Five game-changers to consider before investing in the US electric energy market.
In today’s volatile power market, what you don’t know can cost you.
Navigating the new energy market.

Many in the United States’ power generation industry no doubt long for the relative market tranquility of the late 20th century. The generation plants built and operated then were carbon-fueled or nuclear-powered, with a few hydro-electric plants sprinkled in. The economics were largely stable and predictable, often thanks to regulation that shielded utilities from market fluctuations.

But even in those simpler times, when the market was far less volatile, there was still much due diligence required when investors and developers were considering multi-million-dollar commitments in new generation projects.

Today’s market is more volatile, due in large part to the disruptive effect of low-cost natural gas and the subsequent, rapid growth of affordable renewable energy.

As more uneconomical and inefficient generation plants go offline, there is, for the most part, sufficient carbon-free or carbon-reduced generation to meet the growing demand for electric energy. There are pockets of growth areas in the country (e.g., ERCOT) that continue to exhibit strong demand. To replace shuttered plants and meet growing power demands in recent years, there has been a development frenzy in wind, solar and other clean-generation resources.

Deciding whether or not to enter the market with new energy projects is not a clean-cut issue. Investors and developers interested in determining a project’s viability and optimizing profitably face a daunting set of calculations. Market shifts, changing legislative priorities, regulatory mandates, and evolving technology are only some of the variables that must be considered.

This paper examines five of the most critical factors that investors, developers and others must recognize in the due-diligence research before investing in a new power generation project in the United States.
1. New fuel supplies are disrupting the once-predicable generation plant lifecycle.

There is a normal cycle of power generation plant retirement and replacement, but that formerly somewhat-predictable cycle has been disrupted in recent years. The disruption is largely due to increased availability of new fuel supplies: first natural gas, and then more-affordable solar and wind. An additional driver is the pressure to reduce emissions by shifting to cleaner fuels, especially renewables.

While coal plants are capable of reliably meeting much of the United States’ baseload power needs, they continue to be taken out of service. One reason for that is pressure to reduce the environmental impact of power production.

In 2011, the US Environmental Protection Agency issued the Mercury and Air Toxics Standards rule, which limited the amount of mercury and other toxic air pollutants that could be emitted. Retrofits and upgrades required for coal plants to comply with that rule could be made, but the rapid arrival of large volumes of low-cost natural gas made newer, gas-fired plants a far more economical choice.

But the most-significant force driving coal plant retirements is simple fuel economics: low-cost shale gas is pushing more-costly coal aside as the preferred fuel. Even some nuclear and older natural gas generation plants were shuttered, both because of the lower cost of gas and the higher efficiency of newer gas-fired combined cycle or natural gas turbines.

The sudden availability of natural gas was largely unpredicted and highly disruptive. As recently as 10 years ago, most experts were forecasting continued development of new or upgraded coal-fired facilities, as well as a resurgence in nuclear power. But since 2008, innovations in gas production technology have continued to push costs down while increasing well output, supplanting older generation resources.

Identifying areas of growth, technological advances, disruptive forces, drivers, and trends related to the evolving regional generation mix, etc., demand an in-depth understanding of the US electric energy sector. These can help drive decisions on deployment of capital across the electric energy sector.
2. Clean energy is catching up with conventional energy sources.

The invisible hand

In 1776, economist Adam Smith published “The Wealth of Nations,” which included the concept of “the invisible hand,” an unobservable market force that guides efficient economic decision-making.

The invisible hand plays a key role in energy production economics. While coal was cheap, it was the logical choice as the primary fuel for power generation. The shale gas revolution brought tremendous volumes of cleaner, lower-cost fuel to market, pushing development of new, gas-fueled generation facilities. In turn, the availability and lower costs of renewables are now putting pressure on natural gas as the fuel of choice, at least in some regions of the US.

