Infrastructure Economic Consulting

InfraEcon Insights

Economic Risk in Renewable Project Development

A. Introduction

This note delves into the economic risks of new renewable generation projects. According to the Energy Information Administration, the US has installed about 215 GWs of wind and solar capacity over the last twelve years, but it is expected to add about 800 GWs more by 2036. Stimulating this significant growth are provisions of the Inflation Reduction Act of 2022 (IRA) that provide new incentives for investors to increase the participation of renewables in the US energy matrix. This expected growth will come with new economic risks as the electric power sector adapts to the challenges of intermittent generation.[1] While these issues may not derail the overall growth in renewable power, they could certainly jeopardize individual power projects and the companies that develop them.

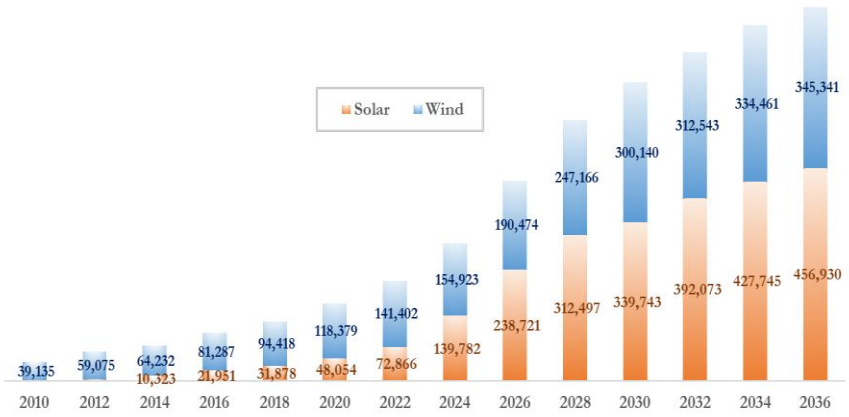
This note focuses on the sources of economic risk faced by new renewable projects, from both cost and revenue sides. On the cost side, it looks at supply chain risk, interest rates, and capital availability. On the revenue side, it addresses power prices, energy market design, and the risk of generation curtailment faced by wind and solar power projects. Although the paper focuses on wind and solar in the US market, there are analogous concerns worldwide and in other renewable subsectors such as hydrogen, biofuels, and batteries.

B. The Growth of Renewables in the USA

As noted above, the forecast for new renewable energy is one of enormous growth. The following figure shows that solar and wind generation has more than doubled in the last ten years and is expected to grow exponentially by 2036. Provisions of the IRA are key drivers of this expected growth. Although there have long been federal and state subsidies and mandates for renewable power deployment, the IRA codifies several new incentives. Among these are long-lived production tax credits and investment tax credits for new generation. The IRA loosens restrictions on transferring these credits from the generators that receive them to other parties that may wish to use them and even allows for a direct cash payment from the federal government in lieu of tax credits under certain conditions. This extra flexibility makes the tax credits more versatile—and desirable—than under previous programs.

[1] New renewable projects must also navigate risks arising from new laws and regulations, though we do not assess those here. For example, renewable tax credits issued under the IRA can be subject to "recapture" if the recipient does not comply with other legislation elements.

Cumulative Wind and Solar Capacity Additions in the U.S.[2]



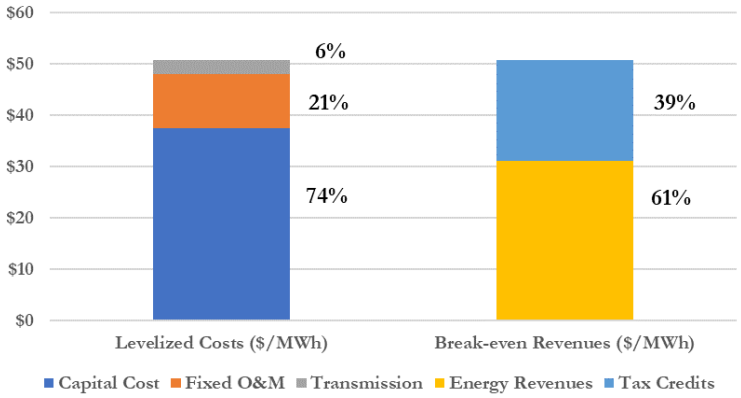
Although the broad outlook for renewables is strong, this expected growth does not mean individual projects do not carry significant economic risk. As explained below, potential investors need to consistently assess significant economic risks on both the cost and revenue sides. Managing these risks requires careful attention to contract language, market dynamics, and regulatory developments. Economic assessments of these risks are paramount when undertaking these investments.

