the reliability of the electric grid by making it more dependent on fluctuations in the weather. This dependency will end in blackouts. In contrast, the current grid maintains the reliability of Wisconsin's electric grid at a much lower cost.

> **"The Evers Plan will seriously undermine the reliability of the electric grid by making it more dependent on fluctuations in the weather. This dependency will end in blackouts."**

Reliability in the Evers Plan

American Experiment's modeling determined the amount of wind, solar, and battery storage capacity needed for the Evers Plan by using hourly electricity demand data for 2021 from the U.S. Energy Information Administration and real-world solar capacity factors from MISO for the year 2021 and wind capacity factors from the NREL SAM database.[51]

With these inputs, our model determined that the 48,081 MW of wind, 35,726 MW of solar, 41,702 MW of battery storage, and 385 MW of SMRs built in the Evers Plan would provide enough electricity to meet demand for every hour of the year, 2021.

Figure 12 shows electricity demand and supply by type for a hypothetical period in the future stretching from January 15, 2050, to February 15, 2050. As you can see, wind, solar, battery storage, SMRs, and Wisconsin's existing nuclear power plants are able to provide enough electricity to meet demand, shown in the black line.

While our model shows there is enough electricity to meet demand for every hour of the year, based on 2021 electricity demand and wind and solar productivity, it is important to remember that this conclusion is based on just one year's worth of weather-driven wind and solar generation data.[52] Given that wind and solar generation is dictated by

FIGURE 12

Evers Plan Hourly Electricity Supply 1/15/2050-2/15/2050: 2021 Demand and Capacity Factors

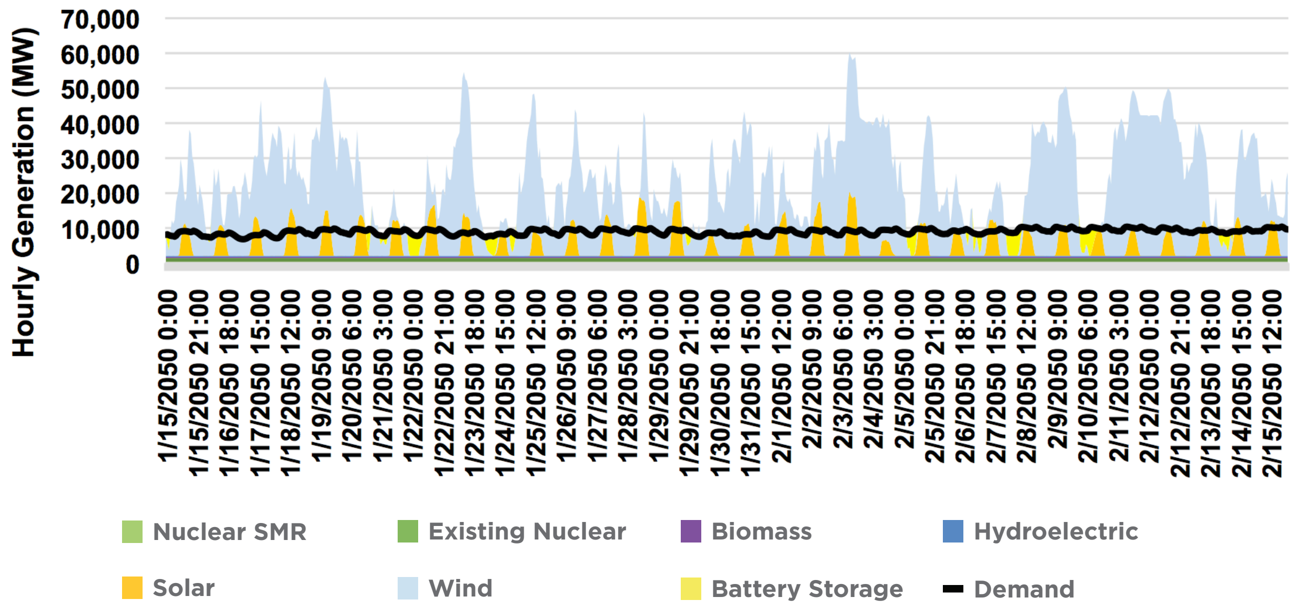


Figure 12. Wind, solar, and battery storage are able to meet electricity demand for every hour of the year.

weather patterns, it is important to evaluate whether changes in the weather would result in a situation where electricity supply could not meet demand—a capacity shortfall—resulting in rolling blackouts or brownouts.

To evaluate the impact of annual changes in wind and solar generation on the reliability of the grid, American Experiment obtained the MISO capacity factors for wind and solar in 2020 to see if the amount of installed wind, solar, battery storage, and SMR capacity in the Evers Plan would be enough to meet electricity demand at all hours of the year, regardless of changes in the weather.

It is not.

The reliability of the Evers Plan with 2020 weather

Using 2020 wind and solar generation data from MISO and 2020 hourly electricity demand data, American Experiment determined that there would be 28 total hours of capacity shortfalls throughout the year.

Figure 13 shows electricity demand and supply during the same hypothetical period in the future stretching from January 15, 2050, to February 15, 2050. As you can see, wind, solar, battery storage, SMRs, and Wisconsin's existing nuclear power plants are ***unable*** to provide enough electricity demand, shown in the black line, resulting in an 8-hour blackout followed

FIGURE 13

Evers Plan Hourly Electricity Supply 1/15/2050-2/15/2050: 2020 Demand and Capacity Factors

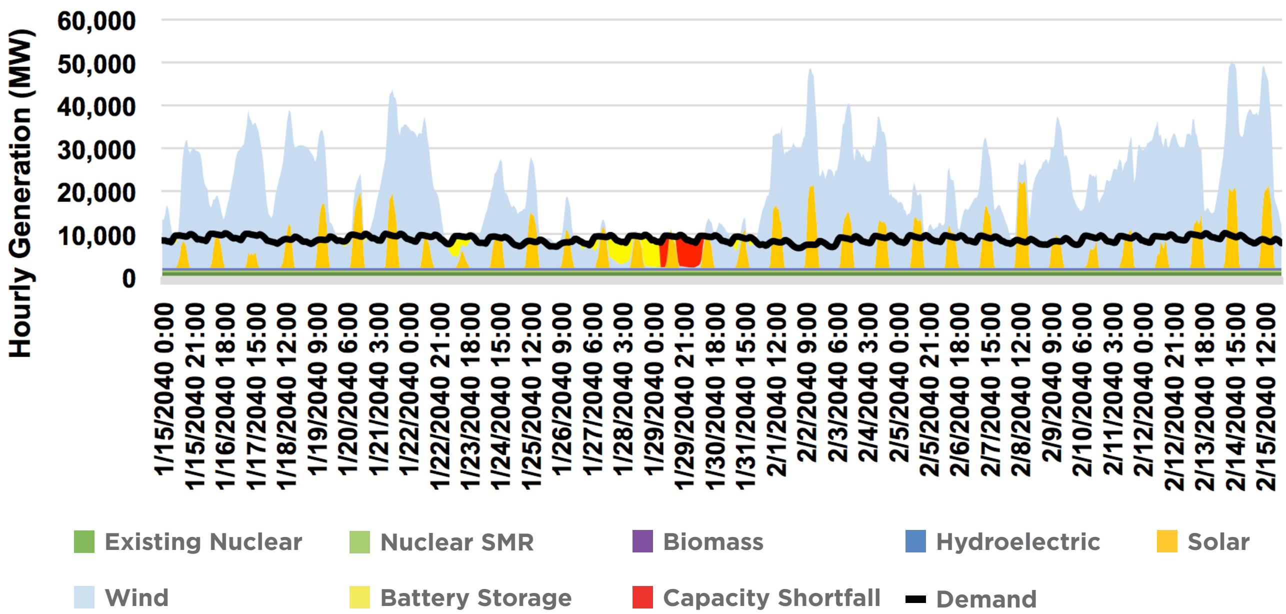


Figure 13. Wind, solar, and battery storage are unable to meet electricity demand for every hour of the year, resulting in a combined 27-hour capacity shortfall in January.

by a 20-hour blackout on January 29 through January 30, shown in red.

The capacity shortfall stretching from January 29 to January 30 is caused by low wind and solar output and insufficient battery storage capacity to store excess wind generation from previous days—even with more than 167,000 MWh of storage available. During this two-day period, solar capacity factors averaged just 6 percent and wind capacity factors 4 percent.

The size of the shortfall is significant, with a maximum shortfall of 7,347 MW occurring at 9:00 A.M. on January 29, which is enough to power nearly all of Wisconsin in an average hour.

Current Grid

While the Evers Plan would result in rolling blackouts under 2020 demand and wind and solar output conditions, keeping the current reliable grid would result in zero hours of capacity shortfalls.

Figure 14 shows there is enough dispatchable capacity on the Wisconsin electric grid to reliably meet electricity demand for every hour during the period from January 15, 2050, through February 15, 2050, regardless of weather conditions.

On the current grid, coal and nuclear plants provide steady electrons around the clock, while natural gas plants increase and decrease their generation to perfectly match electricity demand.

