ENERGY ALLIANCE

The High Cost of Wind, Solar, and Batteries

The Failed War Against Fossil Fuels

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Executive Summary

By the 1800s, wind and solar were both mature and successful technologies. Yet as soon as Western society developed the wealth and technology to take advantage of fossil fuels, they were discarded—along with batteries for electric cars—and had no place in the modern world for grid scale generation of electricity.

Renewable energy still cannot compete with the efficiency, affordability, and reliability of fossil fuels. But this has not stopped it from making a comeback on the backs of American taxpayers and consumers who have paid for hundreds of billions of dollars of subsidies from federal, state, and local governments.

Renewables need these subsidies because the cost of generating electricity from wind and solar plants—and the cost of storing it in batteries—greatly exceeds the cost of generating electricity from natural gas. In a real-world setting, wind generation costs three times that of natural gas, and solar generation and battery storage are four times greater.

Billions of taxpayer money are also being spent on trying to maintain grid reliability as renewable penetration increases on the grid. From 2019 through 2023, Texas spent on average about $9.6 billion a year, for a total cost of $48.4 billion, attempting to deal with the reliability problems caused by renewables. One study found the cost of electrification and Net Zero policies in the Pacific Northwest are projected to increase the bill of the average residential customer in Oregon and Washington by $600 a month by 2050. In New England, another study found the cost of meeting the region's decarbonization goals with renewables is estimated to cost ratepayers $815 billion through 2050.

These and other studies make it clear that the only possible rationale for renewable energy—making significant reductions of CO2 emissions—cannot be achieved. The costs of attempting to do this with renewables are already imposing heavy costs on economies across the world and will rapidly escalate as the grid penetration of renewables increases. As several European countries have already experienced as they plunged into energy poverty, the costs are simply too great for any society to pay.

The Failed War Against Fossil Fuels

Over the past 30 years, the American electric grid has undergone a radical transformation powered by hundreds of billions of dollars of subsidies from federal, state, and local governments. Prior to this, despite the examples of California and New York, the national grid generally provided a relatively affordable and reliable supply of electricity to American businesses and consumers. Today, prices are skyrocketing and reliability problems have greatly increased in frequency and Texas' successful push to embrace renewable energy has caused it to overtake California and New York as the state with the least reliable grid.

All of this has happened because of the ongoing war against fossil fuels. Beginning in the 1960s, special interests assaulted the cheapest, most efficient, and most reliable energy source the world has ever had on multiple fronts. Acid rain, peak oil, ozone layer depletion, global cooling, global warming, the Russia/Ukraine war, and other false narratives have been used in the effort to eliminate fossil fuels. While they have all failed in that regard, what they have accomplished is to impose third-world style energy poverty on much of the developed Western world as energy prices—particularly for electricity—have increased.

Many alternative energy sources to fossil fuels have been proposed along the way. These include algae, saltwater, landfill gas, cold fusion, biodiesel, ethanol, ocean waves, and hydrogen. All these have failed. Another proposed alternative, synthetic fuels, also failed despite being supported by President Jimmy Carter and Congress with close to $1 billion in funding. Nuclear energy has shown commercial promise as an alternative but has largely been shut down by governments even though the process emits no CO_2. Today the darling of the anti-fossil fuel crowd is wind and solar power, along with the batteries needed to store their intermittent and often unneeded generation of electricity for those times when the electricity is needed but wind and/or solar are not generating.

The hallmark of renewable energy sources in the ancient world—wind-, solar-, and hydro-power—was that they were dependent on the weather. But they were all humans had, along with animal power, for several millennia because the capital and technology needed to build the infrastructure to support fossil fuels were insufficient. It stayed that way until the 1800s, when wealth had expanded throughout the Western world to the point where coal, oil, and natural gas became economically viable. As Robert Bryce explains, "By using hydrocarbons (at first coal, then later oil and natural gas) humans were able to harness ever increasing quantities of power and do so in ever-denser packages. In place of animal power, sun power, and wind power, factories began using advanced waterwheels and coal-fired steam engines." By 1900, wind and solar were both mature and very uneconomical technologies that had been discarded—along with batteries for electric cars—and had no rational place in the modern world for grid scale generation of electricity. They still do not.

Government Mandates and Subsidies Created the Renewable Renaissance

A hundred years later, wind and solar energy have made a comeback, exceeding the success of other promoted alternatives to fossil fuels. But not because they are more efficient, economical, or reliable than fossil fuels. The law of power density explains why fossil fuels produce more units of energy per input unit of land (minerals and metals) than renewables and can generally be used, or dispatched—unlike renewables, on demand. The only reason the American landscape is littered with wind turbines and solar panels is because of government intervention through mandates and subsidies.