C. Sources of Economic Risks

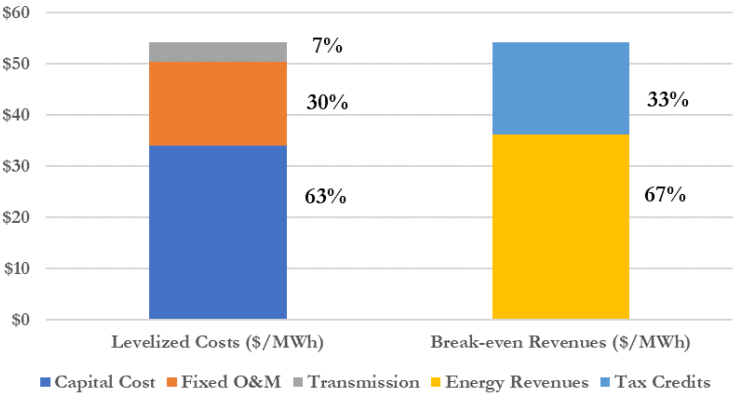
The two following figures present the levelized energy cost for wind and solar generation. Levelized costs are the total cost of a project over its entire life, averaged over each megawatt-hour it is expected to generate. They are equivalent to the revenues a power plant needs to earn in order for its investors to break even. As one can observe, most of the costs in solar and wind projects are capital costs—those incurred to develop, finance, and build the project. About 65% to 75% are capital costs, 20% to 30% are fixed O&M costs, and the rest are transmission costs. On the revenue side, about two-thirds come from energy revenues, and one-third comes from tax incentives such as those from programs under the IRA. Based on these costs and revenue structure, investors must focus on the aspects that impose risk on these variables.

Major economic risks on the cost side include risks arising from the supply chain, volatile interest rates, and capital availability. On the revenue side, major risks include low power prices, electricity market structures that do not favor renewable generators, and the risk of curtailment of a power plant's electricity output.

Levelized Cost of New Wind Generation[3]



Levelized Cost of New Solar Generation



[2] Historic data from U.S. Energy Information Administration (EIA), *Electric Power Annual*. Forecast data from EIA, *2023 Annual Energy Outlook*.

[3] Levelized costs for both wind and solar are from EIA's *Levelized Costs of New Generation Resources in the Annual Energy Outlook 2023*.

I. Cost Side Risk

a) Supply Chain Risks

Supply chain issues present significant economic risks to renewable energy projects, particularly in sourcing raw materials and components essential for wind, solar, and battery storage technologies. Risk assessment is paramount for investors because of the implications for project financing, supplier agreements, and overall project viability.

The dependence on countries with political risk is essential to the supply chain analysis. Most raw materials and manufactured components for wind turbines, solar panels, and batteries originate from countries with inherent political risks and volatile shipping terms. Notably, more than 60% of rare-earth ore and refined metals crucial for wind turbines and batteries are sourced from China[4], with roughly 80% of polysilicon used in solar panels[5]. This heavy reliance on specific geopolitical regions exposes renewable energy projects to supply chain vulnerabilities, including trade tensions, regulatory changes, and geopolitical conflicts.

Global supply shortages present another supply chain risk. Robust global demand growth for renewable energy technologies has found the supply of critical raw materials and components struggling to keep pace. Projections indicate that the current rare-earth element supply will fall short of meeting demand by 2030 without significant new mine development[6]. This supply-demand imbalance exacerbates uncertainties regarding essential components' availability, cost, and delivery timelines, amplifying risks for project developers and investors.

Additionally, contractual tensions and project governance are other supply chain issues to consider when analyzing risks. Uncertainty surrounding components' cost, availability, and delivery dates can strain contractual arrangements governing renewable energy projects. Due to supply chain disruptions, financing agreements, supplier contracts, interconnection agreements, and power purchase agreements (PPAs) may face challenges. Contractual tensions arising from delays, cost overruns, or quality issues in the procurement process can impede project progress, increase costs, and erode investor confidence.