FIGURE 14

Current Grid Hourly Electricity Supply 1/15/2050-2/15/2050

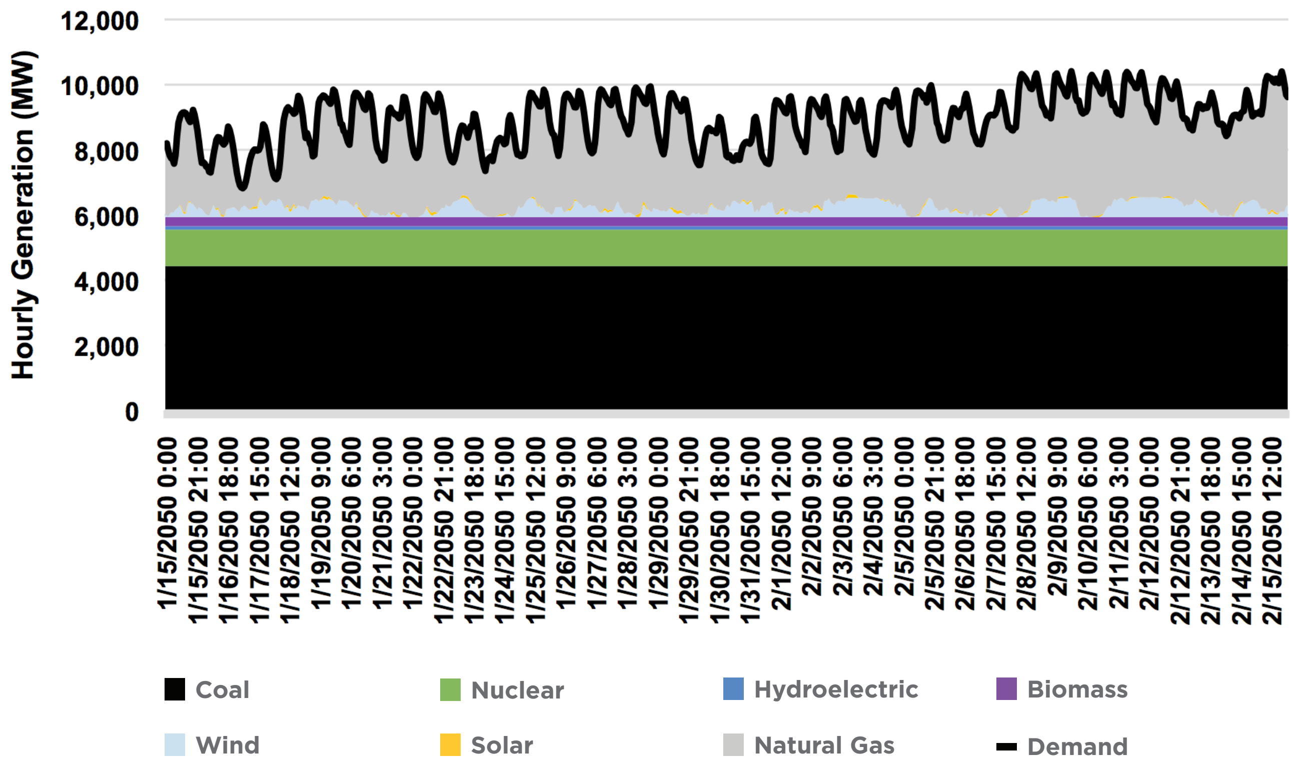
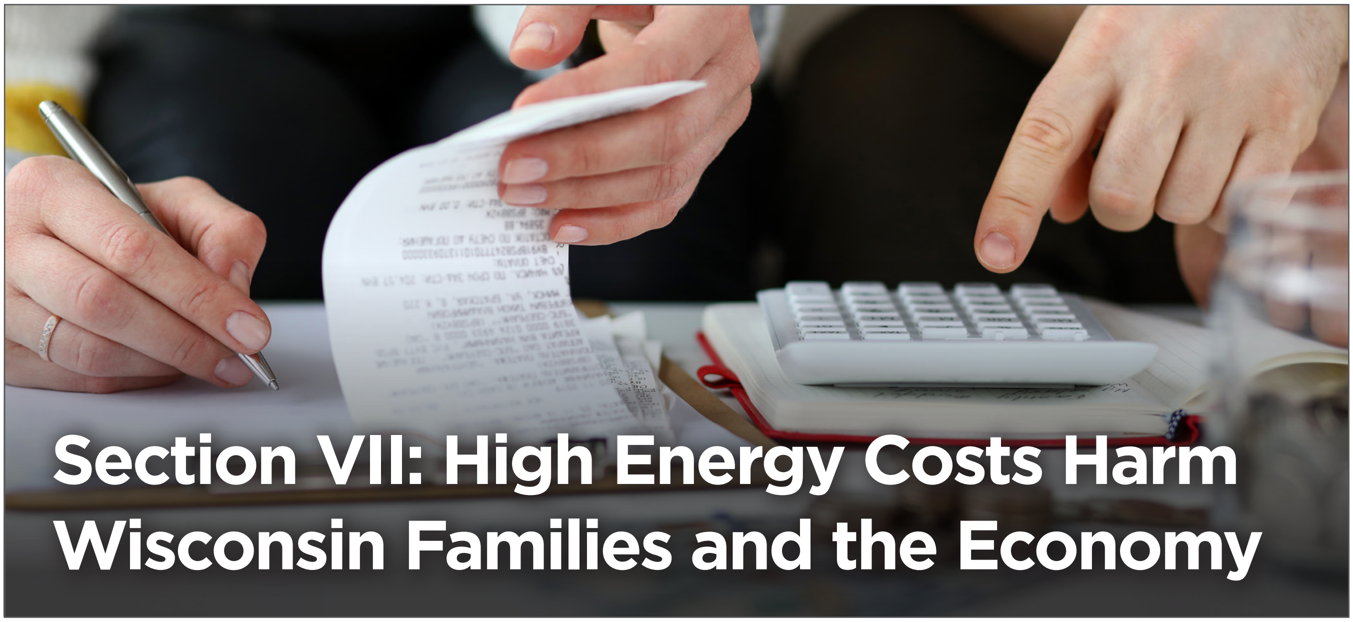


Figure 14. The current grid would maintain the reliability of Wisconsin's electric grid by utilizing reliable sources of electricity.



Section VII: High Energy Costs Harm Wisconsin Families and the Economy

Proponents of solar panels and wind turbines often argue that increasing the use of these technologies will benefit local economies. They are wrong. Increasing the cost of electricity does not grow the economy, it simply transfers into the electricity sector money that would have been spent elsewhere.

By drastically increasing electricity costs paid by Wisconsin consumers, the Evers Plan will increase the cost of essential services like refrigerating food and medicine, home heating, and air conditioning. Low-income households will be hurt most by rising electricity costs because they spend a higher percentage of their income on energy bills than other Wisconsin households.

"Low-income households will be hurt most by rising electricity costs because they spend a higher percentage of their income on energy bills than other Wisconsin households."

Data from the U.S. Department of Energy's Low-Income Energy Assistance Data (LEAD) program show a many Wisconsin residents already spend over $2,000 per year on electricity and home heating fuels, such as natural gas, heating oil, or propane (see Figure 15).[53] Unfortunately, this trend will only get worse this winter.

The Wisconsin State Journal reports the average American home heating with natural gas will pay $380 more this winter than two years ago due to rising natural gas prices.[54] Households heating with propane will see costs increase by $670 compared to two years ago, and those using heating-oil will see their costs increase by nearly $960 compared to 2020.[55]

Spending $248 billion on new solar panels, wind turbines, SMRs, transmission lines, and battery storage facilities under the Evers Plan will force Wisconsinites to pay an additional $2,755 per year to keep the lights on.[56]

Broader economic impacts

Increasing the cost of electricity would harm the state's economy in two primary ways. First, it would reduce the amount of household