Figure 1: U.S. Federal Energy Subsidies			
Subsidy	**2010-19**	**2020-2029**	**Total**
Renewables	$74,069,797,000	$244,874,000,000	$318,943,797,000
Fossil Fuels	$37,870,000,000	$22,474,000,000	$60,344,000,000
Nuclear	$15,410,000,000	$19,116,000,000	$34,526,000,000

Early in the "energy transition," renewable energy mandates required retail electric providers to purchase certain amounts of their electricity from renewable sources or, in lieu of that, purchase renewable energy credits from wind and solar generators. In essence, renewable generators were paid twice for their electricity; once for the power and once for the credits.

Subsidies have also been important in increasing renewable energy use and profits. **Figure 1** shows their impact with subsidies for wind and particular solar rapidly increasing since Congress passed the Inflation Reduction Act. Federal subsidies for renewables this decade are more than four times what they were in the last decade, and solar subsidies have increased even more. Many state and local governments have followed suit and are also using subsidies to force the energy transition on Americans.

The roles that mandates and subsidies play vary depending on the state. Texas—the state that generates the most electricity from renewables—relies more on subsidies to promote renewables having changed its mandate for wind credits into a voluntary program in 2024—though its solar program is still mandatory (Texas also eliminated one local subsidy in 2023). However, states like Oregon and Washington are using Net Zero mandates to push the transition to renewables beyond what the subsidies might sustain (see more below). They are doing this because the costs of transitioning to anywhere near 100% renewable are so large the public would likely rebel against subsidies of that amount. So, the states, along with the federal government, are trying to hide the costs by forcing consumers and business to pay for the transition through higher electricity bills.

The High Capital and Operating Costs of Renewable Energy

The necessity of resorting to renewable mandates and subsidies to force an energy transition onto Americans was reinforced last year by data on the cost of generating electricity from a variety of sources. The data, compiled and released by the U.S. Energy Information Administration (EIA), shows that generating electricity from wind and solar and the costs of batter storage are still far more expensive than generation from natural gas, the source of the most generation in the United States. **Figure 2** summarizes the EIA's findings.

Figure 2. 2024 Estimates of Power Plant Capital and Operating Costs (2023$)

	Nominal Capacity (MW)	2019 Overnight Capital Cost ($/kW)	2023 Overnight Capital Cost ($/kW)	Change	2023 Capital Cost ($/avg capacity kW)	Fixed O&M ($/kW-yr)	Fixed O&M ($/avg capacity kW-yr)	Variable O&M ($/MWh)
Coal - Ultra-Supercritical coal (USC)	650	$4,330	$4,103	(5%)	$5,861	$61.60	$88.00	$6.40
Natural Gas								
Combustion turbine—industrial frame	419	N/A	$836	N/A	$3,342	$6.87	$27.48	$1.24
Combined-cycle, multi shaft	1,227	$1,128	$868	(23%)	$1,453	$12.12	$20.30	$3.41
Uranium								
Advanced nuclear	2,156	$7,115	$7,861	10%	$8,453	$156.20	$167.96	$2.52
Small modular reactor	480	$7,292	$8,936	23%	$9,609	$121.99	$131.17	$3.19
Wind								
Wind Onshore	200	$1,490	$1,489	(0%)	$4,485	$33.06	$99.57	$0.00
Wind Retrofit	150	N/A	$1,386	N/A	$4,175	$38.55	$116.10	$0.00
Solar - photovoltaic—tracking	150	$1,546	$1,502	(3%)	$6,476	$20.23	$87.21	$0.00
Battery storage	150 MW/ 600MWh	$1,636	$1,744	7%	$6,976	$40.00	$160.00	$0.00

Source: U.S. Energy Information Administration

According to the EIA, the cost of building a new combined-cycle natural gas generating unit is $868 per kilowatt of maximum capacity. Wind and solar generation costs for a new plant are almost twice as much, and the cost of battery storage is more than double. But these numbers don't tell the full story because natural gas plants can generate electricity much closer to their maximum capacity than can wind and solar plants. Because batteries do not generate electricity, but store it, they run out and thus are also not capable of producing electricity at the same output as natural gas.

