Solar-Plus-Battery Storage Projects

Improving Technology to Moderate Incremental Risks

Special Report

Confidence Follows Technology: Fitch Ratings expects the collective risks of battery storage systems to progressively decline as utility-scale battery technology matures and becomes viewed as proven across a variety of use cases. Improvements in battery life expectancy and greater confidence in lifecycle costs will drive further deployment of battery storage in solar projects. The advent of contracted revenue models with standardized payment terms and performance requirements should provide additional certainty to cash flows.

Growing Market Viability: Further technological developments will improve the potential for solar-plus-storage projects to achieve investment-grade ratings and broaden the range of viable financing options. Fitch intends to refine its views and provide further commentary as the market evolves and solar-plus-storage projects accumulate operational histories.

Completion Dependent on Counterparties: The impact of battery storage on completion risk largely depends on the degree to which it transfers risk to the engineering, procurement and construction (EPC) contractor and manufacturer. The performance of different battery and software management systems varies widely, which can only be mitigated by guarantees. The financial distress of a battery manufacturer can lead to severe consequences, highlighting the importance of mitigating manufacturer nonperformance.

Lifecycle Costs, Technological Challenges: The rapid evolution of battery storage technologies, which are largely unproven at utility scale, creates difficulties in evaluating performance data and applying sensitivities in financial analysis. Potentially volatile lifecycle costs represent the major incremental risk of battery storage. The interplay between battery lifetime optimization and short-term economic benefits is a considerable challenge that varies with each specific battery technology and use case.

Enhanced Energy Delivery Flexibility: Battery storage systems can further moderate a solar project's volume risk by providing greater operational flexibility, arbitrage opportunities and additional ancillary services. The selection of battery technology should align with the intended revenue generation model, whether the value proposition leans toward ancillary services or arbitrage. The use case for a specific battery system will ultimately impact capacity degradation rates and life expectancy, among other measures of performance.

Revenue Models in Flux: Fitch expects contractual revenue structures to vary widely depending on the services provided and the incentives built into regional power markets. Capacity payments for contracted ancillary services can reduce price risk, while energy arbitrage opportunities can exacerbate revenue volatility. Establishing clear contractual performance requirements and penalties for battery storage may be challenging, as market standards have yet to emerge as a guide to allocate risk.

Constraints to Debt Financing: Debt structures may be limited by the length of revenue generating contracts and uncertainly regarding lifecycle costs, but these constraints should ease over time. The degradation rates and life expectancy of battery storage systems can effectively limit a project's ability to leverage the related cash flow beyond a 10-year time frame. This presents a disconnect with conventional solar projects, which often allow for tenors that extend the entire length of a 20- to 30-year power purchase agreement (PPA).

Related Research

Global Renewables Performance Review (Solar Outperforms Wind on a Global Scale) (January 2019)

Power and Renewables - 10 Years in Infrastructure (October 2017)

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New Risks, New Rewards

Solar-plus-storage projects appear poised for a dramatic expansion against a backdrop of rapidly declining battery costs and an increasing need for grid management solutions as renewables become ubiquitous in the dispatch stack. Fitch has considered the risk factors and mitigants for solar-plus-storage projects financed with nonrecourse indebtedness.

The following discussion defines solar-plus-storage projects as utility-scale solar facilities co-located with battery storage systems. Fitch assumes that solar-plus-storage storage projects will predominantly utilize photovoltaic solar panels, though some projects employ other technologies, including a concentrated solar plant. The natural synergies between solar and battery storage allow for the provision of ancillary services and/or energy arbitrage opportunities that can add considerable value to conventional solar.

Fitch does not publicly rate solar-plus-storage projects, but anticipates rapid growth in the asset class and has observed accelerating utility procurements and investor interest. The assessment of key risk factors for solar-plus-storage projects is based on Fitch's experience with solar, utility-scale battery storage and behind-the-meter systems.

Completion Risk

The inclusion of a co-located battery storage component should only incrementally raise the complexity of a greenfield solar project. The modular nature of the battery rack and container systems is comparable to solar panel and inverter packages, which allow for relatively simple installation and scaling of capacity. Interface risks may present additional challenges, particularly for battery storage added to an existing solar facility. More experienced EPC contractors are better positioned to successfully navigate permitting, interconnection, site preparation and other interface-related issues.

The impact of battery storage on completion risk is largely dependent upon whether the specific technology is considered proven by Fitch and the technical advisor (TA). Lithium ion, for example, is a fundamentally proven technology, but it is unlikely that specific batteries will be proven for utility-scale applications.

