AMERICAN EXPERIMENT

WASHINGTON POLICY CENTER

THE HIGH COST OF REMOVING THE LOWER SNAKE RIVER DAMS

A Joint Analysis by the Washington Policy Center and Center of the American Experiment.

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Executive Summary

- Proposals to remove the Lower Snake River (LSR) dams would transform Washington from a state with some of the lowest electricity prices in the country to a state with much higher costs.
- The total cost of replacing the generation of the LSR dams with 100 percent wind, solar, and battery storage would be $34.3 billion based on 2021 LSR dam generation and real-world wind and solar capacity factors for the region.
- Electricity rates would increase from 8.33 cents per kilowatt hour (kWh) in 2020, to 10.34 cents per kWh by 2028, an increase of 2.01 cents per kWh, a nearly 25 percent increase.
- Under this scenario, Washington would go from having the 7th lowest total electricity prices in the country in 2020 to the 18th highest in 2028.
- Washington electricity consumers would see their electricity expenses increase by an average of nearly $330 per year through 2050.
- Removing these dams would reduce the reliability of the grid by making the state more vulnerable to fluctuations in output from weather-dependent energy sources like wind and solar.
- The LSR dams provide other benefits, including transportation for goods, irrigation, and tourism, which must be addressed in any proposal advocating their removal.
- In contrast, replacing the dams with new natural gas facilities would provide reliable electricity at a cost of $10.3 billion—$24 billion less than replacing the dams with wind, solar, and storage, even with current high prices for natural gas.
- The $34.3 billion cost reported in this study pertains only to the expenses incurred replacing the electricity generated by LSR dams with new generation sources. This figure is notably higher than cost estimates produced by those who advocate destroying the dams, which do not include the cost of full replacement or transmission.
- Washingtonians would benefit most from keeping the LSR dams online. The next best option would be to build natural gas power plants to replace them.

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 Inslee and Senator Murray's proposal to eventually replace the Lower Snake River dams.

Policy Recommendations

Our research leads us to three common-sense policy recommendations that will keep Washington's electricity reliable, and affordable, while improving outcomes for salmon recovery. If adopted, these recommendations would save Washington electricity consumers billions of dollars in the coming decades.

1. **Keep the state's existing hydroelectric dams:** Washington has some of the lowest-cost electricity in the nation due to its hydroelectric dams. Removing the LSR dams and attempting to replace them with a combination of wind, solar, and battery storage facilities would be a costly mistake that will dramatically raise electricity prices.

2. **Allow for the construction of new natural gas plants in Washington.** Removing the LSR dams would be far less costly if Washington allowed the construction of new natural gas plants, but it is currently not legal to do so. Dam opponents admit dam removal will increase reliance on natural gas, so that electricity might as well be produced in Washington state.

3. **Dedicate salmon-recovery funding to projects across the state.** Rather than waste huge amounts of taxpayer money on one stretch of river, only to leave Washington's electricity less reliable, salmon-recovery advocates should push for funding to be used where it can be most effective across the Northwest.

Introduction

Washington state had the 7th lowest electricity prices in the United States in 2020 and the lowest carbon dioxide emissions from the electricity sector for any state in the nation.[1,2,3]

These economic and environmental feats were only possible because the original New Deal built the Grand Coulee and Bonneville dams. The hydroelectricity generated from these dams continues to be the largest source of power in Washington to this day.[4]

Hydroelectric power provided 66 percent of total in-state electricity generation in 2020, but several groups have advocated for removing the four LSR dams: Ice Harbor, Little Goose, Lower Granite, and Lower Monumental, to aid in salmon recovery efforts.[5]

These groups received a boost when Washington Governor Jay Inslee and Senator Patty Murray released their joint recommendations stating that salmon and other species in Washington state face a dire future that is in part due to the existence of the LSR dams.[6]

While Inslee and Murray stated that breaching the dams is not feasible in the short term, the pair said "federal and state governments should move forward with a program to replace the benefits provided by the Lower Snake River Dams, consistent with the Pacific Northwest's clean energy requirements and decarbonization future, so that breaching of the Lower Snake River dams is a pathway that can be credibly considered by policymakers in the future."[7]

"American Experiment's modeling shows removing the four LSR dams and replacing the electricity generated by them with onshore wind, solar, and battery storage would increase energy costs by $34.3 billion through 2050."

The pathway sought by Governor Inslee and Senator Murray has several challenges. While Washington is a net exporter of electricity, this statistic is misleading. Washington is a net exporter of electricity in the summer months, but it is a net importer of electricity during the winter. This makes the retention of the LSR dams crucial to keeping Washington's lights on as state laws mandate a shift away from oil and natural gas in its transportation and home heating sectors.

American Experiment's modeling shows removing the four LSR dams and replacing the electricity generated by them with onshore wind, solar, and battery storage would increase energy costs by $34.3 billion through 2050. This sum does not account for the economic losses that would affect Washington farmers who rely on the dams for irrigation and to send their wheat to market via barges.

Section I: Scenarios Modeled

The four LSR dams have a combined nameplate capacity of 3,033 MW, constituting nearly 10 percent of Washington's installed power plant capacity.[8,9] They accounted for 4.68 percent of Washington's in-state electricity generation in 2021, the most recent year data are available.[10] Over the past decade, generation from the LSR dams accounted for an average of 7.2 percent of Washington's in-state electricity generation. This report uses the 2021 percentage to provide a conservative estimate of potential costs.

This analysis examines two scenarios to determine the cost of replacing the lost electricity resulting from the removal of the four LSR dams in 2028. One scenario, the Renewable Scenario, calculates the cost of replacing the electricity generation of the four LSR dams with a combination of onshore wind, solar, and battery storage. All facilities would be located in Washington.

"The four LSR dams have a combined nameplate capacity of 3,033 MW, constituting nearly 10 percent of Washington's installed power plant capacity."

The other scenario modeled determines the cost of replacing the electricity generated by the LSR dams with new combined cycle and combustion turbine natural gas generation in Washington State. This scenario is called the Natural Gas Scenario (NG Scenario).

Both scenarios evaluate replacing the generation from the LSR dams of 5.4 million megawatt hours (MWh), based on real-world generation data for 2021 on an hourly basis.[11,12] Readers should note that this analysis does not account for federal subsidies paid to wind and solar operations. 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.

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

Section II: Replacing the Lower Snake River Dams with Renewables, or Natural Gas

Our model calculates the generation mix needed to replace the electricity generated from the LSR dams for every hour of 2021 using the resources mixes in the Renewable Scenario and NG Scenario.

Under the Renewable Scenario, Washington electricity providers would be required to invest heavily in wind, solar, and battery storage technologies to make up for destroying the dams. Figure 1 shows the resource mix needed to replace the dams under the Renewable Scenario in a hypothetical situation in 2028 after the LSR dams have been destroyed.

The black line shows the 2021 electricity production from the LSR dams, which must be matched by wind, solar and battery storage for every hour of the year to maintain the same level of reliability as the LSR dams after they are destroyed in 2028.

Wind and solar generation data were modeled using real-world, 2021 hourly capacity factors of these resources in the Bonneville Power Administration (BPA) territory during the dates depicted in Figure 1.[13] These dates were selected because they show the days where battery storage is needed most to match generation from the LSR dams.

"Our model calculates the generation mix needed to replace the electricity generated from the LSR dams for every hour of 2021 using the resources mixes in the Renewable Scenario and NG Scenario."

