HIGHLIGHTS

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- The Trend: Two-thirds of corporate wind power purchase agreement (PPA) volume signed to date has occurred in a Great Plains state. Texas led the way through 2014, but Oklahoma and Kansas have been catching up.
- The Drivers: Central Plains states have benefited from investments in transmission infrastructure and marketplace improvements, resulting in a better environment for corporate PPAs.
- Why It Matters: Corporations considering PPAs in the Southwest Power Pool (SPP) will be impacted by changes in congestion and curtailment patterns. Careful analysis of the risks will be critical, as historical analysis alone may not capture the effects of emerging trends.

INTRODUCTION

The Great Plains have long been a leader in wind energy, with 41% of total national wind generation coming from plains states in 2014.¹ Texas in particular led the way, and now has almost three times the installed wind capacity of the next leading state (Iowa).² Corporate PPAs have followed suit. Two-thirds of corporate wind PPA volume has been in the plains, with Texas accounting for the vast majority of transactions through 2014.

However, states further north—most significantly Oklahoma and Kansas—have experienced increasing PPA activity in 2015 and 2016. As Figure 1 shows, the volume of wind PPAs signed in SPP in 2015 alone was more than double the volume over the preceding 7 year period from 2008-2014. And despite dropping last year, SPP wind PPA volume was still greater in 2016 than the 2008-2014 total. Transmission infrastructure improvements, falling capital costs, and electricity market restructuring implemented by the SPP, the grid operator in the region, resulted in a more favorable environment for both wind development and corporate PPAs.

¹ EIA Form 923
² AWEA U.S. Wind Industry Third Quarter 2016 Market Report
Looking at the history of pricing and development trends in the Electric Reliability Council of Texas (ERCOT) territory can be useful for understanding the future of wind energy in SPP. Both territories cover areas with strong wind resource. Both territories have population centers in the east and favorable regions for wind development in the west. As a result, both territories have faced shortages of transmission capacity to deliver wind energy to major cities, causing intramarket regional price differences.

Therefore, it is critical to analyze the effect of transmission constraints on ERCOT and SPP wind PPA economics. Worsening congestion could result in reduced hedge value for PPAs. Worsening curtailment could result in lower volumes of renewable energy procured through the deal, putting the buyer at risk of falling short of sustainability goals. Identifying these risks and implementing mitigation strategies can make the difference between a deal that pays off year after year versus one that the buyer regrets.

For example, it may make sense to sign two smaller deals in different markets to hedge against transmission risks in either market. It also may make sense to take delivery of a PPA at a location less affected by congestion and curtailment. Ultimately, a prospective buyer should weigh the benefits of risk mitigation with the potential extra cost of those measures. Some measures, such as market diversification, may even cost the same or less than other approaches.
THE GREAT PLAINS HAVE THE CHEAPEST WIND POWER

The Great Plains lead the nation in wind energy for one main reason: the wind blows more strongly and consistently there than anywhere else. Figure 2 below shows average wind speed across the country, with red and purple regions representing the highest wind speeds.

Figure 2: Annual Average Wind Speed with SPP territories

Higher wind speeds translate to more generation over the course of a year per megawatt (MW) of installed capacity. This ratio between the average output and the installed capacity of a wind generator is called its capacity factor. For example, if a 100 MW wind generator were to produce an average output of 35 MW over the course of a year, it would have a 35% capacity factor.
Generators with higher capacity factors (i.e., more output per MW of capacity) are able to recover up-front capital costs over larger production volumes, resulting in lower unit costs for the energy produced. A generator with lower unit costs can offer lower negotiated PPA prices, improving economics for corporate buyers. This is the main driver of the high level of corporate PPA activity in the plains.

