



Thought Leadership / 2025

# Power Struggles: Renewable Power Generation in a Changing Global Economy

**A THREE-PART SERIES**

Part 1: Wind Power Plants



The U.S. renewable energy market is experiencing an abrupt shift which will not only affect its recent rapid pace of growth but may very well lead to an increase in the cost of electricity around the country. There are two recent challenges, which are combining to slow the rate of growth of renewable energy over the near term. First, federal tax subsidies are being phased out for both residential and commercial entities. Second, U.S. tariffs are being implemented on certain specific imported goods which will directly impact the cost of equipment and raw materials for the renewable power generation industry. Despite these negative developments, the projected astronomical increase in demand for electricity to service the A.I., digital currency, and robotics revolution will sustain renewable energy as an important source for new power generation. Considering its continued importance in the mix of future power generation, the affiliated risk and insurance communities must come to terms with the risks in this new environment and adapt to the new realities of catastrophic failures in these volatile times.

Renewable energy (including hydropower) provides 21% of U.S. electric power generation. The remaining portion is generated by fossil fuels (60%) and nuclear energy (19%).<sup>1</sup> Of these three sectors, renewable energy provided 75% of all new power production over the past five years.<sup>2</sup>

Regardless of the changes to the economic environment, the demand for electric power generation is growing at an unprecedented pace. Data center growth to support computation-heavy technologies is set to drive electricity demand by as much as 67 Gigawatts (GW) by 2030.<sup>3</sup> The traditional power generation industry cannot meet this additional demand without renewable power generation sources. For example, the time it takes to develop and construct a traditional combined cycle natural gas fired turbine is considerably longer and more capital intensive than renewable energy power generation facilities.

The economic policy incentives for renewable energy systems were destined to shift. The new economic reality has arrived much more quickly than anticipated. All players, from manufacturers, risk managers, insurance carriers, and insurance brokers, must recalibrate their risk expectations and business continuity plans to adjust to these new economic realities. This three-part series will explore the power struggles for renewable energy sources: Wind Power Plants in Part 1; Solar Photovoltaic Power Plants in Part 2; and Battery Energy Storage Systems (BESS) as Part 3. The goal of this series is to pragmatically consider how the current climate will affect decision making and risk of the key stakeholders for each renewable energy asset class and propose methods for how these issues may be addressed.