Any wind and solar generation that exceeds the LSR dam generation is used to charge the batteries on the system. 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 are placed into service on the grid.[14]

Under the NG Scenario, Washington would replace the generation from the LSR dams with new natural gas power plants, which are capable of being turned up and down to match fluctuations in electricity generation from the LSR dams (see Figure 2).

FIGURE 1

Renewable Scenario Hourly Generation 3/14/2028-3/21/2028

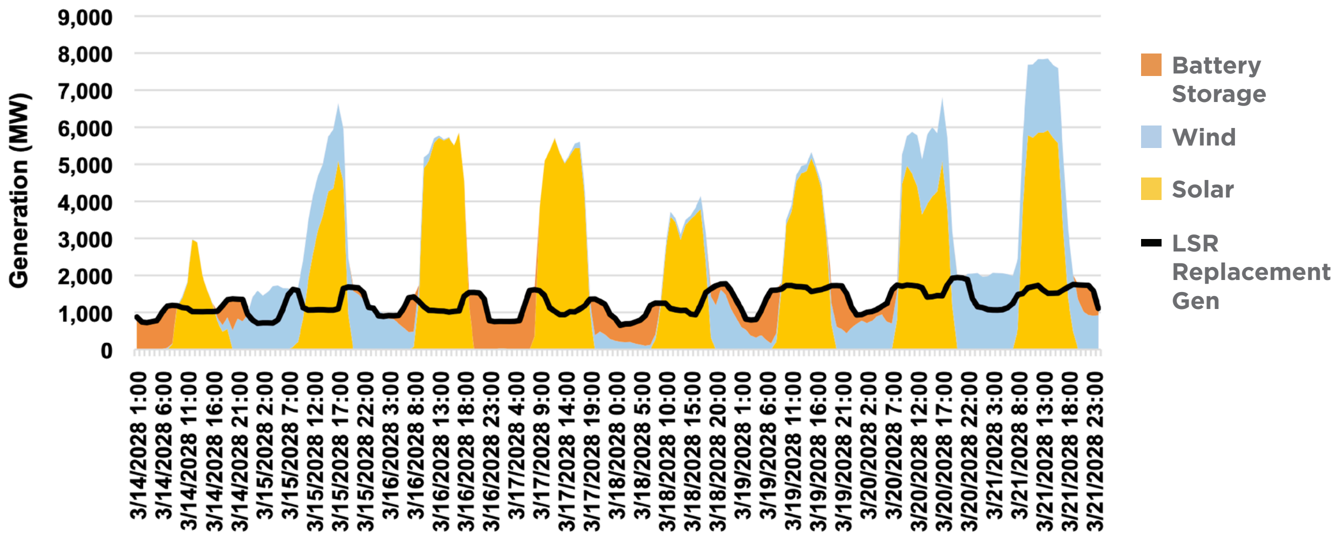


Figure 1. Solar energy is used to meet electricity demand and charge the batteries on the system during the day. These batteries are discharged at night if there is not adequate wind generation to match LSR dam generation.

FIGURE 2

NG Scenario Hourly Generation 3/14/2028-3/21/2028

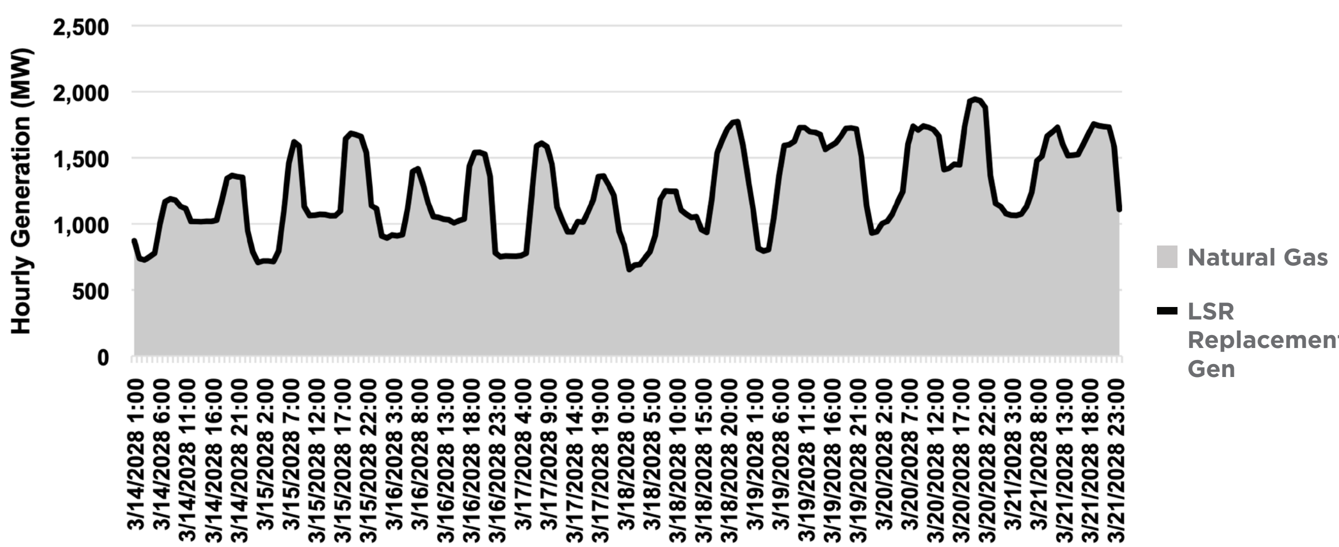
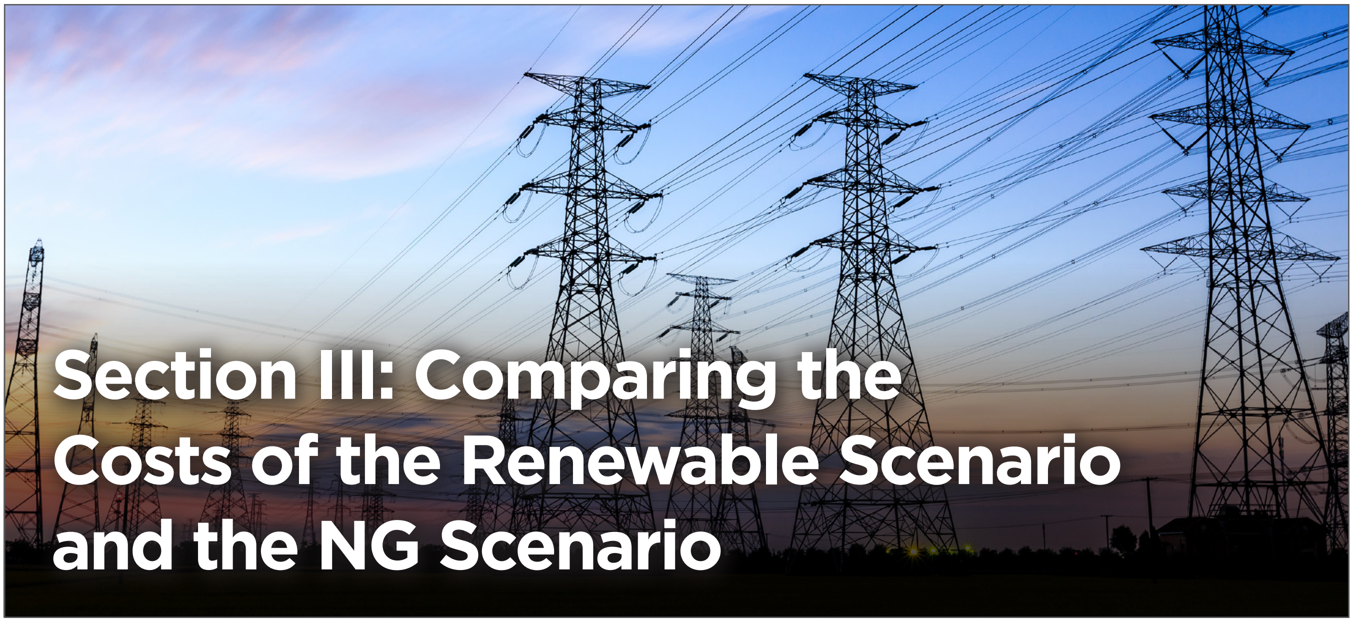


Figure 2. Because natural gas plants can easily be turned up or down, they can perfectly match LSR dam generation on an hourly basis.