However, wind resource is not everything. Capital costs for new wind farms have fallen steadily over the past decade due to declining technology costs and economies of scale. While solar costs have dropped dramatically in recent years, wind power in regions with abundant resources remains significantly cheaper to produce. At the same time, it is important to note that despite the macro trend of declining costs, capital costs for wind farms vary by location. For example, harder-to-reach project sites can create extra costs for transporting workers and materials to the site and building interconnection lines to the grid. The best sites in a region are developed first, meaning the remaining sites are more expensive to develop, so over time the costs for new projects increase as installed capacity increases.

In addition, states in the region have implemented policies in support of wind generation. Texas, Oklahoma, Kansas, and Nebraska all have implemented tax credits or exemptions specifically for renewable generators. These benefits vary by state, but all create extra incentive for wind development in the region.

The two main wholesale markets in the region are ERCOT and SPP. ERCOT’s territory covers most of Texas, while SPP’s territory (outlined in white on the map in Figure 2) covers parts of Texas and 13 other states, including most of the Great Plains. It is important to analyze trends in those two markets to understand the environment for wind development in the region.

**ERCOT LED THE WAY**

Texas produces more wind energy than any other state, and by a wide margin. With nearly 45 TWh of wind generation in 2015, Texas accounted for 24% of all wind energy generated in the nation that year. The vast majority of this wind generation is located in the ERCOT market rather than the SPP market. Iowa was a distant second to Texas with about 18 TWh of wind generation in 2015.³

While strong wind resource and declining capital costs were the main driving factors, significant transmission infrastructure investments also allowed ERCOT to take the lead in wind generation. The most significant was the $7 billion Competitive Renewable Energy Zone (CREZ) project implemented by the Public Utility Commission of Texas (PUCT).⁴ Initiated in 2005, the project identified major zones with potential for wind generation in the windy western portion of the state. Transmission service providers constructed several large transmission lines in the state from late 2010 through 2014 to transport energy from windy West Texas to the population centers further east.

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³ EIA Form 923
⁴ https://www.texastribune.org/2013/10/14/7-billion-crez-project-nears-finish-aiding-wind-po/
The effects of the CREZ project are clear in two trends: wind capacity additions and the incidence of congestion and curtailment. First, wind capacity additions fell in Texas until the CREZ lines were completed, after which capacity additions reached new highs. In the three years leading up to the start of the project (2007–2009), project developers interconnected an average of 2,223 MW of new wind capacity each year. As existing transmission capacity reached its limit, new wind capacity additions slowed down. In the four-year period when most CREZ lines were under construction (2010–2013), an average of 738 MW of new wind capacity was finished each year. The completion of the last CREZ line in January 2014 was met with a new surge in wind development: an average of 2,679 MW of incremental wind capacity was completed each year in 2014 and 2015.

Second, congestion and curtailment in ERCOT follows a similar pattern. These two factors, both of which are related to surplus generation in a specific location on the grid, can negatively affect the value of a renewable generator and add risk to a PPA. CREZ effectively reduced the incidence of both congestion and curtailment in the ERCOT territory.

Congestion occurs when the transmission infrastructure between electricity generation and consumption reaches its capacity, creating a constraint on the system. Both ERCOT and SPP have regions of strong wind resource in the west and population centers to the east. When there is not enough transmission capacity to bring electricity from wind generation eastward to the major cities, it causes a surplus in the west. As with any surplus, this drives prices down in the area, cutting into revenues paid to wind generators. In this way, congestion can cause reduced revenue from corporate PPAs. If congestion is severe enough, prices can even become negative during these periods.

Congestion can also lead to curtailment. Curtailment occurs when grid operators direct generators to reduce output to maintain system balance. In ERCOT and SPP, this is done to avoid overloading lines running west to east when there is surplus wind generation. Even though wind generators have lower marginal operating costs than conventional generators further east, they must be shut down if there is no transmission capacity available. The result is that wind plants can generate less electricity and fewer renewable energy certificates (RECs) than would be anticipated based on the strength of the wind resource.