Some regulators and utilities are rethinking the value proposition of natural gas. In March of 2018, Arizona regulators rejected the integrated resource plans of the state’s major utilities, citing too much reliance on natural gas and the risk of stranded assets. They placed a nine-month moratorium on new natural gas plants larger than 150MW and asked utilities to model scenarios with high penetrations of renewables and storage.

Renewables are seeing continued and dramatic improvements regarding both cost and technological advancements. Despite a short-term impact from the Section 201 Tariffs, solar costs are predicted to decline from current levels to two percent annually from 2025 onward.2

Battery storage costs are also expected to decline by approximately one-half by 2030 and, when aggregated with intermittent generation from solar and wind resources, can allow the intermittent electric-supply resource to be a firm, constant power source. For example, China is developing a 200MW / 800MWh vanadium-flow battery that will be a multi-purpose asset, meeting peak load demands, enhancing grid stability and enabling black starts in case of emergency.1 These types of projects bring renewables closer to being reliable baseload providers.

While the basic economics of gas versus renewable generation is currently not in favor of renewable resources, considerations of carbon emission reductions provide added impetus for solar and wind deployments in the near future. Depending on technology developments in the future, natural gas may turn out to be a bridge fuel on the path to a primarily renewable generation network.

As evidence, California regulators forced the Pacific Gas & Electric utility to solicit bids for energy storage instead of continuing payments to three natural gas plants (two peakers and one combined cycle gas turbine). The utility has since opted to replace them with the one of the largest storage procurements, totaling 2,270MWh.

1 Electrek, https://electrek.co/2017/12/21/worlds-largest-battery-200mw-800mwh-vanadium-flow-battery-rongke-power/
2 ABB North American Power Reference Case, Fall 2018
The profitability picture

Earlier renewable energy projects benefited greatly from government incentives. Today though, new projects are being built purely on their own merits, reducing the risk to investors and developers. Renewable projects are highly scalable, which enables a wider range of investors to participate in power generation and related markets. In place of those incentives, many renewable power providers today rely on power purchase agreements (PPA) to ensure the profitability of their output.

The drive for increased renewable penetration now appears unstoppable for the next generation, as a combination of lowering prices, environmental demands and consumer pressure makes renewables an attractive value proposition to electric energy market investors. Finding the opportunities that present the best potential for profitable operation requires in-depth market data supported by sophisticated analytics and models. The most capable of these models can rapidly provide reliable insights; as an example, ABB’s Enterprise Software product group updated its energy market model based on campaign statements shortly after the last US presidential election. The ability of a market model to incorporate this type of data enhances decision-making and provides market guidance via a broad range of long-term forecasts.

3. New and evolving technologies will forever change the energy generation landscape.

Led by California, Hawaii and New York, many states are creating energy policies that encourage renewable resources, distributed-energy resources, and energy-storage technologies. The cost of solar is dropping fast and the key to integrating solar appears to be battery storage. In the summer of 2018, California passed Senate Bill 100, a landmark legislation that requires California utilities to achieve 60 percent renewable portfolio standards by 2030 and be 100 percent carbon-free by 2045. Reaching these ambitious sustainability targets will require battery energy storage systems to become mainstream resources.

Battery storage systems

Battery storage systems are one of the most promising technologies to address the variability of renewables. These systems excel at short-term grid stabilization, rapidly accepting or injecting power to help ride through a cloud passing over the solar panels or a lull in the wind. With storage, generation peaks and troughs can be leveled, enabling renewables to be a baseload power provider. New systems are being deployed that can feed networks for several hours, moving far beyond today’s very short-term applications.

The utility of these battery systems has been proven and, more recently, so has their profitability. A recent headline from Electrek, an online news site tracking the transition from fossil fuel to electric transportation, announced that “Tesla’s giant battery in Australia made around $1 million (AUD) in just a few days.” The 100MW / 129MWh Powerpack project in South Australia is owned by Neoen. The largest such system in the world at the start of 2018, it was paid up to $1,000/MWh to charge itself. The installation also demonstrated this technology’s stabilization function when a coal generator failed. The batteries provided a burst of power to normalize the grid, demonstrating the disruptive nature of new technology, and this battery system was installed in only 100 days.