Section III: Comparing the Costs of the Renewable Scenario and the NG Scenario

Our modeling indicates that the Renewable Scenario would cost Washingtonians an additional $34.3 billion (in constant 2022 dollars) compared to keeping the dams in place.

This would increase electricity rates by 24 percent in 2028, with average electricity rates rising from 8.33 cents per kWh in 2020 to 10.34 cents per kWh. As a result, the average cost for each Washington utility customer would increase by $485 in 2028, the equivalent of paying an additional $40 per month (see Figure 3).[15]

These cost estimates assume a declining cost of renewables and battery storage using projected future costs from the moderate scenario in the National Renewable Energy Laboratory (NREL) Annual Technology Baseline (ATB). Even with declining costs for wind, solar, and batteries, the cost to replace the electricity from the LSR dams is very high and nearly 3.5 times more than replacing the dams with natural gas generation.

"Our modeling indicates that the Renewable Scenario would cost Washingtonians an additional $34.3 billion (in constant 2022 dollars) compared to keeping the dams in place."

In contrast, the costs associated with the NG Scenario would total $10.3 billion, which would translate to a 6.6 percent increase in electricity rates. Prices would rise from 8.33 to 8.88 cents per kWh in 2028, resulting in an additional cost of $134 for each utility customer in Washington that year, or $11 per month. Under the NG scenario, Washington electricity rates would remain one of the lowest (13^{th}) in the country based on 2020 rates.

Figure 3 shows the annual additional costs of complying with the Renewable Scenario and the NG Scenario from 2022 through 2050, compared to the current cost of electricity. This number is obtained by dividing the annual cost of the programs among all Washington utility customers, including residential, commercial, and industrial electricity users.

Renewable Scenario costs decline from 2028 through 2048 as wind turbines, solar panels, and battery storage facilities depreciate over

FIGURE 3

Additional Cost per Washington State Customer

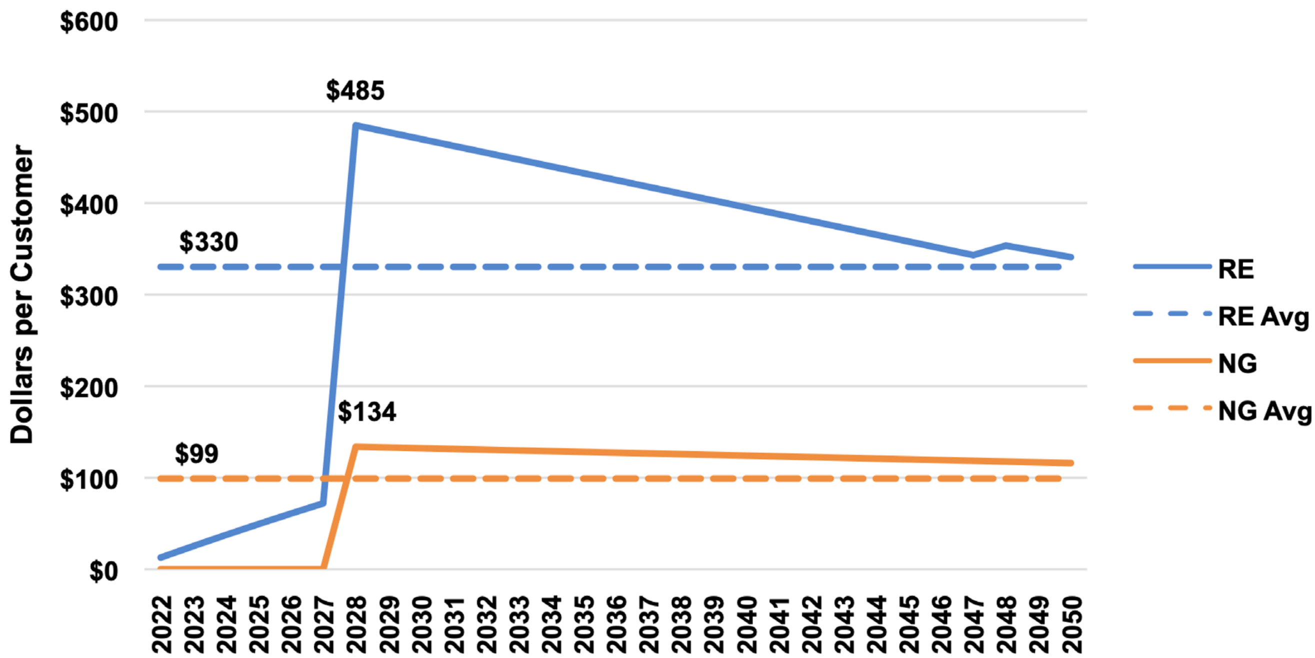


Figure 3. Annual costs for Washingtonians increase by an average of $330 under the Renewable Scenario. Costs peak at $485 in 2028. The NG Scenario would cost an average of $99 per year, with costs peaking at $134 in 2028.

time. Costs increase slightly again in 2048 because wind turbines and battery storage facilities only last for 20 years, and these facilities must be rebuilt, or "repowered," at the end of their useful lives in order to maintain adequate electricity generation capacity to replace the LSR dams.

Residential customers

Under the Renewable Scenario, residential electricity prices would increase by 2.38 cents per kWh in 2028. Rising prices would cause Washington families to see their annual electricity costs increase by an average of $242 per year through 2050 (see Figure 4).[16]

Residential customers under the NG Scenario would see an average additional cost of $73 per year compared to the current electric grid through 2050, an increase of $6.08 per month.

Commercial customers

Under the Renewable Scenario, commercial electricity customers like small businesses, grocery stores, and other retailers would see their electricity prices increase by 2.15 cents per kWh in 2028. Rising prices would cause Washington businesses to see their annual electricity costs increase by an average of $1,315 per year (see Figure 5).[17]

Commercial customers under the NG Scenario would see prices increase by 0.59 cents per kWh in 2028. Rising prices would result in commercial customers paying an additional cost of $394 per year compared to the current electric grid.