Therefore, addressing supply chain risks in renewable energy projects requires proactive risk management strategies and collaborative efforts across the value chain. Diversifying supply sources, investing in domestic manufacturing capabilities, and enhancing transparency in supply chain logistics are crucial steps toward mitigating vulnerabilities. Moreover, investors must prioritize resilience in project governance structures and contractual frameworks to navigate uncertainties effectively.

b) Interest Rates and Capital Availability

Financing cost is another economic risk that impacts renewable power projects. Because the renewable sector is characterized by high capital costs, renewable project economics are extremely sensitive to interest rate fluctuations.

Consider the first figure below, which depicts the Federal Reserve interest rate trajectory over the last ten years, showing its substantial increase since early 2022. The impact of such a rate increase on the levelized cost for wind and solar energy projects is significant, as seen in the subsequent figure. An increase of 500 basis points in interest rate over the 3% of recent history would raise the levelized cost for wind and solar generation by 33%. This volatility demonstrates that the interest rate available during project development could be far different than what is available at project closing and shows how dependent these projects are on interest rate fluctuations.

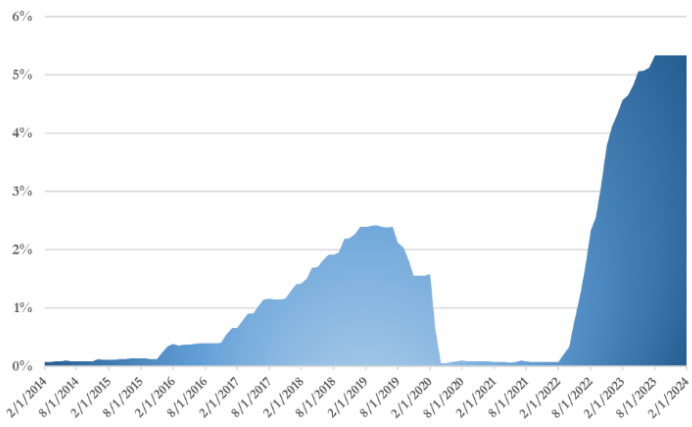
[4] Boston Consulting Group, *Five Steps for Solving the Rare-Earth Metals Shortage*, 06 July 2023.

[5] McKinsey & Company, Renewable-energy development in a net-zero world: Disrupted supply chains, 17 February 2023.

[6] Boston Consulting Group, *Five Steps for Solving the Rare-Earth Metals Shortage*, 06 July 2023.

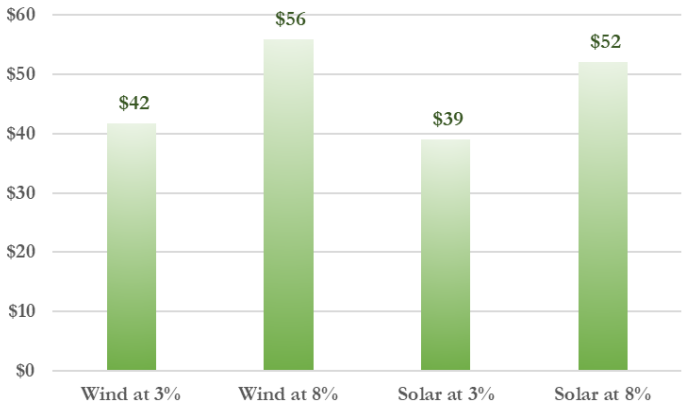
Federal Funds Effective Rate

(i.e., "The Fed Rate")[7]



Levelized Cost of Electricity ($/MWh)

at Different Interest Rates[8]



Heightened development activity within the renewable energy sector will result in a surge in demand for tax equity ("TE") investment. Typically, these power plants are project-financed and rely on tax equity investors who provide capital for the project and receive, in part, the federal tax credits the project generates. These investors are typically major banks. Forecasts project a substantial increase in demand for tax equity, rising from $18 to $20 billion annually to $50 billion.[9]