FIGURE 15

Low-Income Energy Affordability

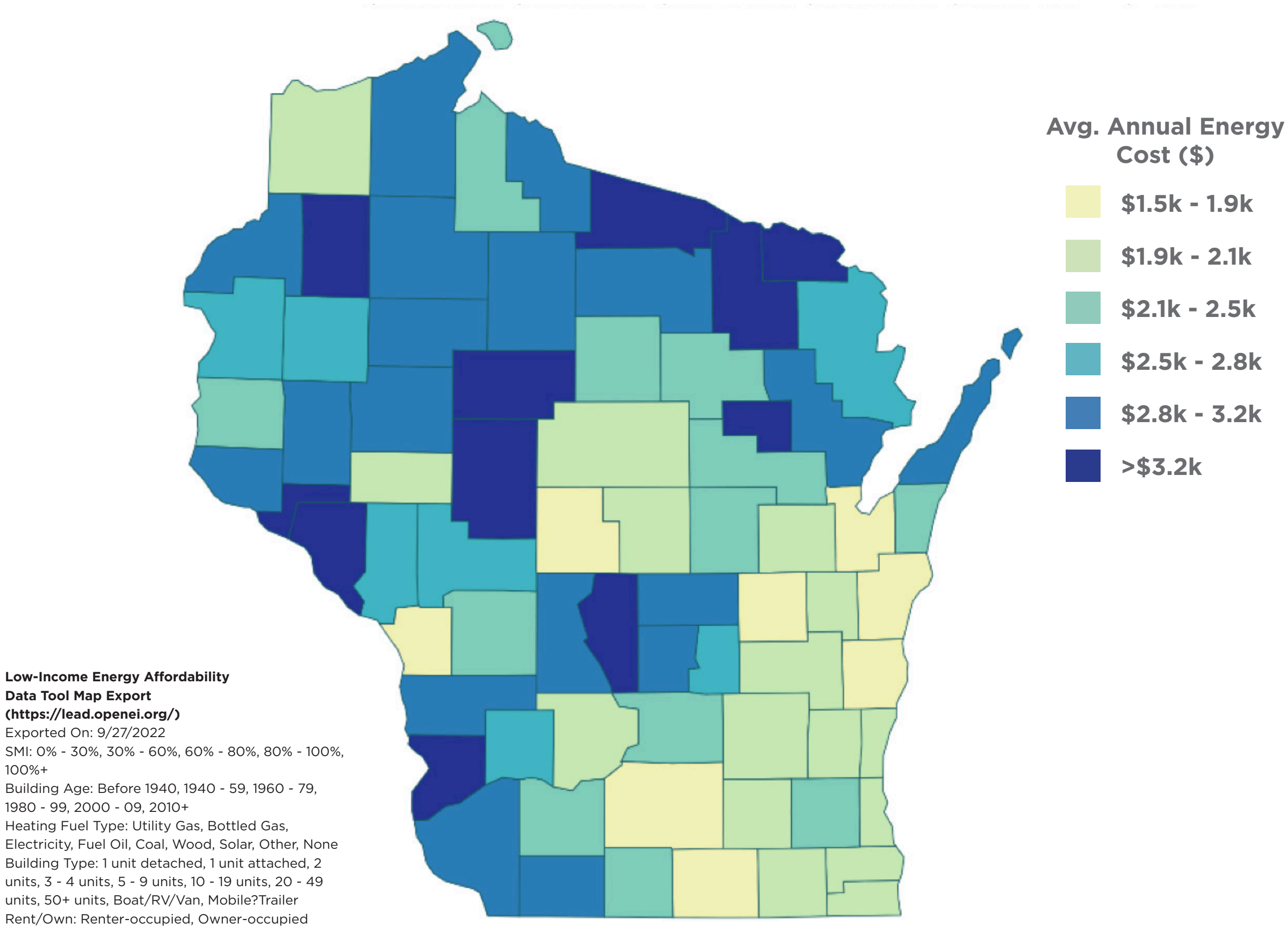


Figure 15. Federal data show households living in 68 percent of Wisconsin counties already pay more than $2,000 per year for energy, and Wisconsinites living in many counties pay more than $3,000 per year.

income available to families to spend on goods and services, therefore reducing demand in other sectors of the economy. For example, the extra money a family spends on electricity may mean less money for rent or mortgage payments, fewer meals at local restaurants or delayed repairs to a home or automobile.

Second, it would increase the costs of healthcare, education, food, and durable goods, because electricity is the invisible ingredient in everything. Rising electricity costs force businesses to raise the prices of the goods and services they offer or reduce staffing or other expenses to help offset additional energy costs.

More money on electricity means less money for teachers

Wisconsin schools spent $175 million on electricity in 2019.[57] This makes energy the second largest expense for schools after the salaries of teachers, administrators, and support staff, which means energy constitutes a larger portion of the budget than books and supplies.[58] Every extra dollar spent on electricity is one less dollar that could be spent on improving the education of children.

Schools can take steps to reduce their electricity consumption, such as shutting down computers when they are not in use and switching to energy-efficient light bulbs. But the easy and affordable means of reducing electricity consumption are quickly exhausted, especially when electricity costs continue to increase.

For example, the Muskego-Norway school district used 5.48 million kWh of electricity in 2021 for a total cost of almost $803,000 that year.[59]

Increasing the price of electricity by an average of 9.81 cents per kWh under the Evers Plan would cause these expenses to rise by $537,588, on average. Muskego-Norway schools would have to lay off nine teachers making the average salary of $58,000 per year to pay these higher electric bills, or raise property taxes to keep them on staff.[60]

"Industrial electricity expenses in Wisconsin would increase by an average of $1.47 billion per year under the Evers Plan, the equivalent of 20,200 of high-paying manufacturing jobs."

High electricity prices drive up costs in the manufacturing, papermaking, and agricultural sectors

Energy-intensive industries such as manufacturing are at the highest risk of becoming uncompetitive due to increasing electricity prices. Industrial electricity users in Wisconsin spent $1.6 billion on electricity in 2020, consuming 22.1 million MWh of electricity, nearly 32.9 percent of Wisconsin's total electricity use that year.[61]

Under the Evers Plan, these expenditures would grow to more than $4.3 billion by 2050, a near tripling of costs compared to 2020 expenses.

Manufacturing

Manufacturing is a staple of Wisconsin's economy. Manufacturing jobs are good, family-supporting jobs. According to the National Manufacturers Association, manufacturing accounted for $64 billion in the state's economy in 2019, accounting for 18.57 percent of Wisconsin's gross domestic product (GDP). Wisconsin manufacturers employed 472,000 people in 2020, accounting for nearly 17 percent of the workforce, with average annual compensation of $74,252 in 2019.[62]

The high wages paid in the manufacturing sector are why each job in manufacturing supports 3.87 indirect and induced jobs (the "multiplier effect") in other sectors of the economy, bringing the total employment impact of manufacturing to more than 1.8 million jobs.[63]

Because manufacturing has a high multiplier effect, a factory closing down in Wisconsin would have a large, negative ripple effect throughout the entire community where it is located. Unfortunately, this sector is especially sensitive to rising energy costs because manufacturers consume large quantities of electricity.

Industrial electricity expenses in Wisconsin would increase by an average of $1.47 billion per year under the Evers Plan, the equivalent of 20,200 of high-paying manufacturing jobs.

Papermaking

Wisconsin's papermaking industry contributed $5.4 billion to the state's GDP in 2021, making it the fourth-largest industry in the manufacturing sector.[64] Nearly 27,880

Wisconsinites are employed in the paper industry, earning an average wage of $90,000 per year, according to data from the Bureau of Economic Analysis.[65,66]

The large number of people employed at high wages makes the paper industry one of the most important in the state, and these jobs are especially crucial in Central Wisconsin and the Fox Valley, where these facilities are located.

Unfortunately, high electricity prices threaten the paper industry because it is incredibly energy intensive. Paper mills in Wisconsin used an estimated 5.5 million MWhs of electricity in 2020, at a cost of $404 million. Under the Evers Plan these costs would increase by an average of $358.4 million, the equivalent of 3,982 papermaking jobs.

Rising electricity costs under the Evers Plan would make Wisconsin's paper producers uncompetitive with other areas of the country, such as the Southeastern area of the United States, that have lower labor, benefit, and energy costs.[67]

"Higher costs for farmers will translate into higher rates of inflation at the grocery store, as agricultural producers attempt to pass higher electricity expenses on to consumers."

Agriculture

Rising electricity prices will negatively impact Wisconsin agriculture because electricity is a significant expense for farmers and food manufacturers. Electricity is used at livestock operations for heating and cooling, milking, heating water tanks, and powering barn cleaners, and crop farmers use electricity for irrigation and grain drying, among many other uses.

The University of Wisconsin Extension estimates that dairy farms use between 800 kWh and 1,200 kWh per cow per year.[68] Under the Evers Plan, farmers would see their electricity prices increase from 10.75 cents per kWh to an average of 20.56 cents per kWh, assuming they pay commercial rates.

This means that a small dairy farm with 80 head of cattle would see their electricity costs increase by $7,848 per year.

Higher costs for farmers will translate into higher rates of inflation at the grocery store, as agricultural producers attempt to pass higher electricity expenses on to consumers. This is top of mind for many families, as milk prices have increased from $3.04 per gallon in 2019, to $4.19 cents per gallon in August of 2022.[69]

Section VIII: Emissions Reductions

Given the large cost of reducing carbon dioxide emissions from the Evers Plan, it makes sense to ask two questions: How much future global warming would these policies prevent, and are these measures worth the cost?

Temperature impacts of reduced emissions

The Evers Plan would reduce carbon dioxide emissions by 35 million metric tons by 2050 (See Figure 16).

To understand the global-temperature impact of reducing emissions by 35 million metric tons, it helps to examine the temperature impact of the Clean Power Plan (CPP), which was widely considered to be the Obama administration's signature climate change initiative.

The Obama administration claimed the CPP would have reduced annual CO_2 emissions nationally by 730 million metric tons by 2030.

The Obama administration's Environmental Protection Agency used a climate model called the Model for the Assessment of Greenhouse-Gas Induced Climate Change (MAGICC) to determine the CPPs temperature impact.