The adoption of battery systems for power generation may coincide with a revolution in transportation electrification. Fighting climate change requires decarbonization of the entire economy. The battery-storage technology used in electric vehicles is more or less the same storage technology used for power generation. In early 2018, the Federal Energy Regulatory Commission passed Order 841, which directs system operators to come up with market rules for energy storage to participate in the wholesale energy, capacity and ancillary-services markets that recognize the physical and operational characteristics of the resource. The passage of this rule will help to eliminate a major barrier to energy storage by providing for more opportunities to provide grid benefit with fair compensation for those services.

As the modern electric power system decentralizes, energy storage resources located at the “grid edge” will play a major role in supporting the proliferation of distributed energy resources and reduce the need to invest in costly distribution and transmission equipment.

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Battery energy storage system

4. Transmission factors create issues and opportunities.

Just like any commodity, electricity can be sold profitably only if it can be economically delivered to consumers. Unlike other commodities, electric power supply and demand must always match, i.e., the supply of electricity must exactly match the load plus losses.

Investors and developers need to thoroughly investigate the costs involved in getting the output of their power generation assets to the point of use. That’s true of all generation assets, but it’s particularly critical for renewable assets.

Utility-scale renewable-generating farms are typically located far from end users, primarily because these sites require a considerably larger footprint than comparable-output fossil-fuel-burning plants (coal, gas, etc.). A coal-fired 100MW plant might require a 50-acre site, while a comparable solar farm would require about 800 acres and a wind farm about 2,500 acres.

As such, the first consideration when siting a plant is finding an area that is both large enough and suitable for wind and/or solar generation. Next on the list of criteria is access to a connection point on a transmission line. But proximity of transmission lines to a generation site doesn’t ensure an economical power conduit.
Calculating profitability requires comparing LMPs at the point of generation with the LMPs at the point of use. The LMP at the point where the power is injected into the grid might be $30 per megawatt-hour, while the LMP at the hub or node where it’s sold might be $35. The difference between them is the basis differential, and that price spread is a matter of critical interest to investors.

There is no doubt that, for the foreseeable future, the US power market is ripe with opportunities for developers and investors, particularly in solar and wind. One of the first steps in ensuring a profitable project is finding appropriate generation sites. Close behind in profitability predictions is evaluation of the availability and capability of transmission networks, which is usually determined by system impact studies. Finally, it’s essential to assess what lies ahead by conducting an LMP forecast, congestion evaluation, curtailment assessment, and basis risk evaluation. These analyses require consultants with the accurate data, tools, and knowledge to perform detailed nodal studies to aid the developers/investors with their decision-making process and their ongoing PPA negotiation.

Network operators are continuously challenged to balance power supply with demand and losses. Constant fluctuations in demand, combined with contingencies and forced outages of transmission lines and generating units, require system operators to routinely adjust the output of available generating units and/or commit and dispatch standby units. These changes result in an ever-changing flow of electricity in transmission lines. At any given time, some lines could be fully loaded, limiting the injection of additional energy from any given plant.

Fossil-burning units can ramp down their output to prevent transmission line thermal violations. Although they lose revenue, they also realize some offsetting cost savings because of reduced fuel usage. When renewable farms are compelled to curtail generation, they see no cost savings.

Another issue that could compel curtailment by renewable-generating farms is over-generation. Some large fossil-based plants are unable to cycle; they need to reduce their output at night and stay online despite unprofitable generation. Wind farms may realize peak generation at night, but lack of demand could force operators to curtail output. This situation could also happen during daytime periods in areas with an over-concentration of solar farms, such as California.

These market realities compel investors and developers to carefully analyze their ability to economically transmit the output of planned generation facilities. This entails calculations of the locational marginal price (LMP), the predicted price per megawatt-hour at a given time of the day. With a foundation of broad, accurate historical data; knowledge of planned generation and transmission projects; projections of demand and use; and the appropriate analytical tools, it’s possible to model future markets and develop accurate LMPs.