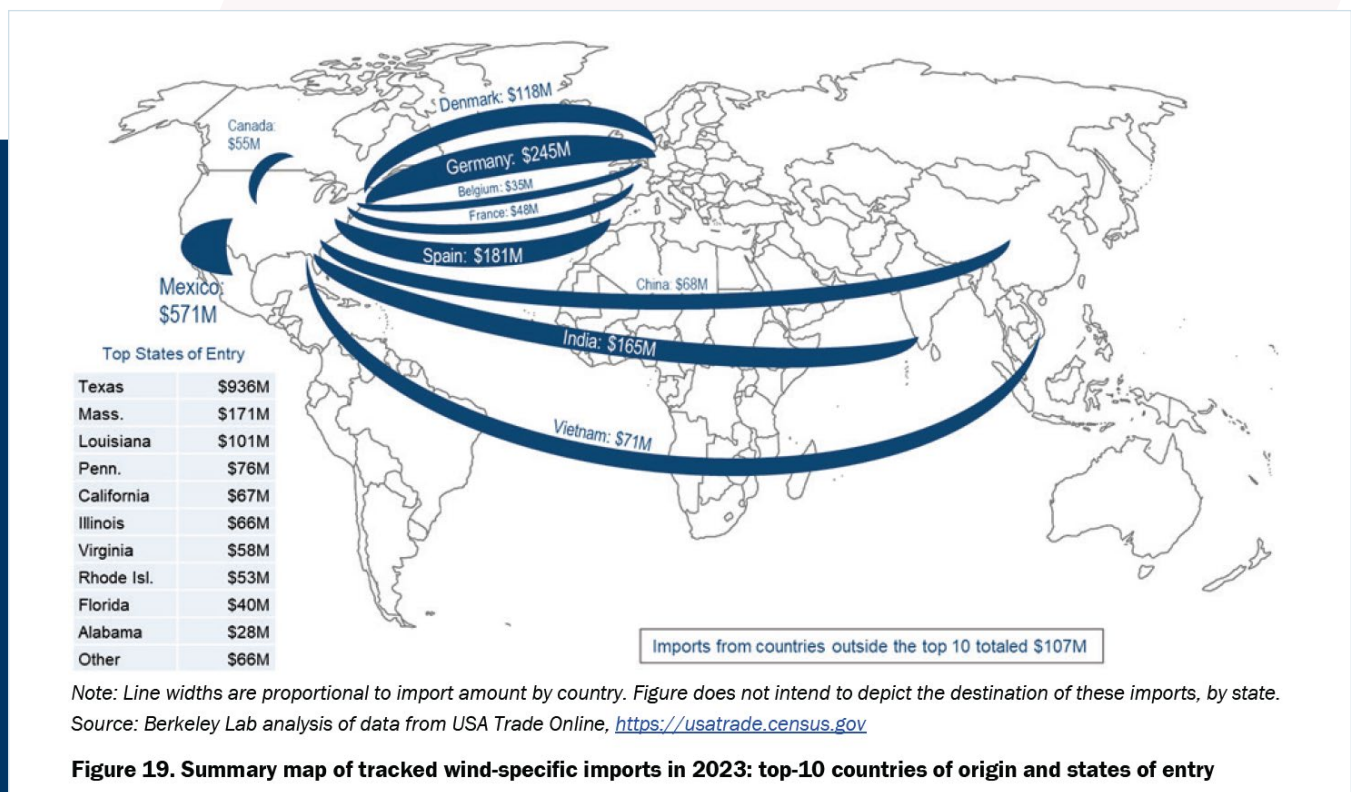
## WIND POWER PLANTS

The cumulative wind energy installed capacity in the U.S. is nearly 160 GW.<sup>4</sup> Of this total, 130 GW (81%) may be outside of the standard manufacturer warranty period. This means that the costs related to service, repairs and losses will fall to owners and their insurers. Halliwell’s experience indicates the cost of replacing a wind turbine can be 43–60% higher than the original construction cost; Tarriff-based cost increases will undoubtedly add to these already high repair costs. In this environment, owners will now be incentivized to consider the possibility of decommissioning and collecting the actual cash value (ACV) of the damaged equipment as allowed by their commercial insurance policy because repairs to a single turbine in an aging fleet may not make economic sense.

Compared to utility-scale solar photovoltaic (PV) power plants, wind power plants are much older. Of the 160 GW of installed wind power plants, 70 GW (44%) are at least 10 years old and candidates for redevelopment. Onshore wind turbine technology has changed dramatically over 20 years, specifically related to energy density. In the past there were federal tax subsidies for redeveloping wind sites with increased wind turbine capacity, which are referred to as “Repowering”. Repowering subsidies will likely be eliminated in 2025 as the current tax incentives sunset,<sup>5</sup> and no replacement subsidy is under

consideration. This will slow the redevelopment of aging wind sites. Redevelopment plans in the future may focus on replacing a large amount of smaller capacity wind turbines with a smaller quantity of larger capacity wind turbines to make them more economically viable. A 200 MW site built in 2010 would have required 100 to 150 wind turbines. A similar 200 MW site built in 2025 can consist of as few as 34 wind turbines. Although this limits property damage values at a site, it concentrates the risk of potential business interruption losses.