**EARLY SIGNS OF TRANSMISSION CONSTRAINTS IN ERCOT**

While CREZ has done an excellent job of reducing congestion and curtailment so far, there are early indications that transmission capacity may be approaching its limits. One way to evaluate congestion and curtailment is to look at the incidence of negative pricing for ERCOT’s West Hub, and the average pricing spread between the West Hub and North Hub. Both of these variables can indicate congestion and curtailment due to surplus wind generation in the western part of the state. Some analysts have pointed to recent trends in negative pricing as an indication that CREZ lines are running out of capacity.⁵

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In 2011, in the middle of the build-out of CREZ projects, there were 760 hours over the course of the year (8.7%) that experienced negative West Hub prices. As CREZ projects began to go into service, congestion dropped, with negative prices reaching a low of only 50 hours (0.6%) total in 2014. However, in 2016, ERCOT saw 274 hours of negative pricing in the west—more than 2014 and 2015 combined. The pricing spread between the West Hub and North Hub has followed a similar but less drastic trend reversal, averaging $5.52/MWh in 2011, dropping to $0.11/MWh in 2014, and rising to $0.56/MWh for 2016.

It is important to note that this is an emerging trend, and that one year is a short time over which to evaluate transmission constraints. One should not draw the conclusion that CREZ lines are out of capacity or that we are about to return to pre-CREZ levels of congestion and curtailment. Furthermore, even in the presence of congestion and curtailment, CREZ lines are still fulfilling their purpose of bringing more cheap wind power to market.

However, these trends are indicative of the cyclical relationship between wind development and transmission investments. As wind generators are built in regions with good wind resource, it strains the transmission system due to the fact that most areas of good wind resource are located far away from load. Also, the best sites with good wind resource and close proximity to existing transmission are developed first. This creates a need for new investment in projects to increase access to transmission capacity. As wind development ramps up in response to new capacity, the cycle restarts as transmission lines approach full utilization once again.

SPP IS CATCHING UP

As of the third quarter of 2016, Texas had 81% more installed wind capacity than Oklahoma, Kansas, and Nebraska combined. However, because Texas has significantly more conventional generating capacity, the three other states have a higher proportion of wind capacity: wind makes up 20% of total installed capacity in the latter states versus 15% in Texas. Analyzing interconnection queues suggests that wind capacity as a percentage of total capacity in the two regions will diverge further over the next five years. Planned capacity additions show that SPP is more heavily weighted towards wind development than ERCOT, which is expected to add a higher proportion of natural gas generation. As a result, by 2021, 29% of installed capacity in Oklahoma, Kansas, and Nebraska is expected to be wind generation versus 19% in Texas.

SPP IS CREATING A BETTER ENVIRONMENT FOR WIND DEVELOPMENT

So why is wind generation growing in SPP, other than the great wind resource there? First, the most attractive sites in ERCOT were naturally developed first, leaving the less attractive (i.e., more expensive) sites remaining, so capital costs rise. In 2010, when many attractive sites remained in Texas, it was 7% more expensive to build a wind farm in Kansas than in Texas. However, this reversed as build-out in Texas continued apace: in 2015 it was 6% less expensive to build a wind farm in Kansas than in Texas.

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7 SNL Financial
Second, similar to CREZ in Texas, SPP has made significant upgrades to its transmission infrastructure. In the three-year period from 2012 through 2014, SPP spent $819 million on transmission projects, versus $127 million for the preceding three-year period from 2009 through 2011. These projects have resulted in significant value for SPP, due in large part to the integration of more cost-effective wind generation. SPP estimated that the build-out would create $16.6 billion of benefit over 40 years.⁸

In addition, SPP made improvements to its market structure. In March 2014, SPP launched its Integrated Marketplace, which implemented a number of more sophisticated features already used in most other regional wholesale electricity markets. The goals of the marketplace were to “coordinate next-day generation across the region to maximize cost-effectiveness... improve regional balancing of electricity supply and demand, and facilitate the integration of renewable resources.”⁹ The changes created $131 million of net savings to customers in its first year of operation.¹⁰