However, this capital source may dry up due to regulatory changes proposed to bring the US into compliance with Basel III international banking regulations.[10] These regulatory changes could potentially shrink capital availability for tax equity investment by 80-90%.[11]

The regulations proposed for Basel III compliance would categorize TE investments as higher risk, necessitating banks to maintain significantly increased reserves and reducing the investment's attractiveness. The heightened capital requirements would impact the industry in several ways by creating other barriers to entry. For instance, higher capital requirements would reduce bank lending capacity, and therefore, it would increase the capital cost for developers. Also, the proposed Basel III would create risk-weighting complexities, and disputes could arise between project developers and lenders over risk complexities. In addition, it could generate liquidity constraints since banks would be funding assets with liquidity issues, and disputes may arise over the timing of disbursements, loan terms, and liquidity provisions. Finally, a measure such as the one proposed could create reporting burdens, deterring banks from participating in tax equity investment, thereby hindering project financing and development.

Therefore, proactive engagement with regulatory bodies, advocacy for industry-friendly regulations, and exploration of alternative financing avenues are critical strategies to mitigate the adverse impacts of Basel III regulations on renewable energy projects. By proactively addressing capital availability risks, stakeholders can bolster investor confidence, fortify industry resilience, and sustain momentum in the transition to clean energy.

c) Others

Renewables face other cost-based risks on an individual basis. While these risks may not apply generally, they can be extremely important on a project-by-project basis. Such risks include the time and cost of permitting and gaining regulatory approvals for construction, which can

[7] Source: St. Louis Federal Reserve.

[8] Source: National Renewable Energy Laboratory, 2023 Annual Technology Baseline cash flow model.

[9] American Council on Renewable Energy, *Expectations for Renewable Energy Finance in 2023-2026*.

[10] Specifically, the Basel III rules proposed to increase almost 4 folds the capital requirements of banks.

[11] American Council on Renewable Energy, *December 11, 2023 Letter to the Federal Reserve Board of Governors, etc*.

be significant given the large amounts of land that must be dedicated to wind and solar installations. The cost of transmission upgrades and interconnection costs required to connect to the grid can also be significant and can be impacted by the actions of other nearby projects under development that are also trying to connect to the electricity grid.

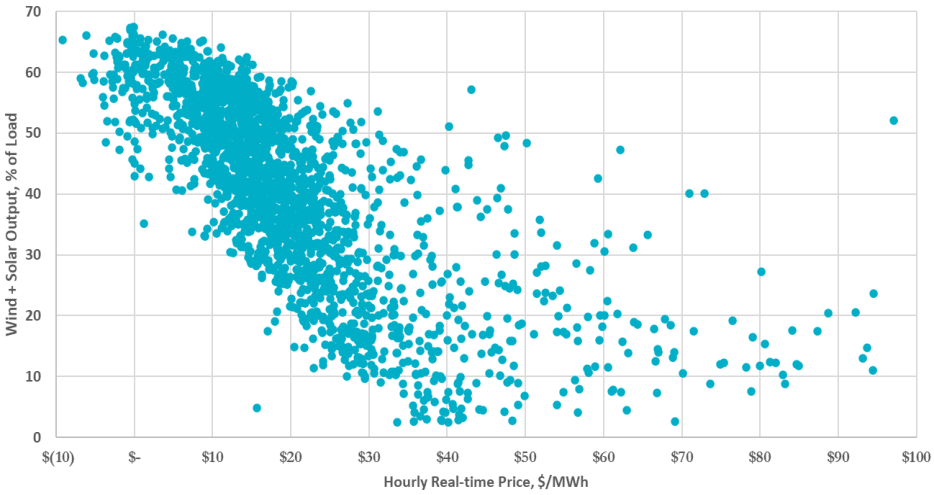
II. Revenue Side Risk

a) Power Price Risk

Renewable energy projects face unique challenges beyond supply chain and capital availability risks. Notably, they encounter revenue risks associated with power market dynamics. Unlike conventional generators, wind and solar power generators operate under distinct characteristics that can significantly influence electricity prices and project profitability. Since about 70% of renewable revenues depend on energy revenues, the specific challenges posed by power market dynamics need to be incorporated in any risk analysis, and strategies for mitigating revenue risks in renewable energy projects need to be explored.