Taking this into account, **Figure 2** shows the cost of natural gas combined-cycle generation at its average operating capacity factor of 59.7% is $1,453 per kilowatt. For onshore wind at its capacity factor of 33.2%, the cost is $4,485 per kilowatt—three times that of natural gas. Solar, at its capacity factor of 23.2%, costs $6,476 per kilowatt—more than four times natural gas. And the cost of batteries, with a capacity factor of 25%, is $6,976—again more than four times natural gas. Even coal—with all the costly regulations generators must pay for, is almost competitive with wind and less expensive than solar or batteries.

These costs only account for the cost of building new generation. But there are also fixed costs such as interest and maintenance to be considered. Again, taking into account the capacity factors of each type of generation, natural gas (combined cycle) comes in much cheaper than renewables with a fixed cost of $12.12 per kilowatt annually, compared to $33.06 for onshore wind, $20.23 for solar, and $40 for battery storage.

The Myth of the No Fuel Cost Advantage of Renewables

One of the myths about wind and solar generation is that it has an advantage over fossil fuels because it has no fuel costs. For instance, the International Renewable Energy Agency claims, "The fossil fuel price crisis has accelerated the competitiveness of renewable power." And in a recent article, *The Problem with Solar*, the authors wrote a benefit of solar is that "it's basically free" when the sun is shining.

Yet, as we have seen, this is not the case. The costs of building generation plants for both wind and solar are still much more expensive per kilowatt generated than for natural gas. These costs must be allocated to generation and reflected in prices even though renewable generators have no fuel costs. The question remains though; if a wind or solar farm generates enough electricity with no fuel costs, can they lower their overall costs to be competitive with the cost of generating with natural gas? The short answer is no. There are several reasons for this.

One is that solar and wind cannot always generate electricity when it is needed. Solar, for instance, only generates electricity during the day. As the authors of *The Problem with Solar* explain,

> The dirty little secret is that, at the scale relevant to most people, solar generation's cost advantage is sort of beside the point. For solar to serve as the backbone of a grid, it needs to be backed with storage. That can come in the form of batteries, hydrogen, or pumped hydro. All of these are expensive; none of them scale. Storing a kilowatt-hour of electricity in a chemical battery costs an order of magnitude more than just generating it in a nuclear power plant. Which is why a 100% solar grid would be insanely expensive ...

Wind has a similar problem; it is most productive at night when less power is needed. Of course, the problems solar and wind can offset each other so the cost of dealing with the intermittency of wind and solar might be somewhat mitigated by operating them together. But only somewhat. Batteries are still needed to make up for the gaps between the two, for instance around sunset, but also for when wind and solar underperform because of changing weather. What this means is that renewable generators must account for the cost of batteries much like fossil fuel generators have to do with fuel. And as the EIA data tells us batteries cost more than natural gas or coal. Additionally, there are other costs associated with the intermittency and underperformance of renewables which we will examine in the next section.

Three Examples of the High Cost of Renewables Operating on a Grid

The EIA data is very helpful in determining how expensive it is to build and operate facilities that generate electricity from wind and solar. Yet the data from EIA and most other efforts to compare the costs of generation across fuel types ignore the fact that the facilities do not operate in a vacuum. Instead, generating plants must operate on a grid where maintaining reliability is mandatory. Not only can reliability issues cause customers to lose power, but they can shut down entire grids if the balance of supply (generation) and demand (load) are not maintained within razor thin margins. In this section we'll examine the reliability and total costs of renewables on grids in three different regions of the country.

The Pacific Northwest: Zero Fuel Costs Don't Help Consumers

The high cost of renewable energy operating on a grid where load must be met and reliability maintained is captured in a recent Discovery Institute study, *The Crippling Costs of Electrification and Net Zero Energy Policies in the Pacific Northwest*. The authors, Jonathan Lesser and Mitchell Rolling, examine the cost of policies calling for electrification of energy use in Washington and Oregon through laws that mandate 100% of cars be electric by 2035 and that heating for homes and businesses be provided by electric heat pumps by 2050.

The study estimates that these policies will require a total increase in electricity consumption of 54,057 gigawatt hours, representing a 40% increase over 2023 electricity sales in the two states. While significant for those states, to put this in a broader context this increase is only slightly more than the estimated 49,155 gigawatt hours Texas' electricity demand is expected to increase in 2025.

Because "Oregon law HB 2021 requires the state's electric utilities to eliminate all fossil-fuel generation and supply 100% zero-emissions electricity by 2040," the study assumes that all the new electricity required for electrification will be generated by renewable energy. For comparison, it estimates how much it would cost to generate the mandate-driven increase in demand from natural gas and nuclear power. **Figure 3** provides the results.