Onshore wind turbine generators (WTGs) are built from components that are sourced both domestically (in this case, referring to the USA) and internationally. The map in image 1-1 shows the top 10 countries with wind-specific component imports to the USA. Mexico leads the list with approximately 32% of all wind-specific component imports in 2023. The majority of the wind-specific components being manufactured in Mexico for the USA market are wind turbine blades and towers, with many of these facilities located in Ciudad Juarez, Chihuahua and Matamoros, Tamaulipas near major land ports of entry in the USA (El Paso, Texas and Brownsville, Texas, respectively). Europe is an equally large WTG component supplier (collectively) at almost 37% of all WTG component imports. These components are more likely to be gearboxes, generators, control systems, conductor cables, nacelles and hubs, and all these components are imported by sea.



**Figure 19. Summary map of tracked wind-specific imports in 2023: top-10 countries of origin and states of entry**

## Capital Costs for WTG Installation 2013-2023

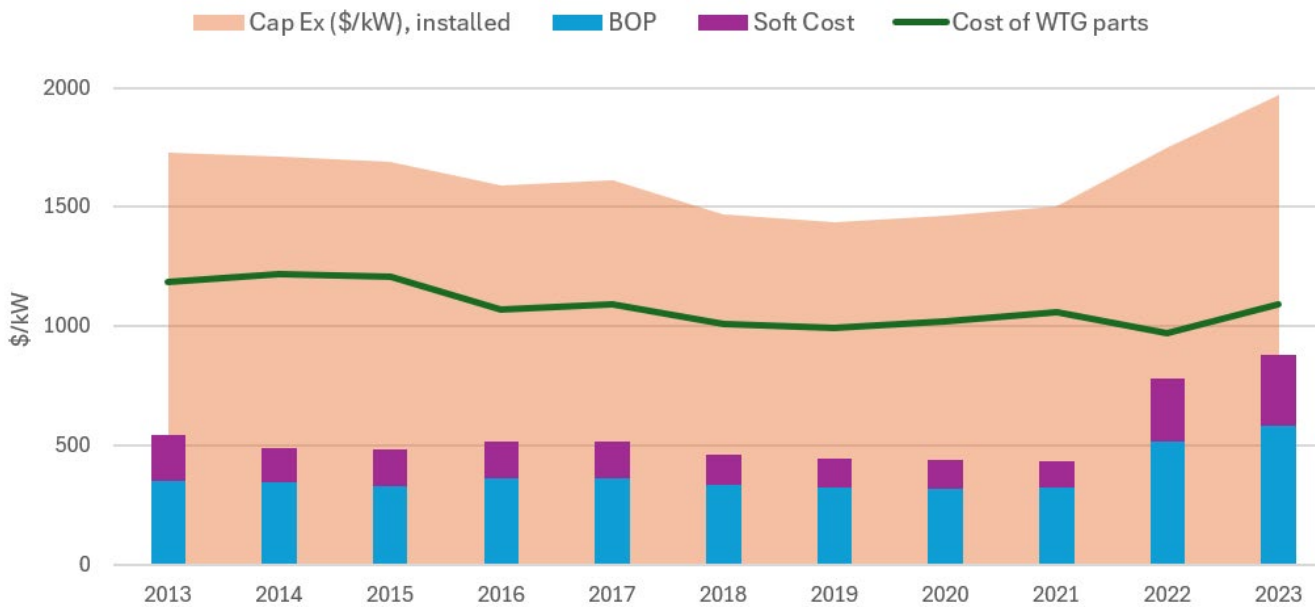


Image 1-2: Historical wind turbine construction costs. Image created by Matthew Senn, Halliwell, from data from NREL Cost of Wind Energy Review 2013-2024. All rights reserved.

The capital expenditures for wind turbine construction in 2023 were \$1,968 per kilowatt (kW) of capacity (an average of all construction projects).<sup>6</sup> Of these costs, \$1,090 (55%) are related directly to

wind turbine components, with the remainder related to soft costs or balance-of-plant (BOP). Image 1-2 shows how these costs have changed from 2013-2023.