Using MAGICC, the Obama administration estimated the CPP would have reduced future warming by only 0.019° C by 2100, an amount too small to be accurately measured with even the most sophisticated scientific equipment. The 35 million metric tons of CO_2 no longer emitted from power plants serving Wisconsin would account for 5 percent of the 730 million metric tons averted by the CPP.

From this figure, we can extrapolate that the Evers Plan would avert 5 percent of the 0.019° C by 2100, for a potential future temperature reduction of 0.00092° C by 2100, meaning the reductions will be too small to measure, even with the most sophisticated equipment available.

"We can extrapolate that the Evers Plan would avert 5 percent of the 0.019° C by 2100, for a potential future temperature reduction of 0.00092° C by 2100, meaning the reductions will be too small to measure, even with the most sophisticated equipment available."

FIGURE 16

Evers Plan Annual Carbon Dioxide Emissions

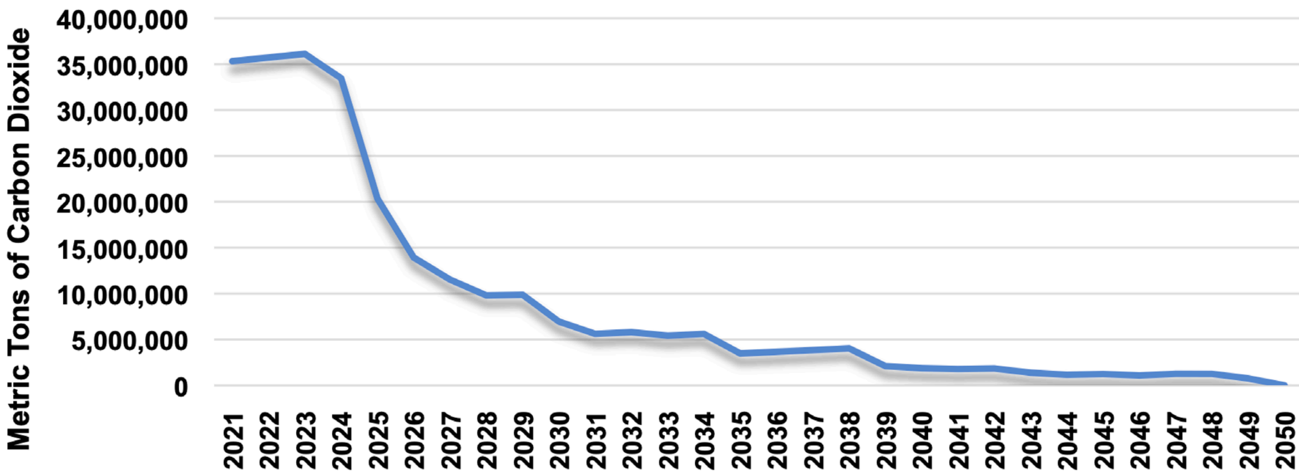


Figure 16. The Evers Plan would eventually eliminate CO_2 emissions from the electricity sector.

Assessing the costs and benefits of reducing emissions

When evaluating energy policies aimed at reducing greenhouse gas emissions, it is important to weigh the cost of reducing emissions against the expected benefits of doing so. If the costs of reducing emissions exceed the expected benefits, the policy does not make sense to enact.

To conduct this cost-benefit analysis, policymakers often use a tool called the Social Cost of Carbon (SCC) to estimate the economic costs, or damages, of emitting one additional ton of carbon dioxide into the atmosphere in terms of changing temperatures, and thus the benefits of reducing emissions.[70] While the SCC has serious shortcomings, it can help illustrate when the costs of a proposed policy obviously outweigh the benefits.[71]

Figure 17 shows the cost of reducing each ton of carbon dioxide each year under the Evers Plan and compares it to the SCC estimates established by both the Obama and Trump administrations.

Figure 17 shows that the cost of reducing carbon dioxide emissions in the Evers Plan exceeds the Trump and Obama administration SCC estimates for every single year. This means the cost of reducing carbon dioxide emissions under the Evers Plan far exceed the benefits of doing so. In short, it is better to do nothing than to implement the Evers Plan.

Wisconsin cannot save the planet by implementing the Evers Plan, but it can greatly increase the amount of money Wisconsin families are forced to pay to keep the lights on while simultaneously making them more vulnerable to blackouts.

FIGURE 17

Obama Social Cost of Carbon vs. Cost of Reducing CO_2 Emissions

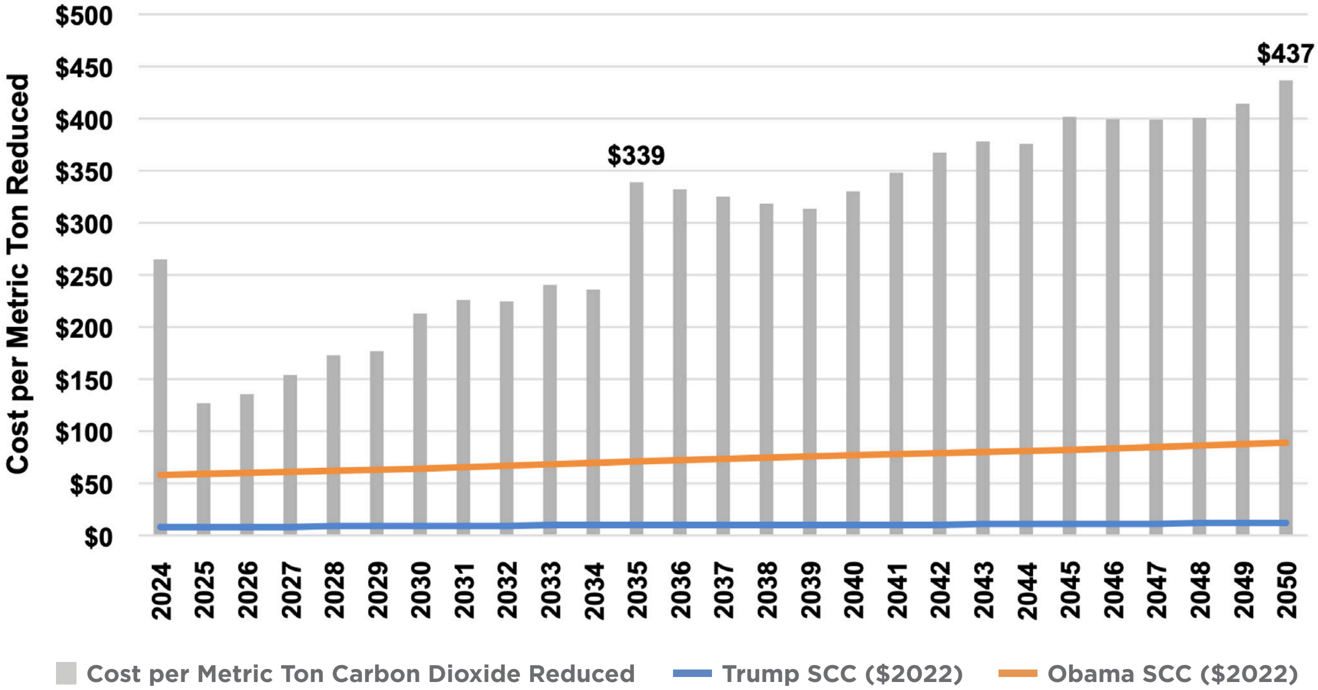


Figure 17. The cost of reducing emissions under the Evers Plan vastly exceed the Obama SCC estimates in every year studied and exceed the Trump administration estimates to a far greater extent.

Conclusion

Compliance with the Evers Plan in Wisconsin would cost $248 billion through 2050. Wisconsin families would see their electric bills increase by an average of nearly $1,089 per year. Commercial businesses would see their costs increase by $6,108 per year. Industrial customers, like manufacturers and papermaking operations, would see their electric bills increase by an average of $262,292 per year.

The costs incurred in the Evers Plan are driven by a massive buildout of solar panels, wind turbines, SMRs, and transmission lines, in addition to the costs associated with higher state taxes, utility profits, and the cost of building battery storage facilities to provide power when the sun is not shining, or the wind is not blowing.

In the end, the idea that Wisconsin can run its electric grid on wind turbines, solar panels, and batteries is a dangerous and unserious proposition.

Acknowledgements

We thank Brent Bennett, Ph.D. of the Texas Public Policy Foundation for his assistance on this report, particularly with respect to determining the capacity of battery storage capacity necessary to meet Evers Plan requirements.

Appendix

Electricity consumption assumptions

Electricity consumption is kept constant at 75.1 million MWhs throughout the course of this model run based a three-year average of total electricity source disposition data from Wisconsin EIA electricity state profile. Electricity use in each customer class — residential, commercial, and industrial — is also held constant.

This assumption is made for two reasons. One, this analysis is intended to show the difference in cost between operating the electric system in Wisconsin today compared to what it would cost to generate the same number of MWhs of electricity under the Evers Plan. Doing this is especially insightful when new capacity is not being built to meet expected growth in electricity demand but rather to comply with government mandates like the Evers Plan.