Even within the universe of lithium ion technology, performance (throughput, discharge rates, degradation, etc.) varies widely across various use cases for different manufacturers. The software used to manage the batteries and energy output will further influence the potential range of performance. The uncertainties presented by unproven battery storage technologies are much greater than for solar technology, shifting the focus of the analysis to the guarantees provided by the EPC contractor and battery manufacturer.

Fitch's evaluation of the EPC contractor's expertise and implementation plan primarily depends upon the relationship between the battery manufacturer and the EPC contractor. Performance guarantees may be linked to the warranty provided by a specific battery manufacturer, which is often the only source of detailed battery performance data. As with conventional solar projects, Fitch relies upon the opinion of a TA and any available peer data to assess the battery performance guaranty, procurement costs and the construction schedule. Fitch's review will emphasize the proprietary and/or advanced nature of the battery technology and the ability of other manufacturers to step in as a replacement provider during construction.

The impact of battery storage on Fitch's assessment of completion risk will depend upon the level of risk transfer to the EPC contractor and additional contingency in light of the risks presented by the manufacturer and its technology. Broadly speaking, the industry consensus is that battery procurement costs will continue to decline and the supply of lithium ion batteries

Related Criteria

Renewable Energy Project Rating Criteria (February 2019)

Rating Criteria for Infrastructure and Project Finance (July 2018) will increase. However, similar to the solar panel industry, Fitch does not expect many battery manufacturers to receive investment-grade ratings. Unlike the solar panel industry, a suitable replacement manufacturer may be difficult to find. Depending on the specific use case for a particular battery, an EPC contractor may be unable to procure a replacement manufacturer within the bounds of the contingency.

The implications of project delays due to the financial distress of a battery manufacturer extend beyond capital costs. A project may lose an opportunity to qualify for tax credits if delays cannot be resolved in a timely manner, potentially undercutting a major driver of project economics. Battery storage with an arbitrage-based value proposition could also lose a first-mover advantage. These potential consequences highlight the importance of including strong mitigants against manufacturer nonperformance.

Operation Risk

The operation and management of battery storage systems introduces additional risks and complexity to conventional solar facilities, which benefit from proven technology with a long operating track record. The rapid evolution of battery storage technologies, which are largely unproven at utility scale, creates difficulties in evaluating performance data and applying sensitivities in financial analysis. The interplay between battery lifetime optimization and short-term economic benefits is a considerable challenge that changes with the specific battery technology and use case. Even batteries that nominally utilize the same technology (e.g. lithium ion) can demonstrate a high degree of performance variability between manufacturers.

The potential volatility of lifecycle costs represents the major incremental risk of battery storage. Solar project financings often extend through the estimated useful lives of the generating assets, which are generally known with a high degree of certainty. In the face of unpredictable estimates of battery degradation, additional capex may be necessary to replace batteries prematurely. Financial projections should also include additional costs for asset disposal as battery capacity degrades to uneconomic levels. Fitch otherwise expects the operating cost risks associated with battery storage to be generally comparable with those of solar, which can exhibit modest variability.

Prospective mitigants to lifecycle cost risk can help hedge against operation risks. Sponsors can incur additional up-front capital costs to overbuild the battery storage system and hedge against greater-than-expected degradation. Alternatively, financial projections could include detailed provisions for battery augmentation or repowering. The inclusion of reserve funding mechanisms in the financing structure would be particularly beneficial given the uncertain timing of potentially lumpy capex and the eventual need for asset disposal. A continual upgrade program may be feasible depending on the project's flexibility to incorporate replacement technology, which can reasonably be expected to demonstrate lower costs and higher energy densities.

Battery degradation is a critical assumption that impacts both revenues and lifecycle costs. The specific use case for a battery will determine degradation rates, which can progress in an unpredictable manner due to the lack of a long operational track record at utility scale. Battery storage designed for ancillary services will perform differently than applications involving energy arbitrage or capacity shifting to peak times. The effects of discharge/charging rates, the average state of charge, temperature and other technical factors affecting battery capacity and efficiency can be challenging to predict over the long term.

The successful optimization of battery storage is highly dependent on system management software, which is otherwise a peripheral risk factor for the operation of solar facilities. Fitch expects the operator of a solar-plus-storage project to be well versed in the use of battery and energy management systems to track performance and manage lifecycle costs. Sophisticated software is also required to make real-time decisions concerning the trade-off between degradation and immediate revenue generation. The sponsor may view accelerated degradation as an acceptable exchange for near-term cash flow, and the TA should address the extent to which revenue volatility could arise as a result.