One of the most significant improvements was the combination of several existing balancing authorities into a single balancing authority. A balancing authority is an entity that directs which power plants (commonly referred to as “resources”) to operate and when (a process known as “dispatch” in the electricity sector) in a defined region (the “balancing authority area”) to balance supply and demand and maintain power quality.¹¹ Before the implementation of the Integrated Marketplace, the SPP territory included 16 balancing authorities in charge of dispatching different parts of the system.

The Integrated Marketplace combined them all into a single balancing authority in charge of the entire system. By comparison, ERCOT consolidated operations to a single balancing authority in 2001.¹² A single balancing authority results in better interregional coordination because a single entity is able to utilize generators across the region. SPP further increased its reach in 2015, expanding its footprint northward to encompass several additional states, including the Dakotas and Montana. These changes mean that it is easier for resources in one region to serve load in another region, leading to more efficient dispatch and resource utilization overall.

Another significant recent improvement in SPP was the addition of day-ahead markets. In comparison, ERCOT implemented its current day-ahead market in 2010. SPP previously had only an energy imbalance market, which meant that generators for the most part directed their own dispatch. Most transactions happened through bilateral contracts. The balancing authority maintained reliability by running a central market-clearing mechanism to address real-time imbalances between supply and demand.

In a day-ahead energy market, the balancing authority centrally commits all generators a day in advance, based on bids and offers submitted to the market. Those generators are obligated to follow their committed schedules on the following day. A separate real-time market accounts for real-time imbalances in supply and demand, similar to an imbalance market.

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⁸ “The Value of Transmission,” SPP 2016
⁹ https://www.spp.org/markets-operations/integrated-marketplace/
¹² http://www.ercot.com/about/profile/history
Combined with a single larger balancing authority, the addition of a day-ahead market results in more efficient dispatch because it can be centrally optimized. The larger balancing authority increases the size of the pool of resources, while the day-ahead market and unit commitment give the balancing authority more direct control over those resources.

This has specific benefits for wind generators, which are usually the lowest-cost generators to run. Facilitating interregional dispatch coordination allows cheaper wind generators to get their power to load centers, and reduces congestion and curtailments. In 2014, SPP curtailment was on par with ERCOT, and significantly lower than in the Midcontinent Independent System Operator (MISO), another leading ISO for wind generation. This leads to more certainty of future revenues for wind developers, facilitating development and PPA negotiation.

Finally, because PPAs are settled based on energy market prices, it is important to have a reliable pricing point on which to base the contracts. After almost three full years of pricing history, counterparties have become more comfortable signing deals based on SPP's market prices. SPP previously lagged other ISOs in terms of market sophistication, but now is on par with others.

**WILL SPP FOLLOW THE TREND IN ERCOT?**

Currently, congestion and curtailments in SPP are relatively low due to the transmission investments over the past few years. Wind curtailments in 2014 and 2015 were well below where they were in 2012 and 2013. And while we saw an uptick in curtailments in 2016, they were still well below where they were in 2012–2013. However, SPP likely will follow in ERCOT's footsteps and see some increased levels of congestion at some point. The question is how long this period of lower congestion and curtailment will last.

There are signs pointing in both directions. The full pipeline of wind projects suggests that the strong trend of growing wind generation in the region will continue, putting more strain on the transmission system. After noting that congestion in parts of the footprint had reduced in 2015, the SPP Market Monitoring Unit highlighted increasing wind-driven congestion in 2016. In December 2016 the chair of SPP’s Strategic Planning Committee highlighted the challenges the regional transmission organization faces in integrating more wind capacity.