## Import costs vs. Installed capacity

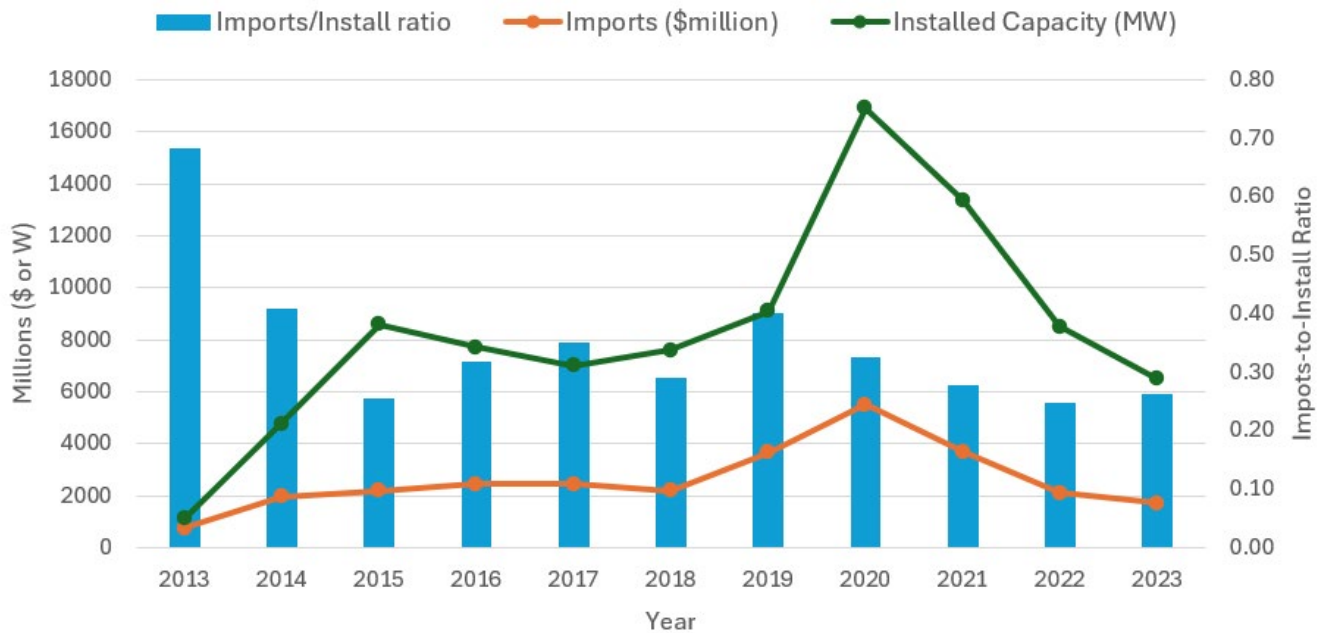
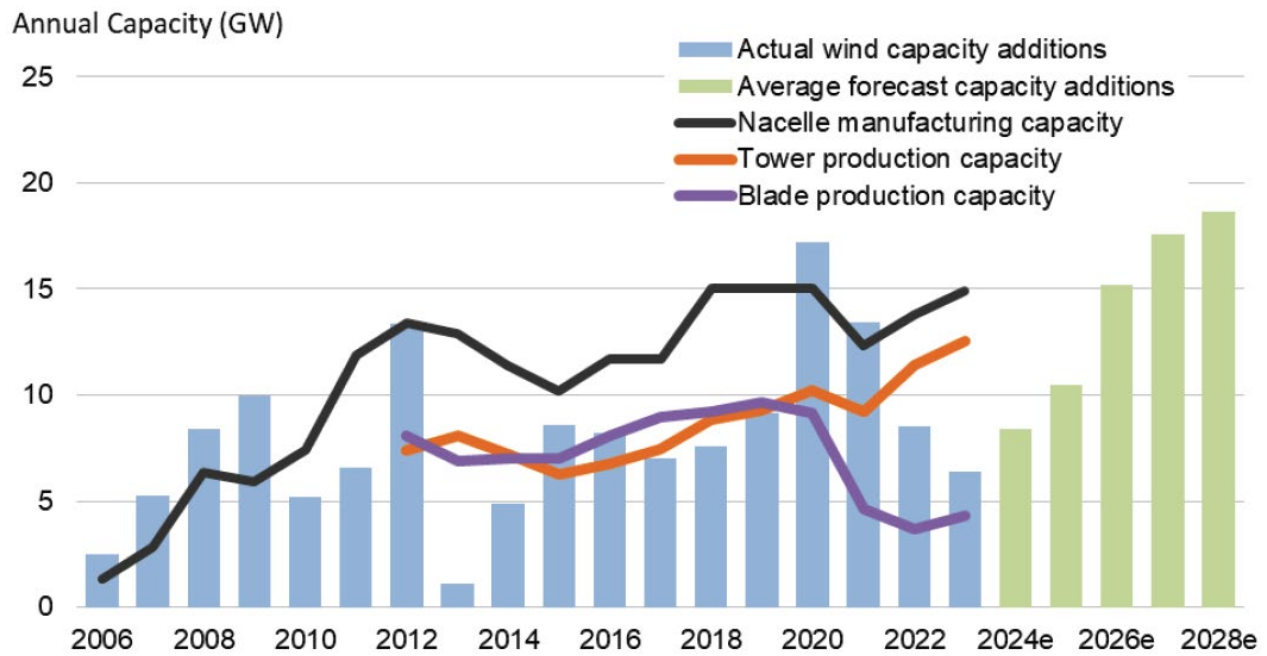