Traditional power markets were designed with the assumption that generators burn fuel and the cost of fuel drives operational decisions and resulting electricity prices. However, wind and solar power generation have zero fuel costs and operate intermittently based on weather conditions. This serves to exert downward pressure on electricity prices as zero-cost generation enters the market regardless of whether or not it is needed. This trend is observable in markets such as Texas (see figure below), where power prices and renewable output are negatively correlated, and prices frequently plummet below $20 per megawatt-hour and occasionally turn negative. As the share of renewable generation capacity grows, the surplus of electricity supply contributes to lower prices, thereby impacting the revenue potential of renewable energy projects.

Relationship Between Renewable Output and Power Price (ERCOT market, January-March 2023)



The profitability of wind and solar projects hinges on achieving sufficient revenue from electricity sales. In general, wind and solar need electricity prices to average $25 to $30 per megawatt-hour over a year to remain profitable. However, the increasing penetration of renewable generation jeopardizes its own financial performance.

The behavior of power prices in response to the expanding presence of wind and solar generation highlights the revenue risks inherent in renewable energy projects. To mitigate these risks, developers and investors must adopt proactive strategies that account for power market dynamics. This includes optimizing project designs for maximum revenue generation, exploring diversified revenue streams beyond electricity sales, and implementing risk management measures such as price hedging mechanisms. By explicitly addressing revenue uncertainties in project planning and execution, investors can manage the resilience and profitability of their renewable energy projects.

b) Energy Market Design Risks

Power markets are undergoing significant transformations driven by the increasing penetration of renewable energy sources like wind and solar. This shift from traditional fuel-based generation to intermittent renewables presents unique challenges and uncertainties for renewable energy projects. In addition, renewable projects have typically relied on long-term power purchase agreements (PPAs) with utilities or large consumers to secure revenue streams in the past. Now, most units enter the market directly, exposing them to market prices and rules. This shift prompts a reconsideration of market dynamics and regulatory frameworks to ensure fair compensation for renewable energy generators.

As renewable energy penetration increases, power market operators are revisiting market rules to facilitate the integration of renewables. These revisions impact the services renewables can provide and the compensation they receive. Adequate compensation for renewable energy resources is paramount for the industry's development. Key focus areas include capacity accreditation, capacity market reforms, treatment of renewable energy paired with battery storage, scarcity pricing, and ramping products. Each market may approach these revisions differently, leading to varying implications for renewable energy projects that must be keenly monitored by investors.

One significant concern revolves around capacity markets, where intermittent wind and solar generators often receive little or no revenue. Efforts are underway to address this in many markets, potentially providing additional capacity revenues to renewable projects. Innovative market products like scarcity pricing and ramping products are being developed to address the variable nature of renewable generation. While these products aim to incentivize more flexible generation, they often exclude wind and solar generators.

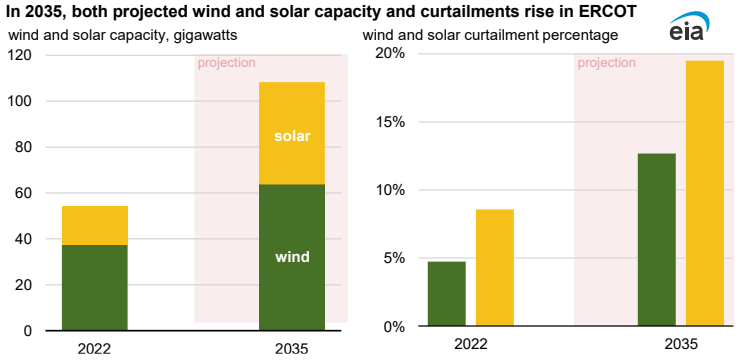
Understanding the intricacies of power market dynamics is crucial for renewable energy projects to manage revenue risks and capitalize on opportunities effectively. By proactively monitoring and advocating for market rule revisions, investors can navigate the evolving landscape and ensure the long-term financial viability of renewable energy projects. As renewable energy continues to play a pivotal role in transitioning to a sustainable energy future, strategic engagement with power markets remains essential for project success.

c) Curtailment Risks

Curtailment, stemming from transmission constraints or surplus power, poses a significant risk to renewable power generation. This issue has gained prominence due to the pressing need to expand transmission infrastructure. However, building new transmission lines requires substantial investments and coordination between federal, state, and local authorities. The time it takes to bring new transmission infrastructure online can easily exceed the time it takes a generating project to go bankrupt. Therefore, understanding and mitigating curtailment risks are critical for renewable energy investors.