Two, load-growth projections are subject to a wide variety of assumptions, such as energy efficiency measures that reduce electricity demand, electric vehicle adoption, and the electrification of other sectors of the economy, which would increase demand for electricity. These factors are difficult to predict accurately, and the assumptions used for load growth or energy efficiency can have major implications for cost. Therefore, the most straightforward analysis looks at these issues assuming all other factors remain equal.

Time horizon studied

This analysis studies the impact of the Evers Plan on electricity prices from 2021 to 2050. This time horizon is examined because like a mortgage, electricity customers pay off the cost of power plants each year, meaning decisions made today will affect the cost of electricity for decades to come. As such, the total costs highlighted by this study do not represent the total costs incurred by the Evers Plan, but rather the total cost that ratepayers would pay through 2050.

Hourly load, capacity factors, and peak demand assumptions

Hourly load shapes were determined using MISO region 1, 2, and 7 generation numbers obtained from EIA and multiplying by the share (30 percent) of Wisconsin's electricity demand. This was determined by dividing the total generation of MISO regions 1, 2, and 7 for 2021 by the 3-year average of the total source disposition in Wisconsin from state electricity profiles provided by EIA.

This is the best available data for approximating hourly load shape profiles for the state of Wisconsin. The peak demand for Wisconsin is estimated to be 13,493 MW, which are the best available data for estimating peak demand in the state.

These inputs were entered into a model provided by the Texas Public Policy Foundation to assess hourly load shapes, capacity shortfalls, and calculate storage capacity needs. Capacity factors used for solar facilities were determined using solar generation data obtained from EIA's electric grid monitor and installed capacity values for wind and solar from MISO.[72] Capacity factors used for wind facilities were determined using wind generation data obtained from NRELs System Advisor Model (SAM).[73]

Plant retirement schedules

Our model uses retirement and end of useful life schedules from Wisconsin Electric Power Company, Wisconsin Power & Light Company, Wisconsin Public Service Corporation, Xcel Energy, and Madison Gas & Electric Company as templates for our analysis, specifically as it pertains to dates for power plant retirements.

However, plans submitted by these utility companies do not satisfy the carbon-free requirements of the Evers Plan extending out to 2050. To meet full compliance, with the Evers Plan this analysis assumes all carbon-dioxide emitting plants will be shut down by 2050 and replaced by wind, solar, battery storage, and SMRs.

Plant construction by type

This analysis assumes no new carbon-dioxide emitting power plants will be built in Wisconsin, with the exception of coal plants that will be converted to natural gas plants by 2035, and these plants are scheduled to retire by 2050.

Under the Evers Plan, Wisconsin would add wind, solar, battery storage capacity and SMRs, to meet the governor's proposal by 2050. This analysis does not account for wind installations in neighboring states that are owned or operated by Wisconsin electric companies. However, given the short, 20-year lifespan of wind facilities, this has a minimal impact on the costs incurred in the Evers Plan.

Load modifying resources

Our model does not allow for the use of Load Modifying Resources (LMRs) or demand response (DR) in determining how much capacity will be needed to meet peak electricity demand in the Evers Plan.

Instead, battery capacity and excess wind and solar capacity is built to provide enough power to supply Wisconsin's electricity needs under the Evers Plan at all times based on a test year using historical generation (30 percent of the 2021 hourly load data from MISO Region 1, 2, and 7), and hourly capacity factors for wind and solar for MISO and the NREL SAM database.[74] Battery storage capacity was assumed to be perfectly efficient and fully charged at the start of the test year.

We acknowledge that voluntary LMRs and DRs can play a role in optimizing system cost and reliability. However, we believe that DR resources are being inappropriately used by many wind and solar special interest groups to manipulate their models to unrealistically reduce the amount of capacity needed to meet peak demand, and thus artificially suppress the cost of their proposals. In this way, these groups are essentially fudging the numbers on the amount of capacity needed to meet current electricity demand and not providing an apples-to-apples comparison of the cost. Their proposals will effectively place more responsibility on behalf of the customer to keep the grid online.

To test this theory, American Experiment allowed the availability of LMRs up to 2,000 MW, or 14.8 percent of the system, to determine the impact on the cost of meeting the Evers Plan. This resulted in a $46 billion reduction in the cost of the proposal from 2021 through 2050 — now totaling $202 billion — by eliminating a substantial portion of the overbuilding required to meet demand during peak hours and periods of low wind and solar output.

As a result, using LMRs would reduce the cost of the Evers Plan by $514 per year on average for each electricity customer. While LMR advocates argue that these resources bring costs down, this argument only looks at one side of the ledger because it assumes that the power that is no longer being consumed produces no value, which is incorrect.

For example, the 2,000 MW of LMRs would be used to reduce electricity consumption by 3.2 million MWhs on an annual basis. Dividing the annual savings of $1.6 billion ($79.4 billion/29 years) by the 3.2 million in MWhs in reduced consumption results in a savings of $500 per MWh. Using our metric of $4,010 of GDP per MWh of electricity consumed, reducing these MWhs would lower the state's GDP by $13 billion annually, resulting in an annual net loss of $11.4 billion for the state.[75]

Utility returns

The amount of profit a utility makes on capital assets is called the Rate of Return (RoR) on the Rate Base for the Evers Plan. For the purposes of our study, the capital structure used is that of Wisconsin Electric Power Company: 47.5 percent debt and 52.5 percent equity, a return on debt of 4.6 percent, and return on equity of 10 percent.[76] Utility profits increase in the Evers Plan because utility companies are earning a government-approved profit on much more new electricity generation and storage capacity.

Transmission

For transmission costs, distance per mile costs were estimated from the 2021 Midcontinent Independent Systems Operator Transmission Cost Estimation Guide.[77] This analysis uses the Wisconsin average cost estimates of double circuit 230 kV and 345 kV lines. We assume a needed transmission costs of $25,102.88 per MW of new nuclear capacity installed, based on cost information from a nuclear plant currently under construction in the United States, the Vogtle nuclear plant. In an August 31, 2018, filing to the Georgia Public Service Commission, Georgia Power stated the cost of interconnection and transmission for the 2,430 MW Vogtle nuclear plant would be $61 million, or $25,102.88 per MW installed.[78] These transmission investments were amortized over 30 years. We assume all transmission expenses are paid by Wisconsin ratepayers.

State taxes

Additional tax payments for utilities were calculated to be 1.59 percent of the revenues resulting with the Evers Plan, based on special state tax rates for utility companies in Wisconsin.

Wind and solar degradation

According to the Lawrence Berkeley National Laboratory, output from a typical US wind farm shrinks by about 13 percent over 17 years, with most of this decline taking place after the project turns ten years old. According to the National Renewable Energy Laboratory, solar panels lose one percent of their generation capacity each year and last roughly 25 years, which causes the cost per megawatt hour (MWh) of electricity to increase each year.[79] However, our study does not take wind or solar degradation into account.

Annual average additional cost per customer

The annual average additional cost per customer was calculated by dividing the average yearly expense of the Evers Plan by the number of electricity customers in Wisconsin.[80] This methodology is used because rising electricity prices increase the costs of all goods and services. Businesses will attempt to pass these additional costs onto consumers, effectively increasing the cost of everything. Therefore, this method helps convey the total cost of the Evers Plan for Wisconsin households in a way that is more representative than calculating the costs associated with higher residential electric bills.

Annual average cost per rate class customer

The annual average additional cost per residential, commercial, and industrial rate class customer was calculated by applying the overall cost per kWh of Evers Plan compliance during the time horizon of the study to rate classes based on historical rate factors in the state of Wisconsin. Rate factors are determined by the historical rate ratio (rate factor) of each customer class.

For example, electricity prices for residential, commercial, and industrial rate classes in Wisconsin were 14.32, 10.75, and 7.29 cents per kWh in 2020, respectively. Based on general electricity prices 10.82 cents per kWh, residential, commercial, and industrial rates had rate factors of 1.32, .99, and .67, respectively. This means that, for example, residential customers have historically seen electricity prices 32 percent above general rates. This model continues these rate factors to assess rate impacts for each rate class.

Impact on electricity rates

The table below (page 42) shows annual additional electricity rates by customer class using the cost of the Evers Plan and adjusting for the rate factor described above in cents per kWh.

Assumptions for Levelized Cost of Energy (LCOE) calculations

The main factors influencing LCOE estimates are capital costs for power plants, annual capacity factors, fuel costs, heat rates, variable operation and maintenance (O&M) costs, fixed O&M costs, the number of years the power plant is in service, and how much electricity the plant generates during that time (which is based on the capacity (MW) of the facility and the capacity factor).

LCOE values for existing energy sources were derived from FERC Form 1 data submitted by Wisconsin Power & Light Company, Wisconsin Electric Power Company, Wisconsin Public Service Corporation, and Madison Gas & Electric Company. Data utilized in FERC Form 1 filings include capacity factors, capital costs, and production expenses.