Image 1-3: Wind turbine component import costs vs. installed capacity. Image created by Matthew Senn, Halliwell, from data collected from NREL data and the Berkely lab report. All rights reserved.

Comparing the cost of imported wind turbine components to the annual installed wind turbine capacity, the ratio, that is the ratio of dollars of imported components to installed capacity, was 35% on average +/-10%. The plot in image 1-3 shows that as installed capacity increased, so did the dollars related to imported components; the obvious correlation is that when more WTGs are installed, more imported components are needed.

Interestingly, this ratio has decreased steadily, i.e. the value of imported components has decreased compared to the installed capacity of WTGs. This may be the result of multiple factors: increased capacity of individual WTG, increase domestic manufacturing incentivized by the Inflation Reduction Act, increasing BOP and soft costs related to the total WTG cost, and the utilization of inventory from previous years.





Sources: ACP, independent analyst projections, Berkeley Lab

**Figure 16. Domestic wind manufacturing capacity vs. U.S. wind power capacity installations**

Image 1-4: Domestic wind turbine component manufacturing\*

The plot in image 1-4 shows how the US domestic manufacturing capacity has changed over the years. Domestic nacelle and tower production increased from 2022 likely due to manufacturing incentives related to domestic production and steel content. The plot shows increased blade manufacturing capacity in Mexico has led to a decrease in U.S. domestic blade manufacturing, regardless of the domestic policy.

U.S. tariffs will become a reality on almost every imported product and manufacturers will increase costs to cover this variability. One estimate would be to expect a 25% tariff on Mexican goods and recent news has confirmed a 15% tariff<sup>9</sup> on European imported wind turbine components. Based on the information stated above, this 25% tariff\* on Mexican imports and 15% tariff on European imports would result in an increase in the cost of imported wind turbine components by 13.5%. This would in turn increase the total installed project cost of a wind turbine by 7.5% or to a total estimated cost of \$2,115.00/kW (based on 2023 cost reporting).

Country	Reciprocal Tariff, Adjusted* (proposed)
China	34-145%
European Union	15%**
India	26%
Vietnam	46%
Mexico	0%
Canada	0%
Brazil	0%

Table 1-1: Current and proposed tariffs related to wind turbine components<sup>8</sup>

\*Subject to change before you finish reading this document.