FIGURE 4

Additional Cost per Residential Customer

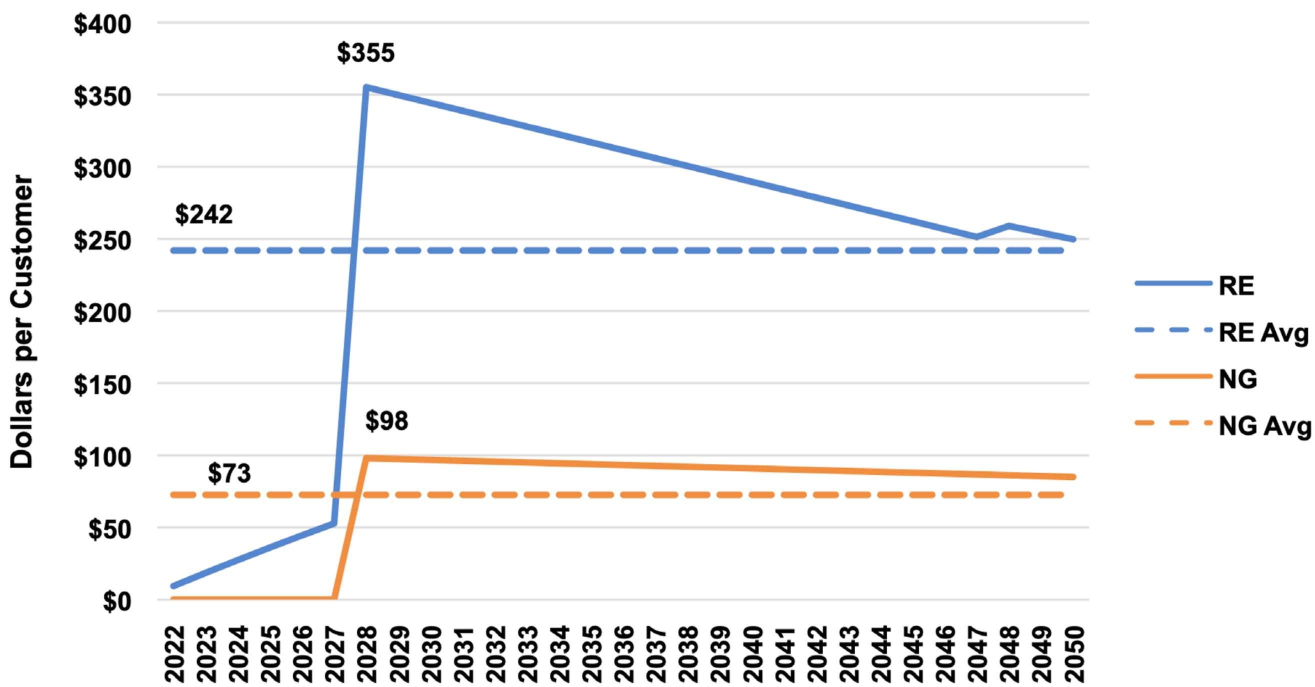


Figure 4. Costs rise sharply in 2028 as the LSR dams are removed in the Renewable Scenario as construction of new wind and solar facilities begins. Costs are lower in the NG Scenario.

Industrial customers

Industrial companies in Washington, as significant users of electricity, would be hit hard under the Renewable Scenario, seeing their electricity prices increase by 1.22 cents per kWh in 2028.

These rising prices would cause Washington industrial customers to see their annual electricity costs increase by an average of $20,668 per year (see Figure 6). Under the NG Scenario the cost of industrial electricity would increase by 0.34 cents per kWh in 2028. Rising prices would cost the average industrial customer an additional $6,198 per year.

With energy-intensive industries in Washington already struggling to keep their doors open, this potential increase is particularly important. Members of Congress are already asking the BPA to cut existing rates for manufacturers.[18]

Renewable Scenario compliance costs are driven by the need to build enough wind turbines, solar panels, battery storage facilities, and transmission lines to meet the same level of electricity provided by the LSR dams in 2021. NG Scenario costs are driven by building and operating new natural gas power plants in Washington.

Other factors that increase costs include rising property taxes and utility profits resulting from building the renewable energy sources needed to replace the dams.

FIGURE 5

Additional Cost per Commercial Customer

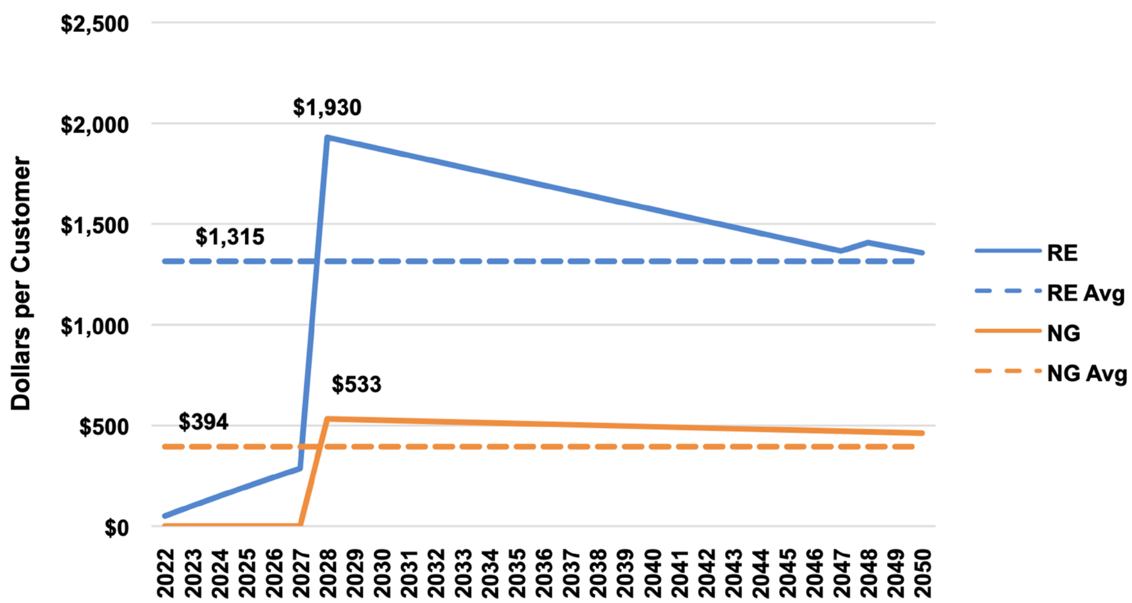


Figure 5. Costs are much lower in the NG Scenario.