Shifting risk to third parties can be essential for the viability of project-financed special purpose vehicles, which typically lack the strong balance sheets of large corporate sponsors. Risk transfer to creditworthy and experienced solar operators may be the only feasible solution to mitigate battery storage risks for nonrecourse solar-plus-storage financings in the near future. Operator guarantees, supported by battery manufacturer and software provider warranties, could protect against both performance and lifecycle cost risks. In the absence of such warranties, Fitch is likely to adopt conservative degradation assumptions and include additional capex in its rating cases.

Revenue Risk – Volume

Battery storage systems can further moderate the volume risk of solar projects, which typically reflect stable profiles near the P50 forecast of solar irradiation. Batteries provide a potential hedge against curtailment during periods of transmission congestion and can raise the effective capacity of a solar project by deferring output in markets with negative pricing. The flexibility inherent to battery storage can amplify a solar project's value by providing off-takers with frequency regulation, spinning reserves, voltage support and other ancillary services.

The inherent arbitrage opportunities offered by battery storage creates clear value for off-takers apart from grid management and reliability benefits. Utilities are increasingly demanding longer durations (typically four hours) and more frequent cycling from battery storage to shift renewable supply toward peak times and smooth pricing. Battery storage can also act as a vehicle for earning merchant revenue, though these incremental cash flows are inherently risky. Utility-scale merchant battery storage is vulnerable to a variety of market factors, including the build-out of more competitive battery storage in an environment of falling capital costs, the adoption of more efficient technology and the proliferation of behind-the-meter systems.

The selection of battery technology should align with the intended revenue generation model, whether the value proposition leans toward ancillary services or arbitrage. The use case for a specific battery system will ultimately impact capacity degradation rates and life expectancy, among other measures of performance. The ability of a solar-plus-storage project to meet contractual energy requirements and avoid penalties for delivery shortfalls can be tightly bound to the long-term performance of the battery storage system. The long-term volumetric risks associated with battery storage can limit the revenue generation potential of PPAs with expiries in the 10- to 20-year range.

Revenue Risk – Price

The accelerating deployment of solar-plus-storage projects reflects their increasingly competitive position and the attractive array of services available to off-takers and independent system operators. The pricing advantage is superior to gas-fired peaking generation in some markets, and some utilities are considering the avoided cost of additional transmission assets in grid planning. Fitch expects contractual revenue structures to vary widely depending on the services provided and the incentives built into the regional power market. Market participants will be forced to reevaluate traditional PPA payment models to properly capture the value provided by battery storage systems.

Solar projects rated by Fitch typically benefit from fixed-price PPAs with limited variability due to time-of-use provisions. The addition of fixed capacity payments for ancillary services derived from battery storage could add further stability to a project's revenue base. A straightforward fixed pricing scheme would help minimize price risk and shift the focus of the financial analysis to the feasibility of contractual performance requirements relative to the battery technology.

Establishing clear contractual performance requirements and penalties for battery storage may be challenging, as market standards have yet to emerge as a guide to allocate risk. PPAs should clearly address matters of operational flexibility, such as the extent to which a project can purchase power from the grid during off-peak hours or profit from arbitrage if not fully dispatched. PPAs should also address the impact of degradation risks in terms of explicit penalties or revenue offsets. Conversely, a PPA may or may not reward a project for upgrading its technology or provide automatic extensions for augmentation and repowering. The foregoing considerations are just a few of the issues that must be addressed when evaluating whether contractual provisions support revenue projections.

Solar-plus-storage projects engaged in wholesale energy price arbitrage represent the riskier end of the price spectrum. Fitch will apply its existing framework for evaluating merchant risk, taking into account third-party market forecasts and historical pricing. Fitch generally takes a conservative approach toward merchant risk, and it may not be practical to accurately model and sensitize the flexibility provided by battery storage in the spot market. The relative dependence upon merchant cash flows to service debt may ultimately present a rating constraint.

Debt Structure

The length of revenue-generating contracts may present a limiting factor to the debt structure of a solar-plus-storage project financed with nonrecourse indebtedness. The uncertainty surrounding the degradation rates and life expectancy of battery storage systems can effectively limit a project's ability to leverage the related cash flow beyond a 10-year time frame. This presents a disconnect with conventional solar projects, which often allow for tenors that extend the entire length of a 20- to 30-year PPA. Asset disposal considerations may further restrict a project's ability to defer amortization due to advance reserve funding near the end of a battery system's life. Certain debt markets might accommodate refinancing risk as a solution, though most lenders may prefer shorter tenors and front-loaded amortization.