\*\*Recently agreed tariff



When replacing a single wind turbine vs. a large project, the cost per kW is 43–60% higher due to the lack of economies of scale, i.e. multiple wind turbine installations to spread fixed costs over. However, since these tariffs impact only imported materials, a similar effect on a single WTG installation is expected, i.e. an increase of 7.5% on materials.

## Perspectives

**Developers:** Industry reports show that wind energy development has slowed to a more linear growth pattern as opposed to an exponential growth pattern even before the withdrawal of tax subsidies and the introduction of tariffs. Power plant and renewable energy developers have shifted to building solar power generation assets for several reasons: the cost of wind turbine materials has increased, solar PV material costs have decreased, the Class II wind sites in the U.S. have been largely developed, and craft labor for wind turbine construction is more specialized (and expensive) than craft labor for ground mounted solar PV power plants. Wind energy is the most mature of the non-hydro renewable energy power generation sources and many component manufacturing facilities have been established in the USA. An extended period of tariffs on solar PV modules may increase the costs for developers as well as strain solar PV supply chains to such an extent that there is a shift back towards building wind power plants. There are many variables that may influence this decision making but the determining factor will be how much the cost of electricity increases to make additional wind investments more attractive.

As stated above, the impact of the proposed tariff schemes on the wind turbine generator (7.5%) is less than other renewable energy technologies; projects may have delays due to material

procurement but are not likely to be cancelled. The deceleration in new construction of additional wind power plants has created excess capacity in the wind turbine component manufacturing arena. U.S. capacity for nacelle/hub manufacturing is 15 GW, tower manufacturing is 12 GW, and blade manufacturing is 4 GW.<sup>4</sup>

The wind energy industry may have excess domestic manufacturing capacity that may be able to be deployed quickly compared to other domestic energy manufacturing industries. Conversely, blade manufacturers moved manufacturing facilities to neighboring countries (e.g. Mexico) to take advantage of lower labor costs and previous free-trade agreements. As the domestic capacity for blade manufacturing is fully utilized, new tariff schemes may increase the cost of new wind turbine blades being produced abroad.

**Operators:** Operational costs of a wind power plant are tied to unscheduled maintenance due to equipment failure. A wind turbine may only receive two scheduled maintenance visits in a calendar year. Many repair components for wind turbines are imported and are subject to tariffs, which may push operators to find alternate sources for this equipment: secondary markets, domestic suppliers, or increased spare capacity. Some operators may choose to decommission a wind turbine in lieu of repairing due to materials costs (assuming this does not violate their power purchase agreements (PPA)). The cost of a replacement set of blades (especially with tariffs) may exceed the value of the revenue that a wind turbine could produce in its remaining life. Another common equipment breakdown category for wind turbines relates to gearbox failures. In Halliwell's experience, gearboxes are the most expensive component in the nacelle at \$300,000–\$450,000. The gearbox

replacement requires a fixed-boom crawler crane which can drive installation costs over \$1 million. These gearboxes are frequently imported and will be subject to tariff cost increases.

**Insurance:** Insurance carriers will need to adjust their pricing and capacity models to consider higher prospective property damage and business interruption exposures. If the installation of new renewable energy power plants decreases due to rising construction costs, electricity costs should rise. Renewable energy power producers will want to take advantage of these higher prices leading to higher exposures for business interruption claims after a loss. It may also lead to wind operators seeking shorter duration PPA agreements to capture the benefits of increasing electricity costs which may make budgeted business interruption estimates less reliable over a 12-month underwriting period.

One of the more common losses for wind turbines are blade failures. When a single blade fails, and a suitable replacement that matches the balance profile of the remaining two blades is unavailable, all three blades may need to be replaced to guarantee a balanced rotor. A 25% tariff would add \$225,000.00 to \$475,000.00 to the blade replacement set cost. Table 1-2 below compares these cost scenarios.