These LCOE values are inserted into the model and adjusted annually based on annual capacity factors for existing resources for the rest of Wisconsin. This method is used because while FERC Form 1 data is the best available source for LCOE cost assumptions for existing resources, it does not account for all power sources in Wisconsin. This report adjusts LCOE values for the IOUs in Wisconsin for the rest of the power plants within the state.

LCOE values for new power plants were calculated using data values presented in the Assumptions to the Annual Energy Outlook Electricity Market Module (EMM) and are based on the cost of operating each energy source during the model. The cost of repowering power facilities that need it at the end of their useful lives is accounted for in each value. These values are described in greater detail below.

	Residential		Commercial		Industrial		Average	
	Rates (Cents/ kWh)	Annual Bill ($)	Rates (Cents/ kWh)	Annual Bill ($)	Rates (Cents/ kWh)	Annual Bill ($)	Rates (Cents/ kWh)	Annual Bill ($)
2022	0.11	$9	0.08	$52	0.06	$2,253	0.08	$24
2023	0.23	$19	0.17	$105	0.11	$4,530	0.17	$48
2024	0.76	$63	0.57	$354	0.39	$15,197	0.57	$160
2025	2.89	$241	2.17	$1,351	1.47	$58,034	2.19	$610
2026	4.42	$368	3.32	$2,064	2.25	$88,649	3.34	$931
2027	5.58	$465	4.19	$2,610	2.84	$112,073	4.22	$1,177
2028	6.72	$560	5.05	$3,143	3.42	$134,952	5.08	$1,417
2029	6.86	$571	5.15	$3,204	3.49	$137,606	5.18	$1,445
2030	9.20	$767	6.91	$4,301	4.68	$184,710	6.96	$1,940
2031	10.22	$852	7.68	$4,779	5.20	$205,234	7.73	$2,156
2032	10.10	$841	7.58	$4,721	5.14	$202,754	7.63	$2,130
2033	10.95	$912	8.22	$5,119	5.57	$219,826	8.28	$2,309
2034	10.68	$890	8.02	$4,993	5.44	$214,432	8.07	$2,252
2035	16.44	$1,369	12.34	$7,684	8.37	$329,988	12.43	$3,466
2036	16.02	$1,335	12.03	$7,488	8.16	$321,579	12.11	$3,378
2037	15.60	$1,300	11.71	$7,292	7.94	$313,145	11.79	$3,289
2038	15.18	$1,264	11.39	$7,095	7.73	$304,686	11.47	$3,200
2039	15.87	$1,322	11.91	$7,417	8.08	$318,521	11.99	$3,346
2040	16.83	$1,402	12.64	$7,869	8.57	$337,909	12.72	$3,549
2041	17.79	$1,482	13.36	$8,316	9.06	$357,118	13.45	$3,751
2042	18.74	$1,561	14.07	$8,760	9.54	$376,193	14.17	$3,951
2043	19.55	$1,629	14.68	$9,141	9.95	$392,540	14.78	$4,123
2044	19.57	$1,630	14.69	$9,148	9.96	$392,834	14.79	$4,126
2045	20.87	$1,739	15.67	$9,756	10.62	$418,957	15.78	$4,400
2046	20.85	$1,737	15.66	$9,748	10.62	$418,618	15.76	$4,397
2047	20.72	$1,726	15.55	$9,685	10.55	$415,898	15.66	$4,368
2048	20.80	$1,733	15.62	$9,724	10.59	$417,567	15.72	$4,386
2049	21.83	$1,819	16.39	$10,206	11.12	$438,288	16.50	$4,603
2050	23.53	$1,960	17.67	$11,000	11.98	$472,367	17.79	$4,961

Capital costs, and fixed and variable operation and maintenance costs

Capital costs and expenses for fixed and variable O&M for new wind, solar, battery storage, and SMR resources were obtained from the EMM. Region 3 capital costs were used, and national fixed and variable O&M costs were obtained from Table 3 in the EMM report.[81]

Unit lifespans

Different power plant types have different useful lifespans. Our analysis takes these lifespans into account for our Levelized Cost of Energy analysis.

Wind turbines last 20 years

Federal LCOE estimates seek to compare the cost of generating units over a 30-year time horizon.[82] This is problematic for wind energy LCOE estimates because the National Renewable Energy Laboratory reports the useful life of a wind turbine is only 20 years before it must be repowered. Our analysis corrects for this error by using a 20-year lifespan for wind projects before they are repowered and need additional financing.

Solar panels last 25 years

Our analysis uses a 25-year lifespan for solar because this is the typical warranty period for solar panels. These facilities are rebuilt after they have reached the end of their useful lifetimes.

Battery storage lasts 20 years

Battery storage facilities are expected to last for 20 years. Battery facilities, like wind and solar, are rebuilt after reaching the end of their useful lifetimes.

New nuclear plants are licensed for 40 years

Capital costs for new nuclear plants were amortized over 40-year periods, rather than 30, because this is the amount of time nuclear plants are initially licensed for by the Nuclear Regulatory Commission. This corrects for EIA LCOE calculations that attribute 30-year lifespans for all energy technologies, which, in the case of nuclear power, artificially inflate the cost of electricity during the initial production years of the facility.

Many nuclear power plants have already had their initial 40-year licenses extended by 20 years, and in 2019, the Nuclear Regulatory Commission approved a second extension — up to 80 years — for the Turkey Point Power Plant in Florida, suggesting a long useful lifespan for new nuclear power plants.[83] However, license extensions are beyond the span of this analysis.

Fuel cost assumptions

Fuel costs for existing power facilities were estimated using FERC Form 1 filings and adjusted for current fuel prices.[84,85] Fuel prices for new power plants were estimated using the most recent nuclear fuel cost data provided by EIA.[86]

Nuclear fuel costs

Fuel costs for new nuclear plants were assumed to be $6.47 per MWh, which was the latest available price for according to EIA.[87]

Natural gas fuel costs

Existing natural gas prices were assumed to be $52.44 per MWh and $98.42 per MWh for CC and CT plants, respectively, based on data obtained from 2019 FERC Form 1 filings and adjusted for current fuel prices based on an average of the first 9 months of natural gas fuel prices in 2022, which was $6.42/ MMBtu. We held this fuel cost constant through 2050.

Coal fuel costs

Existing coal fuel cost assumptions of $30.34 per MWh were based on 2019 FERC Form 1 filings and adjusted for current fuel prices of current fuel prices based on an average of the first 9 months of coal fuel prices in 2022, which was $19.51/MMBtu.

Capacity factors for generation resources

Capacity factors for existing coal, natural gas, and nuclear were determined by a 3-year average utilization rate using the years 2020, 2019, and 2018. This method was used because 2021 and 2022 utilization rates are likely to be different than the most recent data in 2020 due to several reasons, including lower total generation resulting from COVID and fluctuations in coal and natural gas generation due to dramatically increased fuel expenses. As a result, average coal capacity factors were 54.4 percent, natural gas CT was 7.7 percent, natural gas CC was 64.6, and nuclear was 94.8 percent. New facilities had an estimated capacity factor of 28.7 percent for wind, 16 percent for solar, and 95 percent for SMRs.

Levelized cost of transmission, state taxes, and transmission lines

This report calculated the additional levelized transmission, state tax, and utility profit expenses resulting from each new power source during the course of the model and according to the additional capacity in MW installed and generation in MWh of that given source. Capacity installed is used to determine capital costs and additional expenses (transmission, state taxes, and utility profits) of each electricity source over the course of its useful lifespan.[88]

The Levelized Cost of Intermittency (LCOI)

This report also calculated and quantified the levelized cost of intermittency (LCOI) for wind and solar energy on the entire energy system. These intermittency costs stem from the need to build backup natural gas or battery storage facilities to provide power during periods of low wind and solar output, which we call "load balancing costs," in this report and the need to "overbuild and curtail" wind and solar facilities to limit the need for battery storage. It is important to note that these costs are highly system specific to the mix of resources being built and operated in any given area.

Load balancing costs

We calculate load balancing costs by determining the total cost of building and operating new battery storage facilities to meet electricity demand during the time horizon studied in the Evers Plan.[89] These costs are then attributed to the LCOE values of wind and solar by dividing the cost of load balancing by the generation of new wind and solar facilities (capacity-weighted).

Attributing load balancing costs to wind and solar allows for a more equal comparison of the expenses incurred to meet electricity demand between non-dispatchable energy sources, which require a backup generation source to maintain reliability, and dispatchable energy sources like coal, natural gas, and nuclear facilities that do not require backup generation.

The key determinant of the load balancing cost is whether natural gas or battery storage is used as the "firming" resource. While natural gas provides relatively affordable firm capacity, battery storage is often prohibitively expensive. For the Evers Plan, no carbon dioxide-emitting technologies would be allowed after 2040, so no new natural gas was allowed in the model and battery storage was used as the backup source.