FIGURE 6

Additional Cost per Industrial Customer

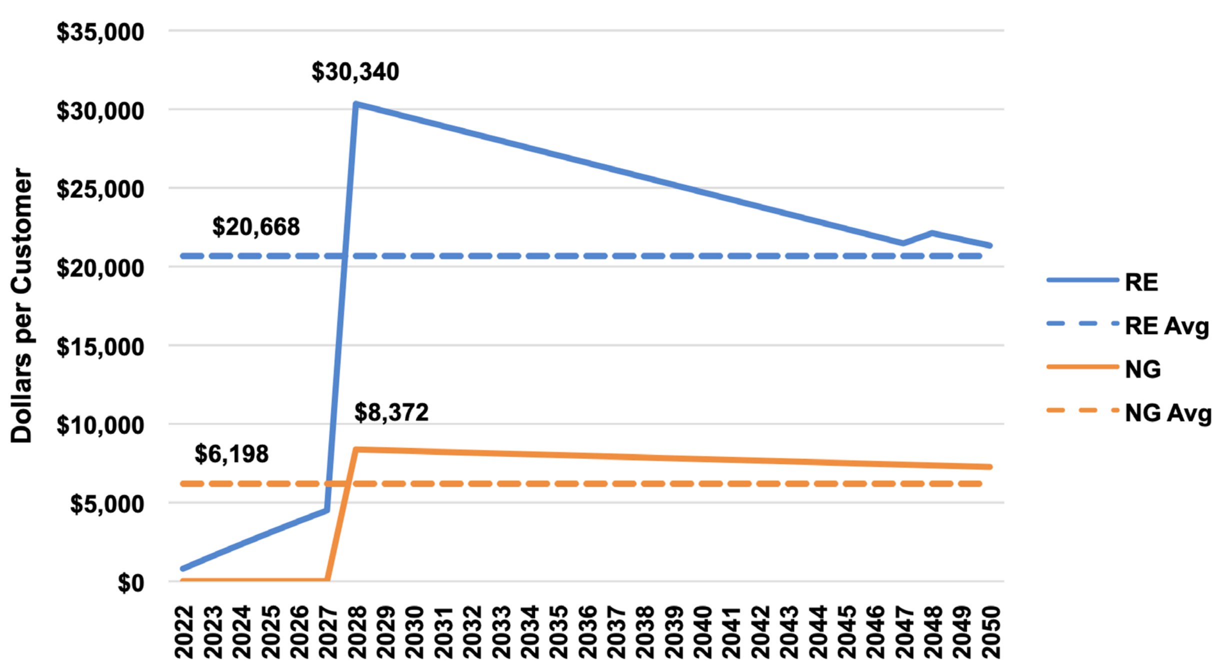


Figure 6. Industrial customers would see costs increase by $30,340 in 2028 under the Renewable Scenario and $8,372 in the NG Scenario.

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 Renewable Scenario and the NG Scenario. In this section, we will discuss how attempting to replace the LSR dams using wind, solar, and battery storage drives up costs to a much greater extent than building reliable natural gas 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.[19] If demand rises as Washingtonians turn on their clothes dryers or plug in their electric vehicles, an electric company must increase the power supply to meet that demand. If companies cannot increase supply to meet demand, grid operators are forced to cut power to consumers—i.e., initiate brownouts or blackouts—to keep the 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 fueled 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.

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 additional costs, including higher profits for investor-owned utilities and higher property taxes. Each of these additional costs will be discussed in greater detail below.

FIGURE 7

Installed Capacity Needed to Replace LSR Dams in Each Scenario

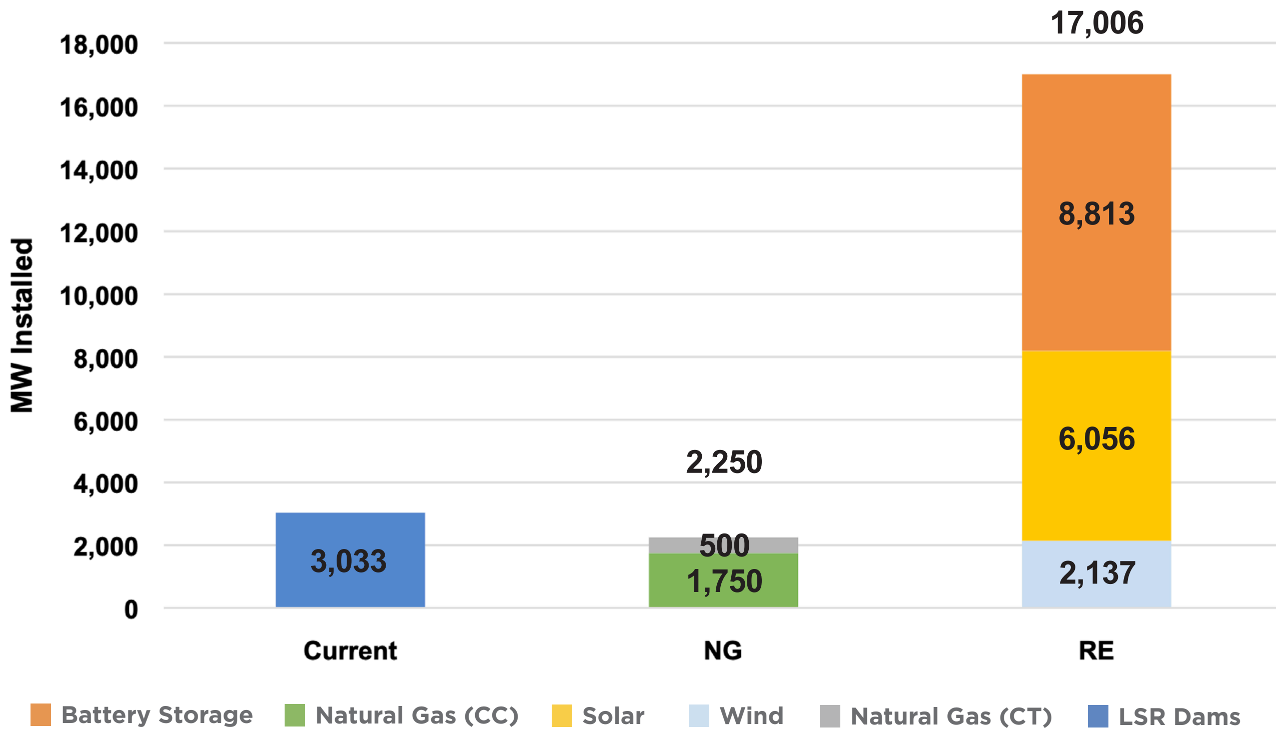


Figure 7 shows the amount of capacity needed to replace LSR output in each scenario. The Renewable Scenario would require 7.6 times more capacity than the NG Scenario.

Increasing electricity generation capacity

Building and operating new power plants is expensive. The Renewable Scenario would greatly increase the amount of power plant capacity on Washington's electric grid compared to keeping the LSR dams, while the NG Scenario would build significantly less new capacity. As a result, the Renewable Scenario is far more expensive.

In 2020, the most recent year power plant capacity data were available, Washington had roughly 30,688 MW of installed power plant capacity on its grid.[20]

Under the Renewable Scenario, the total capacity needed to replace the LSR dams would be 17,006 MW. The amount of capacity that Washington relies upon would increase to 44,661 MW after the dams are breached in 2028 for a net increase of 13,973 MW. Of this new capacity, 6,056 MW would be solar, 8,813 MW would be battery storage with four hours of storage per MW, and 2,137 MW would be wind.

The amount of additional capacity needed under the NG Scenario would be 2,250 MW, which means the Renewable Scenario would require 5.6 times more power plant capacity than the combined capacity of the four LSR dams and 7.6 times more capacity than the NG Scenario (see Figure 7).

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 matching the electricity generated by the LSR dams with carbon-free resources and maintaining grid reliability under 2021 LSR dam electricity generation and real-world wind and solar generation conditions.

Building these solar panels, wind turbines, and battery storage facilities would cost $5 billion, $2.2 billion, and $8.5 billion, respectively, while repowering these facilities at the end of their 20- to 25-year useful lives would cost an additional $7.7 billion for a total of $23.4 billion. However, only $15.1 billion would be paid by Washington consumers through 2050 (see Figure 8).[21]

In contrast, building the natural gas plants in the NG scenario would cost only $1.8 billion, with $1.1 billion paid through 2050. Fuel costs make up the largest expense in this scenario, totaling $6.2 billion through 2050.

"For major buildouts of wind and solar, previous studies show that transmission expenditures range anywhere from $240,000 to $300,000 per MW wind and solar installed."

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 often located in rural areas far from populous regions of Washington, where the electricity will be consumed.