Figure 3: Total Cost of New Generation in Washington & Oregan Through 2050 (Millions of $)						
Scenario	**Capital Costs**	**Fixed O&M Costs**	**Variable Costs**	**Taxes**	**Utility Profits**	**Total Costs**
Renewables Only	$232,791	$73,229	($11,381)	$48,363	$206,909	$549,910
Natural Gas and Nuclear	$17,953	$7,282	$3,226	$10.89	$46,587	$46,587

Source: Lesser and Rolling

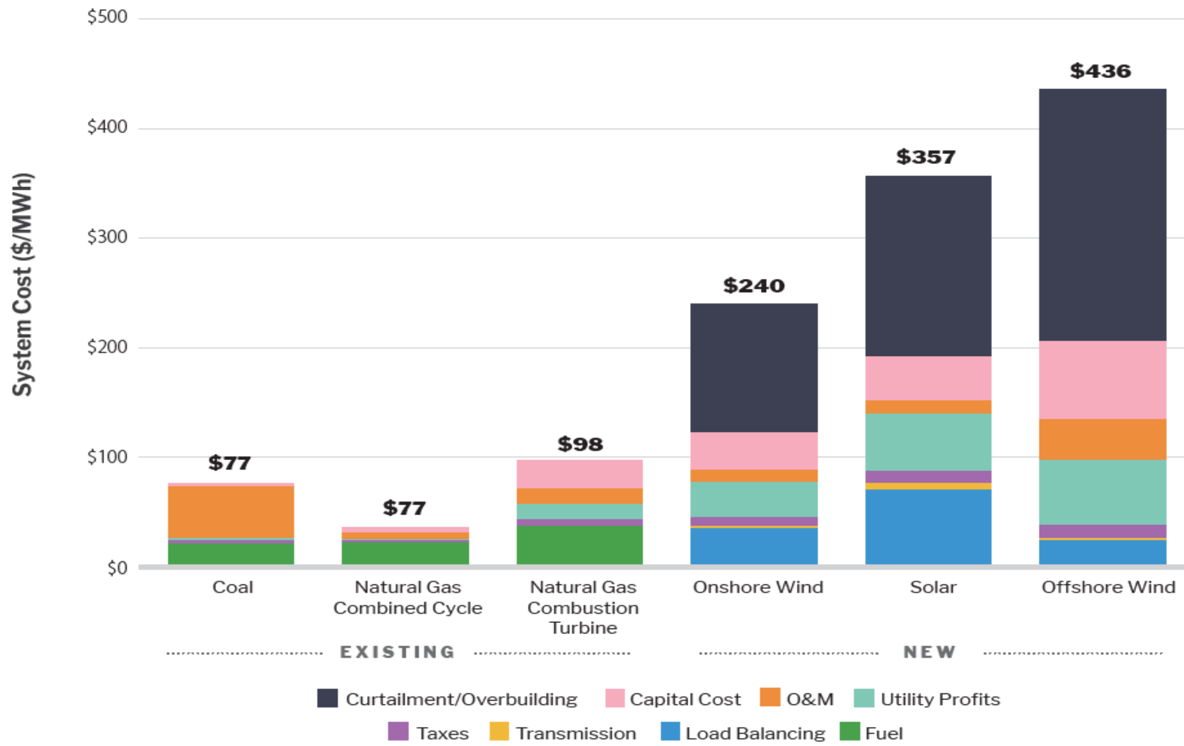
The cost of using renewables to generate enough electricity to meet the increased load is $549 billion, more than 10 times the cost if the demand is met using natural gas and nuclear. While the savings in fuel (variable) costs are significant, they are overwhelmed by the higher capital and fixed costs of renewables—and the profits of renewable generators. The study found that this would result in the bill of the average residential customer increasing $600 a month by 2050, with a similar increase for commercial customers.

The authors of the Discovery Institute point out that these costs might be reduced in two ways. The first is by managing the load, i.e., by reducing access to power for certain users, such as those who want to charge their electric cars. Second, they note, "Costs can also be lowered by reducing the reliability of the electric system, in other words, making blackouts more likely to occur because there is insufficient generating and transmission capacity to meet increased electricity demand." Neither of these should be acceptable to policymakers or consumers.

New England: Curtailment, Overbuilding, and Load Balancing

One reason the fixed costs of wind and solar (and batteries) are much higher than for natural gas and nuclear is because renewables are much less efficient; the thermal generators have a much superior energy density. But there is another reason. As Isaac Orr, Mitch Rolling, and Trevor Lewis explain in their paper examining the cost of renewables in New England, the intermittency of wind and solar also adds significant costs to renewable generation: "It is important 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."