In addition, policy changes in the region could create more challenges for wind developers. Oklahoma’s House of Representatives passed a bill in early 2017 that aims to eliminate its Zero-Emission Facilities Production Tax Credit later this year. The tax credit is assessed similarly to the federal Renewable Energy Production Tax Credit, and provides a 22% increase in tax credits beyond the federal credit alone. This bill would follow the recent expiration of the state’s property tax exemption for wind generators, which ended at the beginning of 2017. If the state’s Senate passes the new bill, wind development in the state could be further stifled and developers may be pushed to explore other states in the region. It will be important to monitor if other states follow Oklahoma’s lead.
Despite these signs of emerging headwinds, new transmission projects in SPP are planned for construction over the next several years, with many intended specifically to add transmission capacity for wind projects. In fact, several of the projects were accelerated last year to alleviate near-term impacts from growing wind generation. As long as transmission improvements keep pace with new wind capacity additions, then congestion should be kept in check. SPP’s forthcoming second phase of its 2016 wind integration study should provide clarity on future impacts of increasing wind generation.

Finally, SPP is currently in talks with the Mountain West Transmission Group regarding a westward expansion of the SPP territory into Colorado and Wyoming. The Mountain West Transmission Group includes 10 entities serving about 6.4 million customers primarily in the Rocky Mountain region. Adding these entities to the SPP footprint would increase the load served by the RTO by more than 20%. This could alleviate some transmission constraints by incorporating new large load centers to the west of current wind generators instead of to the east. In addition, the expansion would bring market access to some areas with excellent wind resource, which could further accelerate wind development in SPP.

IIIIII  KNOW THE DRIVERS AND PLAN TO MITIGATE RISK

What does this mean if you are considering a long-term renewable energy PPA? First and foremost, be sure to understand what specific factors will affect the profitability of the deal, keeping in mind that they vary by market and over time. A lot can happen over the course of a 25-year PPA. Electricity prices are notoriously volatile and can be heavily influenced by other factors like regional natural gas prices and transmission infrastructure investments. When evaluating the cost and economics of a potential wind PPA, it is crucial to think about risk and develop strategies to mitigate risk. It may be valuable to analyze a potential deal under a number of potential future scenarios.

For example, if while analyzing a potential deal in ERCOT you looked at historical congestion with a dataset running through the end of 2015, you might miss the trend of increasing congestion that emerged in 2016. Similarly, understanding where we are in the cycle of wind development and transmission investments can inform your risk analysis. For example, you might reasonably forecast an increase in congestion and curtailment in ERCOT in the coming years as wind development continues and CREZ lines reach capacity.

These trends may not change how you price the deal, since one year is a short time on which to base projections, but it might factor into how you allocate future congestion risk. You may choose to settle your PPA at the ERCOT North Hub, which is located close to load centers on the eastern side of the major transmission constraints. However, it is important to remember that settling at a hub will shift congestion risk to the developer, which will most likely charge you extra for taking on that risk. It could also protect you against future changes in congestion patterns, so it is important to consider if it is worth the cost.
Another risk mitigation strategy to consider is portfolio diversification. Instead of opting for a single 100 MW PPA in ERCOT or SPP, you might decide to do two deals, instead. With 50 MW in SPP and 50 MW in MISO, for example, you would be less exposed to market trends in any one jurisdiction and would instead be spreading your risk. It also may make sense to diversify a wind PPA with a solar PPA. Solar generators can often be placed closer to load centers, reducing some of the risk due to congestion and curtailment.

Ultimately, a company’s culture and appetite for risk will dictate the level of comfort it has with taking on market risk. But it is important not only to consider current forecasts of the costs and benefits of signing a PPA, but also to evaluate emerging or possible future trends that could affect your projections. Running a sensitivity analysis can help to determine risk exposure in a number of future scenarios. Including multiple scenarios for congestion and curtailment is a good idea, especially in ERCOT and SPP. While PPAs provide many benefits that are otherwise unavailable to corporate buyers, it is important to weigh the risks as well as the benefits.

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