For major buildouts of wind and solar, previous studies show that transmission expenditures range anywhere from $240,000 to $300,000 per MW wind and solar installed.[22,23,24] These values are consistent with average transmission cost estimates reported in a technical brief produced by Lawrence Berkeley Labs (LBL) in October 2022 and produced levelized transmission costs within the range found by LBL in 2019.[25,26]

This report uses the low end of this estimate ($240,000 per MW), which results in a total transmission cost of $2.4 billion for the Renewable Scenario, whereas the Natural Gas Scenario uses $450 million based on EIA estimates.

Utility returns

Because the LSR dams are owned by the federal government, they do not reap a rate of return like investor-owned utilities (IOUs).

Puget Sound Energy is the largest investor-owned utility in Washington, and it earns a return on equity of 9.4 percent when it spends money building new power plant capacity, as long as these expenditures are approved by electricity regulators in Washington.[27]

Our study assumes IOUs would own and operate 34.2 percent of the new capacity built in the Renewable Scenario and NG Scenarios because these entities constituted 34.2 percent of total electricity sales in Washington in 2020.

The Renewable Scenario would require utilities to spend $15.1 billion on new infrastructure through 2050, including initial capital costs and repowering, whereas capital expenditures in the NG Scenario during this period would be $1.1 billion. As a result, additional corporate profits for investor-owned utilities would be far higher under the Renewable Scenario, $7.4 billion, than under the NG Scenario, $1.1 billion.

FIGURE 8

Total Additional Cost of Each Scenario Through 2050

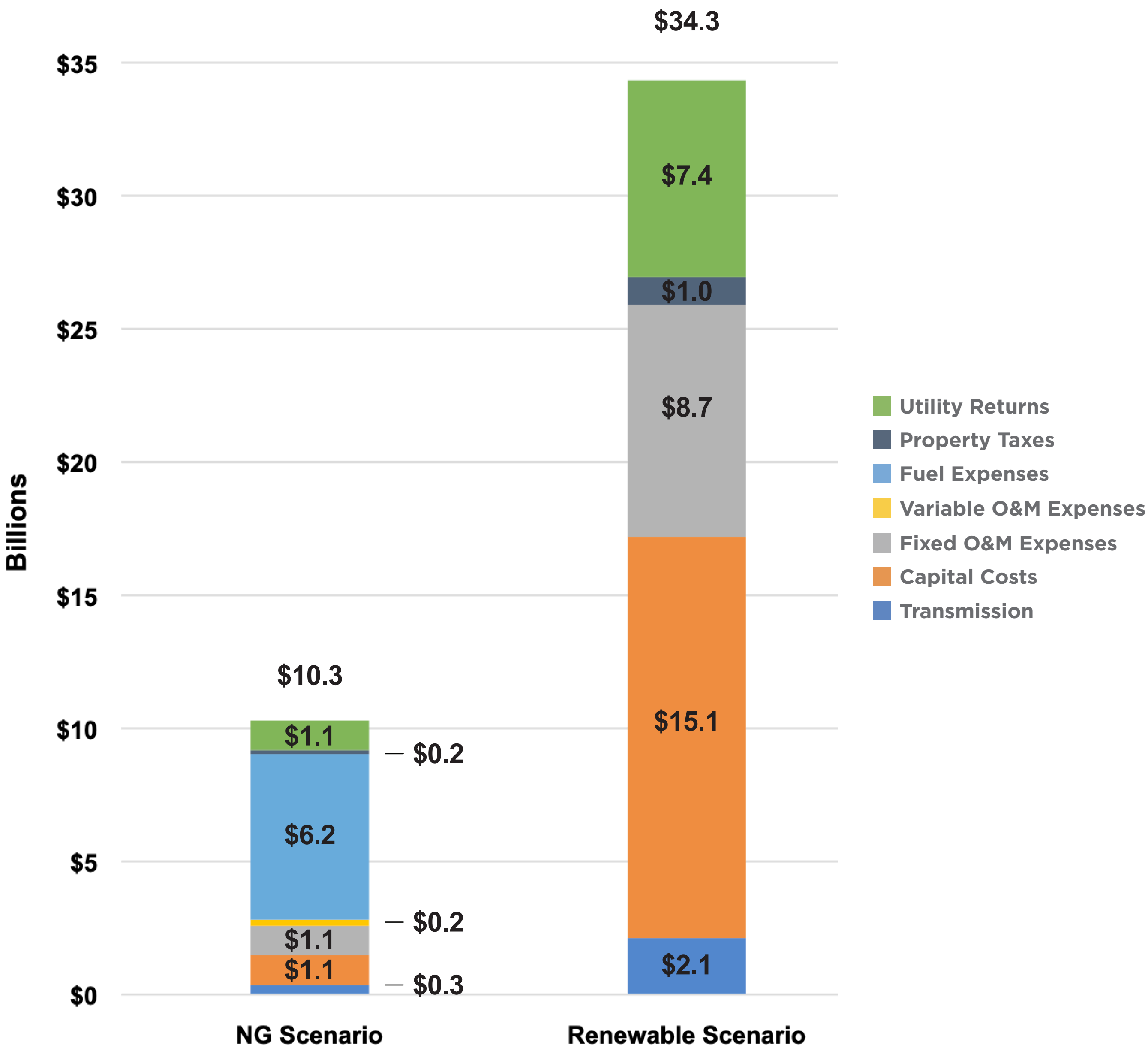


Figure 8. The Renewable Scenario would cost nearly 3.5 times more than the NG Scenario through 2050, with costs driven by higher utility profits and generation costs.

Property taxes

Property taxes increase most under the Renewable Scenario because compared to the current grid and NG Scenario, there is much more property to tax. While the property taxes assessed on power plants are often a crucial revenue stream for local communities that host power plants, these taxes also increase the cost of producing and providing electricity.

Additional property tax payments under the Renewable Scenario were calculated to be $1 billion.[28] Under the NG Scenario, additional property taxes would be $156 million.

Total Costs

Figure 8 shows the total additional cost comparison of the Renewable Scenario and the NG Scenario through 2050. As you can see, the Renewable Scenario is more expensive than the NG Scenario in every aspect, except fuel costs.

Notably, capital costs in the Renewable Scenario are 2.4 times more expensive than fuel costs in the NG Scenario despite using $9/MMBtu fuel prices. Furthermore, fuel costs are known as "pass-through" costs, meaning electricity customers pay only for the cost of the fuel and upkeep to serve it to them. This is in contrast to capital costs, which utility companies are allowed to rate base and earn a rate of return from and explains why utility returns in the Renewable Scenario are nearly 7 times more expensive than in the NG Scenario.

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.[29] 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.

"[Levelized Cost of Energy] 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."

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.[30]

For example, Lazard and EIA do not account for the expenses incurred to build new transmission lines, the additional property 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. [31]

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.[32] In this case, wind, solar, and battery storage must meet the hourly electricity generation provided by the LSR dams.

It is important for the reader to understand that the costs associated with load balancing, overbuilding, and curtailment increase 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 Renewable Scenario has an installed capacity of 17,006 MW by 2028, whereas the NG Scenario has a capacity of 2,250 MW.

American Experiment's model accounts for 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 the LSR dams, allowing for an apples-to-apples comparison of the cost of reliably matching LSR dam production with new power plants built in the NG Scenario and Renewable Scenario.

Data from Energy Environment Economics (E3) show the LSR dams are some of the lowest cost sources of electricity in the state, generating electricity for $17 per MWh (see Figure 9).

Under the Renewable Scenario, these low-cost dams would be replaced with wind, solar, and battery storage by 2028. Figure 9 shows the All-In LCOE of new wind and solar is approximately $415 per MWh and $433 per MWh, respectively.