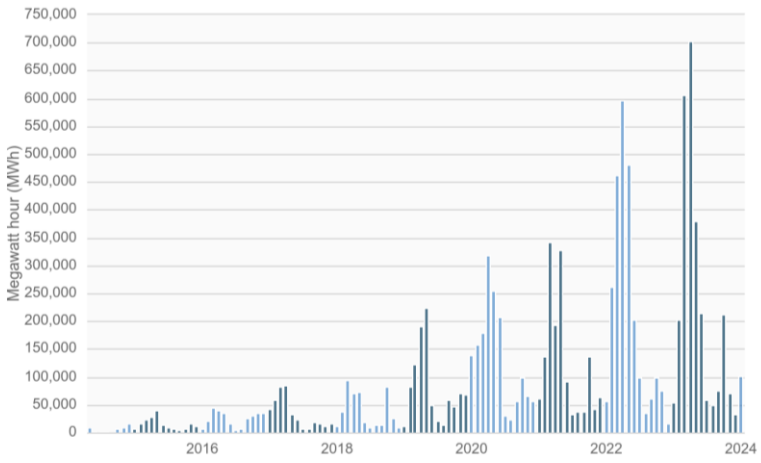
The figures below depict the growing problem of generation curtailment in Texas and California, regions where wind and solar projects are significant sources of electricity supply. Curtailment is on the rise, and as more renewables are added to the grid, the likelihood of curtailment only increases.

Texas (ERCOT) Wind and Solar Curtailments[12]



[12] Source: Energy Information Administration.

California (CAISO) Wind and Solar Curtailments[13]



Understanding the generator's position on the grid and the potential for curtailment becomes paramount. Curtailments have a significant impact on generator revenues, as they are compensated only for power delivered to the grid, and not for the power they would have delivered if they were not curtailed by transmission constraints. This highlights the importance of addressing curtailment risks in contracts, as curtailments will continue to grow absent major investment in transmission infrastructure.

D. Summary and Conclusion

Recognizing and managing economic risks is paramount for ensuring favorable outcomes in renewable energy investments. While initiatives like the Inflation Reduction Act (IRA) have provided stability by safeguarding incentives for new renewable energy projects, they have also introduced new challenges. It is crucial to acknowledge that many risks associated with expanding renewables are inherent to the transition towards cleaner energy sources. However, individual projects remain susceptible to significant challenges in the short term.

To address these risks effectively, it is essential to diligently focus on contract terms and to stay abreast of shifts in energy market dynamics and the regulatory landscape. Engaging seasoned economic and legal consultants becomes imperative for identifying and mitigating economic threats that could undermine investments. Moreover, should economic harm materialize, arbitration offers a pragmatic avenue for resolving disputes and seeking redress. By adopting a proactive approach informed by economic insights, investors can navigate the uncertainties of the renewable energy sector with resilience and confidence.

Infrastructure Economic Consulting and its group of Affiliates have the necessary experience and expertise to support investors in the infrastructure sector to analyze the specific economic issues affecting their investment. In addition, we are experts in assessing from an economic and regulatory perspective the individual damages and remedies that such actions would have on their investments. There are numerous economic risks that renewables face in the context of the new incentives implemented by the governments to increase the participation of these sources of power in the energy matrix. They deserve a thorough analysis from an economic and regulatory perspective, and the potential harm to investments needs to be assessed.

Infrastructure Economic Consulting, LLC (InfraEcon) is an economic consulting boutique specializing in regulatory economics and quantum matters in International Arbitration for a variety of industries. Carlos Pabon-Agudelo is the Managing Director of InfraEcon, and Jeffrey Bloczynski is an affiliate of InfraEcon and Managing Director of Mosaic Economics. Details about our expertise can be found at www.infraconn.com.

[13] Source: California Independent System Operator.