The LMP forecasts for the point of interconnection (injection point), delivery hub, and/or delivery node help developers and investors evaluate the basis risk in a nodal market. The basis risk helps investors with their PPA negotiations and provides an outlook for years beyond expiration of already-negotiated PPAs.
5. EVs have potential to create exponential growth in power demand and opportunities for grid services.

Growth of electric vehicle (EV) sales in the United States is increasing and may be at a tipping point where the market could grow dramatically. The Union of Concerned Scientists has noted that the US electric vehicle market grew 32 percent annually between 2012-2016, and as of mid-2017 was 40 percent. If that rate is sustained, EVs could account for 10 percent of US vehicle sales in 2023, and possibly near 20 percent by 2025.4

Some EV growth in the United States is driven by early adopters eager to own the latest transportation technology. Most buyers, however, opt for EVs out of concerns for energy usage and the environment. The efficiency of EVs relative to hydrocarbon-powered vehicles is impressive: The typical, traditional vehicle efficiency of 17-21 percent is eclipsed by EV efficiency in the 60 percent range.

As the number of EVs grows, so will demands on the grid. The typical EV used to commute 16 miles each way consumes about 7.5 to 10kWh/day5, roughly the same power consumed by an average household. An EV in each home, therefore, would double today’s residential power usage. A new load of this magnitude requires changes to ensure the availability of sufficient energy on demand.

In addition to creating new issues regarding the grid, the surge of EVs creates opportunities for grid services to manage the flow of power between the grid and the vehicles. The availability of a continent-wide fleet of rolling energy storage devices – EV batteries – opens the door to markets and services that are only now beginning to come into focus.

Grid services

Developers and investors are struggling to find profitable approaches to create new revenue streams by drawing power from EV batteries to feed back to the grid. Private EVs spend the vast majority of their time parked, typically in the owner’s garage or place of work. While parked, they are usually plugged in – this is a huge, connected, potential source of battery storage.

Vehicle-to-grid is an emerging technology for sending power back to the grid. It enables plug-in electric vehicles of all types to sell demand-response services by either returning electricity to the grid or throttling their charging rate.

Charging infrastructure opportunities

Another industry still in its formative stage is EV charging. There are currently about 16,000 public charging stations in the US, about one-tenth the number of gas stations.6 According to GTM, that will grow to 1.2 million public charging points installed in North America by 2030, plus 12 million residential points.

Consumers, accustomed to refueling at gas stations, will expect to be able to recharge their EVs at the same place. Oil companies, who own most gas stations, are beginning to meet those expectations while hedging their bets on the future of gas-powered vehicles by making some investments in charging stations. BP has forecast that oil demand will peak in the 2030s as EVs go mainstream.7 EV owners, EV aggregators and system operators can benefit from charging infrastructures, allowing them to maximize their benefits and be able to participate in the energy and reserve markets.

4 Electrek, https://electrek.co/2017/07/21/electric-car-sales-us/
7 Inside EVs, https://insideevs.com/gas-stations-benefit-electric-vehicles/
Navigating the variables can seem daunting. Nevertheless, the opportunities for profitable new power generation, transmission and distribution that exist throughout the US make the gain worth the risk. As in all commercial investments, potential problems and pitfalls exist. That’s why it’s critical to conduct a thoughtful evaluation of market factors to balance opportunity, cost and risks before making a move.

In addition to the five considerations explored here, there is much more that should be considered before investing in a new power-generation project. Unfortunately, adequate due diligence of the many variables and the complexity of the energy market require much more capability than even the most carefully-crafted spreadsheet can accommodate.

Calculating the financial viability and risk mitigation of these projects requires a purpose-built modeling framework that considers the complex interactions between markets and generation resources in the United States. Calculations are only as reliable as the data on which they’re based, which is why it is critical to identify modeling and data-supply partners with deep industry expertise and access to a broad spectrum of relevant data and market modeling to provide decision-making support.
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