Figure 4. All-In Cost per Megawatt-hour of Meeting New England's Decarbonization Plans



Source: Orr, Rolling, and Lewis.

Figure 4 shows the cost the decarbonization plans of the New England states will impose on the grid—and the people of New England by 2050. The costs of using wind and solar to generate the electricity needed to meet increased demand are at least three to five times higher than the cost of using coal or natural gas. The curtailment, overbuilding, and load balancing add greatly to the costs. In fact, curtailment, overbuilding, and load balancing are higher than the direct cost of generating electricity with coal or natural gas. Again, this takes into account the zero fuel costs for wind and solar.

Texas

Despite its reputation as a conservative state that leads the nation in the production of oil and natural gas, Texas is also the leading producer of electricity from renewable energy and has been actively promoting renewables since 1999. In fact, Texas probably leads all other states in providing subsidies for renewables, having paid out almost $20 billion of Texans' wealth to multinational corporations and other participants in the renewables industry.

Nationally, wind and solar account for only 18% of the electricity generated. But in Texas, they account for 34%. Take Texas out of the national numbers, and the Texas output of renewables more than doubles that of the rest of the national grid. Unlike the previous two examples, the problems caused by renewables in Texas are not projected, they are real, causing harm and imposing significant costs on the Texas economy today.

Figure 5 Year	Renewable Subsidies	Thermal-focused Subsidies	Texas (ERCOT) Total	% of Renewable Generation
2014	$1,275,995,355	$850,495,478	$2,126,490,833	10.8%
2015	$1,527,364,920	$1,083,472,123	$2,610,837,043	11.9%
2016	$1,856,789,699	$764,679,313	$2,621,469,012	15.3%
2017	$2,181,736,097	$820,139,285	$3,001,875,382	17.9%
2018	$2,544,709,335	$1,780,468,859	$4,325,178,194	19.4%
2019	$2,533,784,302	$6,335,105,059	$8,868,889,361	21.2%
2020	$2,615,179,107	$2,721,379,122	$5,336,558,229	25.2%
2021	$3,563,567,563	$16,944,745,697	$20,508,313,259	28.4%
2022	$3,506,142,527	$11,429,824,388	$14,935,966,916	30.7%
2023	$4,035,263,673	$15,928,559,292	$19,963,822,965	31.6%

Source: Peacock

Figure 5 helps explain the cost renewables are imposing on the Texas grid. In 2014, renewables passed the 10% grid penetration mark. At about the same time, Texas officials started taking action based on concerns about the effects of renewables on the ERCOT grid, which covers about 90% of the state. Their actions were focused on two issues: the increasing reliability challenges the grid was facing because of the intermittency of renewables and the lack of investment in new dispatchable sources of generation such as natural gas that were having a hard time competing with renewable subsidies.

Unfortunately, Texas did nothing to stop the growth of renewables, such as ending state and local renewable subsidies. Instead, policymakers began subsidizing thermal generation to bring more dispatchable, primarily natural gas, generation to Texas. Within a few years, the amount of subsidies increased substantially, first in 2019 and then in 2021 after Winter Storm Uri precipitated perhaps the worst blackout in U.S. history. The blackout was caused not only by the poor performance of wind and solar at critical times during Uri, but also because renewable subsidies led to very little investment in natural gas generation that could have kept the lights on.

Most, though not all, of the thermal-focused subsidies in **Figure 5** can be attributed to the reaction to renewables—some are other socialized costs built into the system. Taking the average from 2014 through 2018, before renewables reached 20% penetration on the grid, provides a rough estimate of $1 billion of costs not attributable to renewables. Subtracting these costs from **Figure 5**, suggests that the cost of Texas' efforts to avoid and correct the harm imposed by renewables from 2019 through 2023 averaged about $9.6 billion a year, for a total cost of $48.4 billion. And more is coming in future years.

Texas policymakers might have somewhat missed the mark in dealing with the reliability problems caused by wind and solar generation; the actual costs might be higher or lower. But the concerns about the effects on grid reliability are real and Texas provides the best example of the real-world costs of dealing with them. The costs are real and must be paid for by Texans.

Conclusion

The data make it clear that the only possible rationale for renewable energy—making significant reductions of CO_2 emissions—cannot be achieved. The costs of attempting to do this with renewables are already imposing heavy costs on economies across the world and will rapidly escalate as the grid penetration of renewables increases. As several European countries have already experienced as they plunged into energy poverty, the costs are simply too great for any society to pay.