To understand why intermittency costs are required, Figure 9 shows the generation mix by source during the hypothetical week of June 4, 2050 to June 11, 2050. Low generation from wind and solar resources necessitates the use of battery storage to meet electricity demand. Because wind and solar cannot offer stand-alone reliability, the cost of battery storage must be attributed to these resources to accurately convey the true cost of using them.

Overbuilding and curtailment costs

The cost of using battery storage for meeting electricity demand during periods of low wind or solar output is prohibitively high, so many wind and solar advocates argue that it is better to overbuild renewables, often by a factor of five to eight compared to the dispatchable thermal capacity on the grid, to meet peak demand during these low wind and solar periods. These intermittent resources would then be curtailed when wind and solar output improves.

As wind and solar penetration increase, a greater portion of their output will be curtailed for each additional unit of capacity installed.[90]

This "overbuilding" and curtailing vastly increases the amount of installed capacity needed on the grid to meet electricity demand during periods of low wind and solar output. The subsequent curtailment during periods of high wind and solar availability effectively lowers the capacity factor of all wind and solar facilities, which greatly increases the cost per MWh produced.

For example, future curtailment values in the Evers Plan will increase substantially. Annual curtailment levels for this model were estimated based on hourly load forecasts and were found to reach up to 70 percent of total wind and solar generation by the end of the model (see Figure 18).

Rising rates of curtailment stemming from the overbuilding of the grid effectively lower the capacity factor of all generating resources on the grid, thereby increasing the levelized cost of energy, which is a calculation of power plant expenses divided by the generation of the plant. As curtailment rises, wind and solar facilities are forced to recover their costs over fewer MWhs, resulting in huge increases in the overbuilding and curtailment costs as the percentage of electricity demand served by wind, solar, and battery storage increases (see Figure 19).

The annual cost of each energy resource

Metrics like LCOE show the average cost of a power plant through the course of its financial payback period. These average cost estimates can be a helpful rule-of-thumb for comparing the cost of different energy resources, but in the real world, the costs of new power plants are frontloaded, and the cost of producing electricity from a power plant declines as it pays off its initial capital investment, and utility profits fall as the plant is depreciated. This has important implications for electricity consumers in the future, as the short useful lifespans of wind and solar facilities require the building and rebuilding

FIGURE 18

Curtailment vs. Renewable Percentage

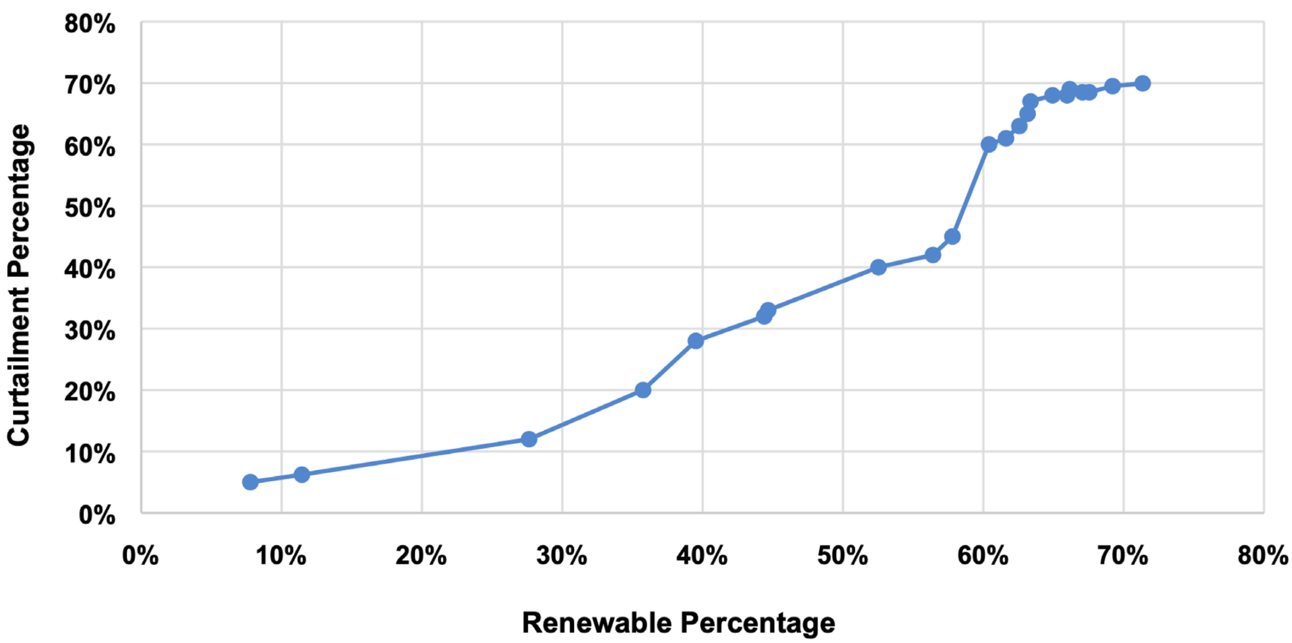


Figure 18. Curtailment increases most severely during the 55 to 70 percent phase due to the need to massively overbuild and the lack of adequate dispatchable resources.

of wind turbines and solar panels to maintain the same level of electricity generation, whereas nuclear, coal, and natural gas plants become more affordable over time.

Wind

Figure 20 shows the annual cost of a wind facility operating at its full potential capacity with additional costs incurred because of utility profits, state taxes, transmission, load balancing, and overbuilding and curtailment costs.

New wind costs begin at $121 per MWh in 2024 and rise throughout the model run to a high of $289 per MWh in 2050. The cost of wind energy reaches over $200 per MWh every year after 2035 as curtailment reaches above 60 percent and wind facilities reach the end of their useful lives and must be rebuilt, beginning the sequence of repaying the debt on the turbines all over again.

Solar

Figure 21 shows the annual cost of a solar facility operating at its full potential capacity with additional costs incurred because of utility profits, state taxes, transmission, load balancing, and overbuilding and curtailment costs.

FIGURE 19

Annual Overbuilding and Curtailment Costs

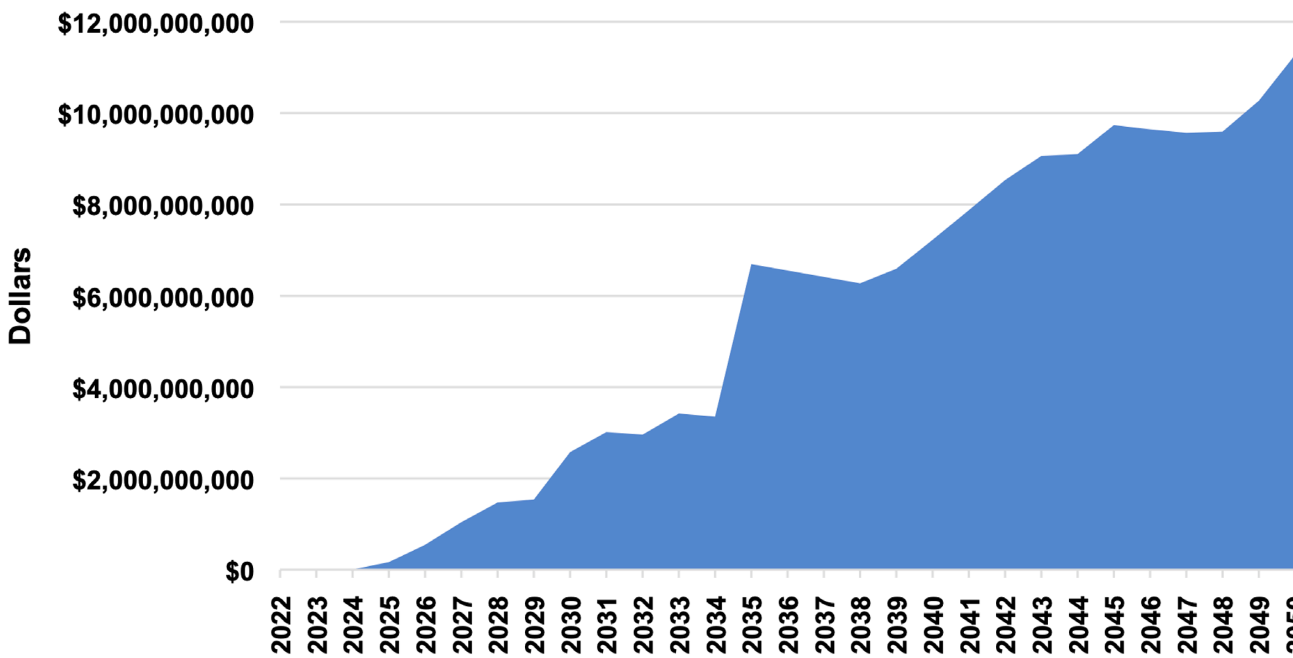


Figure 19. The costs of overbuilding and curtailing excess wind and solar generation grow over time as more of these intermittent resources are added to the grid. These costs reach over $11.3 billion in 2050.

Costs begin at $185 per MWh in 2024 and rise throughout the model run to a high of $398 per MWh in 2050. The cost of solar energy fluctuates after 2042 between $380 to $400 per MWh as solar facilities reach the end of their useful lives and must be rebuilt, beginning the sequence of repaying the debt on the panels all over again.