Because curtailment rates reach 78 percent, overbuilding and curtailment costs are the primary drivers of wind and solar due to the need to build 5.5 times more capacity than would be needed if the LSR dams were left in place.[33] As a result, the cost of battery storage, overbuilding, and curtailing in Figure 9 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 reliably meet electricity demand than systems consisting largely of dispatchable power systems such as traditional fossil fuel and nuclear plants."

In the NG Scenario, new combined cycle (CC) and combustion turbine (CT) natural gas plants are used to replace the energy produced by the LSR dams at a cost of $81 and $164 per MWh, respectively (see Figure 9). Costs for CC and CT plants are largely driven from fuel expenses, which are assumed to be $9 per MMBtu throughout the model run. CT gas costs are higher cost on a per-MWh basis because they are used as a peaking resource and operate less frequently than CC gas plants.

If natural gas prices are assumed to be $5.40 per MMBtu—the Henry Hub cost on October 10, 2022—instead of $9 per MMBtu, the cost of CC gas would be $58 per MWh and CT gas would be $129 per MWh.

As discussed in Section IV, 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 reliably meet electricity demand than systems consisting largely of dispatchable power systems such as traditional fossil fuel and nuclear plants.

FIGURE 9

LCOE: Existing Hydro vs. New Combined Cycle Gas, Wind, and Solar

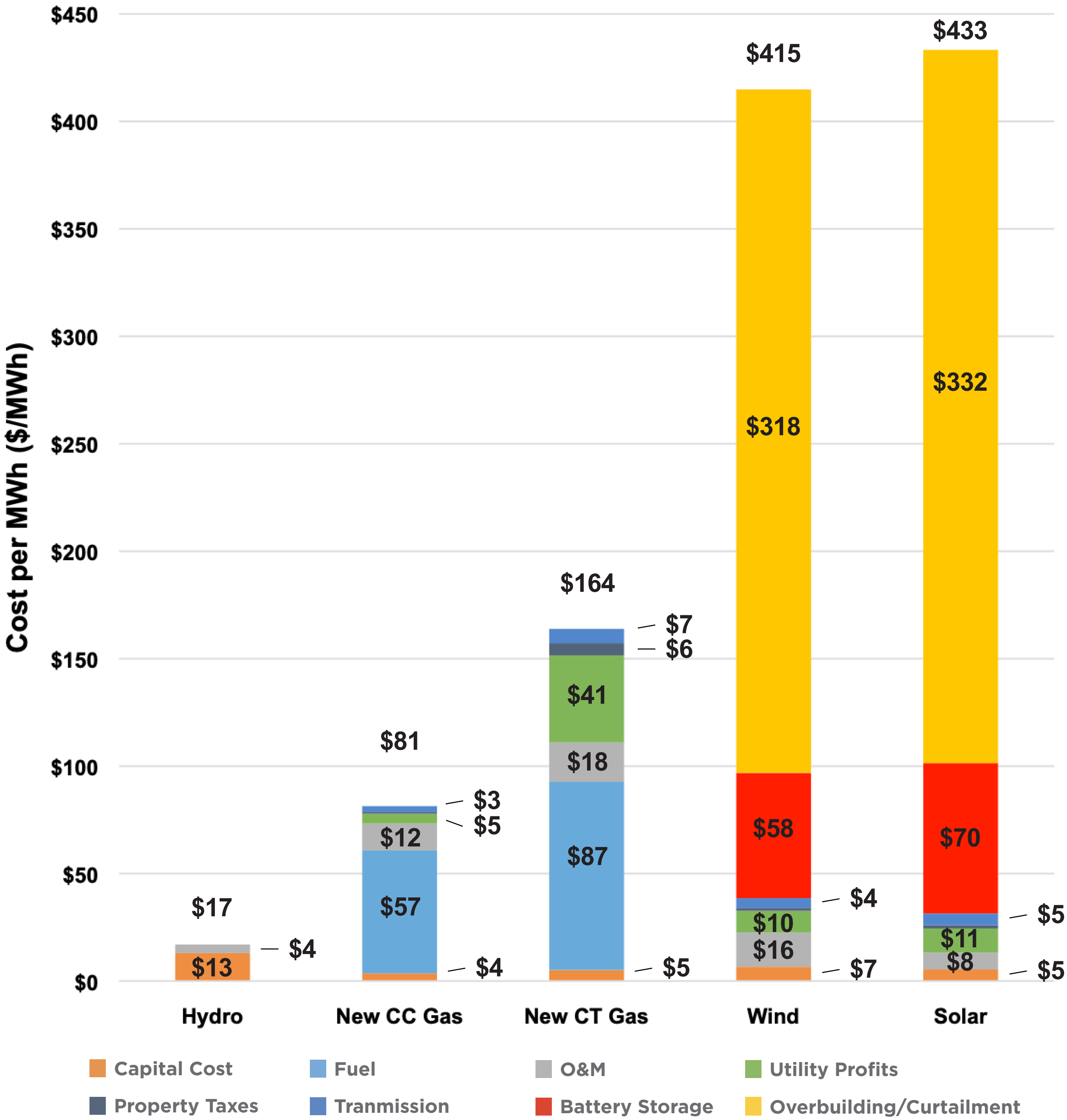


Figure 9. New solar facilities are the most expensive form of new electricity generation built under the Renewable Scenario. Once costs such as property taxes, transmission, utility returns, battery storage, and overbuilding and curtailment are accounted for new wind costs $415 per MWh and new solar costs $433 per MWh.

Section VI: Breaching the LSR Dams Would Harm Washington Families and the Economy

Proponents of breaching the LSR dams often argue that doing so will benefit local economies. They are wrong. Removing these low-cost dams will increase the cost of electricity, harming the state's economy in two primary ways.

First, it would reduce the amount of household 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 fewer meals at local restaurants, delayed repairs to a home or automobile, or less money for nutritious food or healthcare for their children.

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.

"Proponents of breaching the LSR dams often argue that doing so will benefit local economies. They are wrong. Removing these low-cost dams will increase the cost of electricity, harming the state's economy in two primary ways."

Spending $34.3 billion on new solar panels, wind turbines, transmission lines, and battery storage facilities under the Renewable Scenario will cause significant increases in electricity costs for each Washington electricity customer. The NG Scenario, with a cost of $10.3 billion, will increase electricity costs to a much lesser degree.

As discussed earlier in this report, the Renewable Scenario would result in average additional costs of $330 per customer per year through 2050, whereas the NG Scenario would increase costs by $99 per customer per year.[34]

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 Washington households. The policy is incredibly regressive because those with the least will lose the most.

Lost jobs from high energy prices

By increasing energy costs and thereby reducing the income available for spending in other sectors of the economy, the Renewable Scenario and NG Scenario would reduce the ability of Washington families to pay for, thus reducing the demand for, other goods and services in the broader economy. This makes it more difficult for businesses to retain employees and raise wages.

Most importantly, it makes Washington businesses less competitive with companies in other states, or nations, with lower energy costs.

In the Renewable Scenario, prices increase dramatically, and the vast majority of the jobs created would be temporary construction jobs at wind and solar installations. High electricity costs disproportionately jeopardize jobs in energy-intensive industries like agriculture, manufacturing, and mining, which compete in a global marketplace.

Conclusion

Compliance with the Renewable Scenario in Washington would cost at least $34.3 billion through 2050. This is an average of $330 per electricity customer per year through this timeframe. In comparison, the NG Scenario would increase costs for consumers by $10.3 billion through 2050, which is $24 billion less than the cost of the Renewable Scenario while maintaining grid reliability.