Blade set replacement costs	< 90 meter (m) rotor	> 150m rotor
Blades x 3	\$900,000.00	\$1,900,000.00
Shipping	\$105,000.00	\$105,000.00
Tariffs	\$225,000.00	\$475,000.00
<b>Total</b>	<b>\$1,230,000.00</b>	<b>\$2,480,000.00</b>

Table 1-2: Comparison of blade set replacement costs with tariffs

Insurance stakeholders can work together to find ways to mitigate the increased materials costs due to tariffs. Some ideas may include:

- Sourcing blades from spare inventory or construction project stock. This is more plausible for large asset owners, but large asset owners may be willing to sell to other owners with more limited inventory options.
- Work with component manufacturers to share tariff costs. Slower growth in the wind turbine segment for new equipment may incentivize manufacturers to work with long term customers in sharing the cost burden tariffs.

- Owners, manufacturers and insurers could consider working together to encourage the practice of balancing wind turbine rotors in the field. This would increase the pool of potential blades for replacement as opposed to replacing the entire blade set.
- Brokers and Insurance carriers collaborate with risk managers to define an Actual Cash Value (ACV) formula and process, defining the replacement cost that ACV is calculated against. This will facilitate rapid decision making.

The onshore wind energy industry has a more mature and established install base and supply chain compared to solar photovoltaic and battery energy storage systems (BESS). Recent news provides more clarification on the tariff levels on goods imported in the US: duties of 10–25% are a realistic expectation that may increase the average cost of a complete wind turbine by 7.5%. Wind turbine blades may have the highest component cost increases (as high as 25%) as they are sourced from specific nations, e.g. Mexico, and domestic manufacturing capacity is fully utilized. These cost increases will range from between 7.5–25% and will likely impact all stakeholders in the wind industry.

Over the near term, developers will lack the confidence to proceed with new wind projects and will be reticent to redevelop existing sites until higher electricity rates are realized. A decrease in construction related activities and risks in the wind energy segment is anticipated in the near term until the economic climate stabilizes. Operators of existing wind assets will experience increasing costs for repairs and will need to strategize how best to maximize operational assets to meet these increased costs. Insurers property damage and business interruption exposures will increase following a loss which will require more in depth understanding of the assets being insured in a wind portfolio and their respective strategies to contain costs in the event of catastrophic failures. The soaring demand for electricity and an increase in electricity prices will encourage wind energy to continue to grow in the future as the economic climate improves to optimize its operational capacity. Wind energy will continue to be relevant to future domestic energy production but will undergo a period of declining growth and potential stagnation until electricity rates increase.

If this analysis on wind power generation has impacted you, please reach out to us directly at [experts@halliwellglobal.com](mailto:experts@halliwellglobal.com) to continue a dialogue on this topic or related risk and insurance topics in the renewable energy space.

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## Citations

<sup>1</sup> Energy Information Administration (EIA), "What is U.S. electricity generation by energy source?", <https://www.eia.gov/tools/faqs/faq.php?id=427&t=3>

<sup>2</sup> American CleanPower (ACP), "Snapshot of Clean Power in 2024"

<sup>3</sup> TechPolicy.press, "Transcript: US Lawmakers Probe AI's Role in Energy and Climate", <https://www.techpolicy.press/transcript-us-lawmakers-probe-ai-role-in-energy-and-climate/>, April 11, 2025

<sup>4</sup> Berkely Lab Land-Based Wind Market Report, 2024 Edition

<sup>5</sup> Latham & Watkins LLP, "One Big Beautiful Bill: New Law Disrupts Clean Energy Investment", July 8, 2025

<sup>6</sup> NREL cost of wind energy report

<sup>7</sup> White House Press Release, "Fact Sheet: The United States and European Union Reach Massive Trade Deal", <https://www.whitehouse.gov/fact-sheets/2025/07/fact-sheet-the-united-states-and-european-union-reach-massive-trade-deal/#:~:text=As%20part%20of%20President%20Trump's,parts%2C%20pharmaceuticals%2C%20and%20semiconductors.>, July 28, 2025

<sup>8</sup> White House Press Release, "Annex I Country Reciprocal Tariff", April 2025