Nuclear SMR

Figure 22 shows the annual cost of an SMR with additional costs incurred because of state taxes and transmission. Costs begin at $126 per MWh in 2039, decline to a low $103 by 2050, the end of the model's timeline. If capacity factors are held high, these costs should decline even lower.

FIGURE 20

Wind Average Annual Cost of Electricity Dollars per MWh

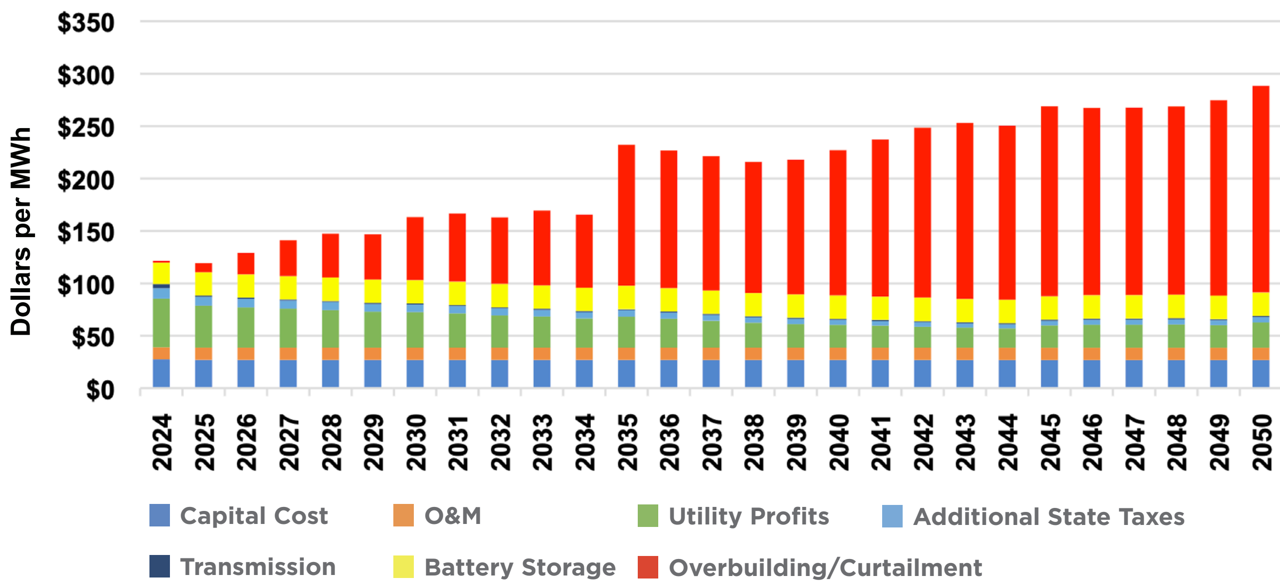


Figure 20. Wind costs increase dramatically after 2024 as wind is expected to meet greater percentages of electricity demand. This graph demonstrates that while it may be "cheap" to add each incremental MWh of wind electricity, meeting the current electricity demand with wind is very expensive.

FIGURE 21

Solar Average Annual Cost of Electricity Dollars per MWh

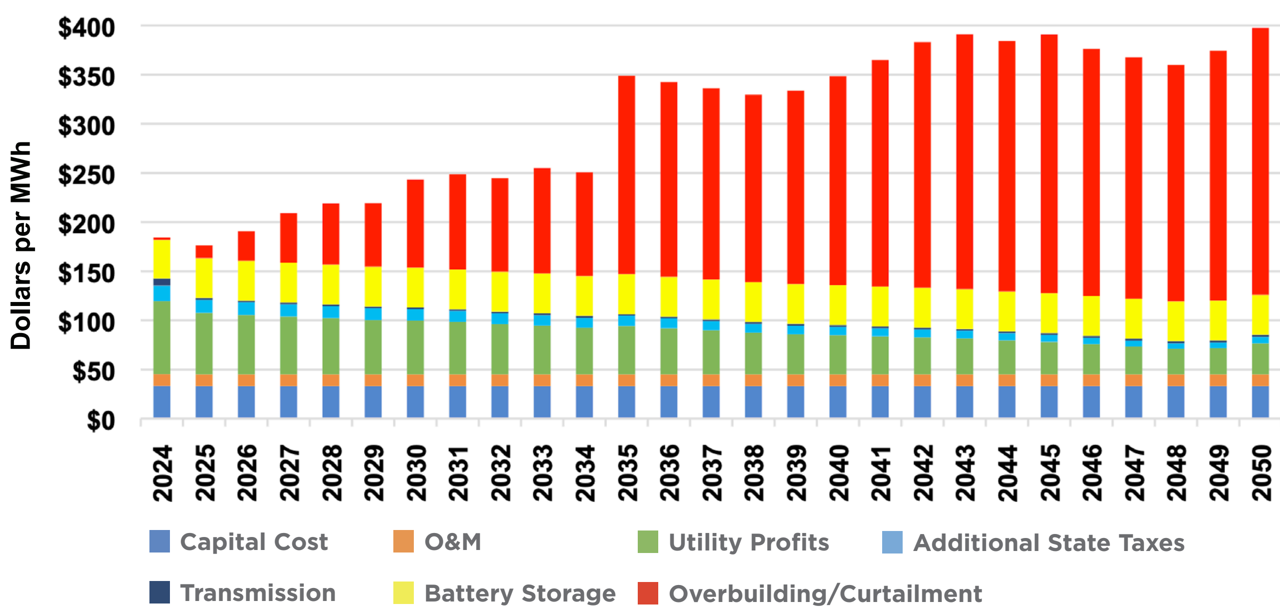


Figure 21. Solar costs exceed $300 per MWh in 2035. Solar costs are higher than wind costs because solar panels produce less electricity on an annual average basis than wind turbines, meaning these facilities recoup their costs over fewer MWhs.

FIGURE 22

Nuclear SMR Average Annual Cost of Electricity Dollars per MWh

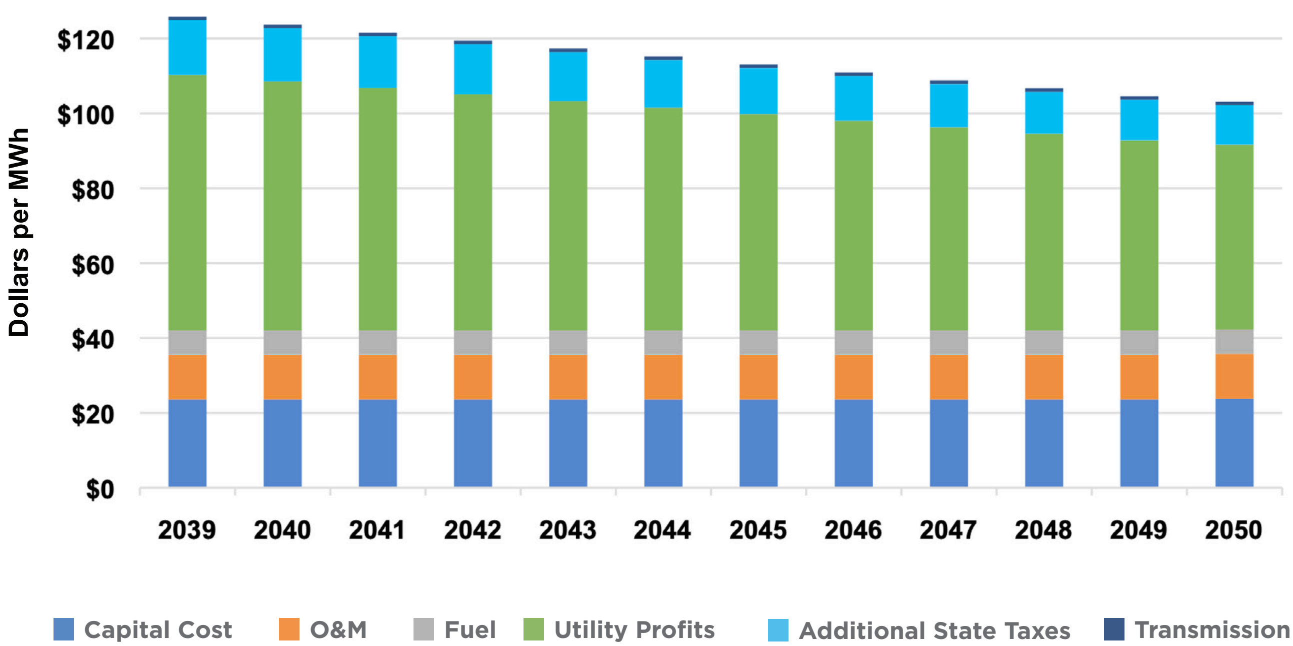


Figure 22. SMRs begin producing power in 2032 at a cost under $126 per MWh and decline to $103 by 2050. The average cost of nuclear SMR technology for the duration of the model is $114 per MWh.

Endnotes

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