Renewable Scenario costs are driven by a massive buildout of solar panels, wind turbines, and transmission lines, in addition to the costs associated with higher property 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. NG Scenario costs are driven by building and operating new natural gas plants.

In the end, the idea that Washington can replace the LSR dams with wind turbines, solar panels, and batteries is an unserious one that will drastically increase energy costs for everyone.

Appendix

Electricity consumption assumptions

Electricity consumption is kept constant at 5.465 million MWhs throughout the course of this model run based on the most recent years' data from the U.S. Army Corps of Engineers database. 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 LSR dams in Washington compared to what it would cost to replicate their generation under the Renewable Scenario and NG Scenario.

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 removing the LSR on electricity prices from 2022 to 2050, to determine the long-term cost.

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 each of the scenarios studied, but rather the total cost that ratepayers would pay through 2050.

Hourly LSR dam generation, capacity factors, and peak demand assumptions

Hourly LSR dam generation was determined using data obtained from the U.S. Army Corps of Engineers. 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 wind and solar facilities were determined using real-time wind and solar generation data obtained from EIA's electric grid monitor for the BPA and dividing it by the installed capacity values for wind and solar.[35]

Utility returns

The amount of profit a utility makes on capital assets is called the Rate of Return (RoR) on the Rate Base for both the Renewable Scenario and NG Scenario. Investor-Owned Utilities serve 34.2 percent of Washington's electricity needs, which is why this study assumed only 34.2 percent of capital expenditures would earn a RoR.

For the purposes of our study, the capital structure used is that of Avista Utilities and Puget Sound Energy: 51.5 percent debt and 48.5 percent equity, a cost of debt of 4.97 percent and return on equity of 9.4 percent.[36] Utility profits are much higher in the Renewable Scenario than the NG Scenario because utility companies are earning a government-approved profit on much more new electricity generation and storage capacity.

Transmission

For major buildouts of wind and solar, previous studies show that transmission expenditures range anywhere from $240,000 to $300,000 per MW wind and solar installed.[37,38,39] This report uses the low end of this estimate of $240,000 per MW wind and solar installed for the Renewable Scenario. For the NG Scenario, we use EIA estimate of transmission expenses.[40]

Property taxes

Additional property tax payments for utilities were calculated to be one percent of the undepreciated cost of generation assets installed to comply with the Renewable Scenario and NG Scenario, based on Washington property tax rates.

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 NREL, 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. 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 Renewable Scenario and NG Scenario by the number of electricity customers in Washington.[41]

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 Renewable Scenario and NG Scenario compliance during the time horizon of the study to rate classes based on historical rate factors in the state of Washington. 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 Washington were 9.87, 8.92, and 5.08 cents per kWh in 2020, respectively. Based on general electricity prices 8.33 cents per kWh, residential, commercial, and industrial rates had rate factors of 1.18, 1.07, and .61, respectively. This means that, for example, residential customers have historically seen electricity prices 18 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 shows annual electricity rate increases by customer class using the cost of the Renewable Scenario and NG Scenario and adjusting for the rate factor described above.

	Total		Residential		Commercial		Industrial	
	NG	RE	NG	RE	NG	RE	NG	RE
2022	0	0.05	0	0.06	0	0.06	0	0.03
2023	0	0.1	0	0.12	0	0.11	0	0.06
2024	0	0.15	0	0.18	0	0.17	0	0.09
2025	0	0.2	0	0.24	0	0.22	0	0.12
2026	0	0.25	0	0.3	0	0.27	0	0.15
2027	0	0.3	0	0.35	0	0.32	0	0.18
2028	0.55	2	0.66	2.38	0.59	2.15	0.34	1.22
2029	0.55	1.96	0.65	2.33	0.59	2.1	0.34	1.2
2030	0.55	1.91	0.65	2.27	0.59	2.05	0.33	1.17
2031	0.54	1.87	0.64	2.22	0.58	2.01	0.33	1.14
2032	0.54	1.84	0.64	2.18	0.58	1.97	0.33	1.12
2033	0.54	1.8	0.64	2.14	0.57	1.93	0.33	1.1
2034	0.53	1.77	0.63	2.1	0.57	1.9	0.33	1.08
2035	0.53	1.74	0.63	2.07	0.57	1.87	0.32	1.06
2036	0.53	1.72	0.62	2.03	0.56	1.84	0.32	1.05
2037	0.52	1.69	0.62	2	0.56	1.81	0.32	1.03
2038	0.52	1.66	0.62	1.97	0.56	1.78	0.32	1.01
2039	0.52	1.63	0.61	1.94	0.55	1.75	0.31	1
2040	0.51	1.61	0.61	1.9	0.55	1.72	0.31	0.98
2041	0.51	1.58	0.6	1.87	0.55	1.69	0.31	0.96
2042	0.51	1.55	0.6	1.84	0.54	1.66	0.31	0.95
2043	0.5	1.52	0.6	1.81	0.54	1.63	0.31	0.93
2044	0.5	1.5	0.59	1.77	0.53	1.6	0.3	0.91
2045	0.5	1.47	0.59	1.74	0.53	1.57	0.3	0.9
2046	0.49	1.44	0.58	1.71	0.53	1.54	0.3	0.88
2047	0.49	1.42	0.58	1.68	0.52	1.52	0.3	0.86
2048	0.49	1.46	0.58	1.73	0.52	1.57	0.3	0.89
2049	0.48	1.44	0.57	1.7	0.52	1.54	0.29	0.88
2050	0.48	1.41	0.57	1.67	0.51	1.51	0.29	0.86
Average	0.41	1.35	0.49	1.60	0.44	1.44	0.25	0.82

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 the LSR dams were derived from the E3 report referenced earlier.

LCOE values for new power plants were calculated using data values presented in the NREL ATB 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.

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 NREL ATB.[42]

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.[43] This is problematic for wind energy LCOE estimates because NREL 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 assumed to last for 20 years, which is longer than the median lifetime of 15 years found by the NREL.[44] Battery facilities, like wind and solar, are rebuilt after reaching the end of their useful lifetimes.

Natural gas plants last 30 years. Natural gas facilities have a financial lifespan of 30 years.

Fuel cost assumptions

Fuel costs for new natural gas plants were assumed to by $9 per million British thermal units, as this was the cost at the Henry Hub in early September 2022.[45] We hold these values constant throughout the entirety of the report.

Levelized cost of transmission, property taxes, and transmission lines

This report calculated the additional levelized transmission, property 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, property taxes, and utility profits) of each electricity source over the course of its useful lifespan.[46]

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," 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.[47] 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.

Overbuilding and curtailment costs

The cost of battery storage for meeting electricity demand 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 periods of low wind and solar output. These intermittent resources would then be curtailed when wind and solar output improves.

As wind and solar penetrations increase, a greater portion of their output will be curtailed for each additional unit of capacity installed.[48]

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 Renewable Scenario will increase substantially. Annual curtailment levels for this model were estimated based on hourly load forecasts and were found to reach up to 78 percent of total wind and solar generation by the end of the model.

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. The annual cost of curtailment is nearly $1.4 billion every year from 2028 to 2050.

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48 Dev Millstein et al., "Solar and Wind Grid System Value in the United States: The Effect of Transmission, Congestion, Generation Profiles, and Curtailment, Joule, July 2021, https://www.sciencedirect.com/science/article/pii/S2542435121002440.

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