IS WIND VARIABILITY BETTER MANAGED IN SPP?

Summary of Analysis

Pursuant to Paragraph 12 of the Commission's Order dated February 11, Grain Belt Express Clean Line LLC ("Grain Belt Express") submits this analysis of whether the variability of the injected wind could be better managed in SPP prior to delivery to MISO and PJM.

The Grain Belt Express Clean Line ("Project") is a ±600kV, HVDC transmission line that will deliver high capacity factor wind generation from western Kansas to Missouri and the broader MISO and PJM markets. The Project's business plan calls for wind generation to be directly connected to the Kansas converter station in order to be transported to MISO and PJM. The energy will be delivered to MISO and PJM "as generated" and without interacting with the SPP system or its integrated marketplace. In this case, the variability of the wind generation is managed by MISO and PJM, not by SPP.

The Commission has asked Grain Belt Express to evaluate managing wind variability through a different model, where wind generators first sell their power to SPP and then buy back "non-variable" power from the SPP market to deliver to MISO and PJM. In its evaluation, Grain Belt Express has concluded that this option is not feasible, economic, or necessary for the three reasons discussed below.

1. **The SPP transmission system does not support injecting over 4,000 MW of generation in western Kansas.**

In order to manage the variability of the wind generation in SPP, it would be necessary to first inject the power into SPP. Therefore, a basic test for the viability of this approach is whether the alternating current grid in western Kansas can accommodate 4,000 MW of power injection. If it cannot, then it is impossible to manage the variability of wind power in SPP before delivering it to MISO and PJM.

The Project will connect with the SPP system by tapping into a new substation along the Clark County-Spearville 345 kV line. While SPP has recently upgraded the transmission system in this region, 4,000 MW is a power level that is larger than is typically planned to be handled by a 345 kV outlet. In fact, SPP has planned its system in western Kansas for a substantially smaller amount of wind generation.

In approving the line with which the Project interconnects, SPP studied a total amount of new wind generation capacity in the Spearville region of about 2,100 MW.[1] Much of this headroom in the transmission system has already been used by existing or planned wind generators, and therefore little remains for the Project. It would simply not be realistic for the Project to inject into western Kansas an amount of capacity that is double what SPP contemplated when it planned the line with which the Project interconnects.

2. Grain Belt Express and the respondents to its capacity solicitation do not possess the necessary transmission rights.

As documented in Schedule AWG-4, A.W. Galli Direct Testimony (Ex. 111), Grain Belt Express is pursuing an interconnection with SPP based on a zero MW interconnection. Grain Belt Express is not pursuing the rights to inject over 4,000 MW of power into SPP on a long-term basis, which would be necessary to manage the variability of the wind generation in SPP. Based on the existing SPP infrastructure, discussed above, such delivery rights would likely require extensive upgrades and render the Project uneconomical. Obtaining these interconnection rights would require a new, multi-year study process.

Grain Belt Express is working with numerous wind generators through its capacity solicitation. These generators intend to connect directly to the Project's converter station via AC tie lines. These wind farms will not have an interconnection with SPP to manage their variability. Obtaining this interconnection would be both very costly and time-consuming. Given the physical limitations of the grid in western Kansas, generators would likely be responsible for significant network upgrades in order to inject over 4,000 MW.

3. MISO and PJM are better able to manage the variability of the wind generation connected to the Project due to their higher load, stronger transmission systems and existing wind generation.

Beyond the problems in managing wind variability in SPP, MISO and PJM are actually better suited to manage this variability. One key factor is the size of the load already managed in their systems. The smaller the percentage of wind energy makes up of a generation portfolio, the lower the cost to integrate additional wind energy. No system can be supplied solely with 100% wind

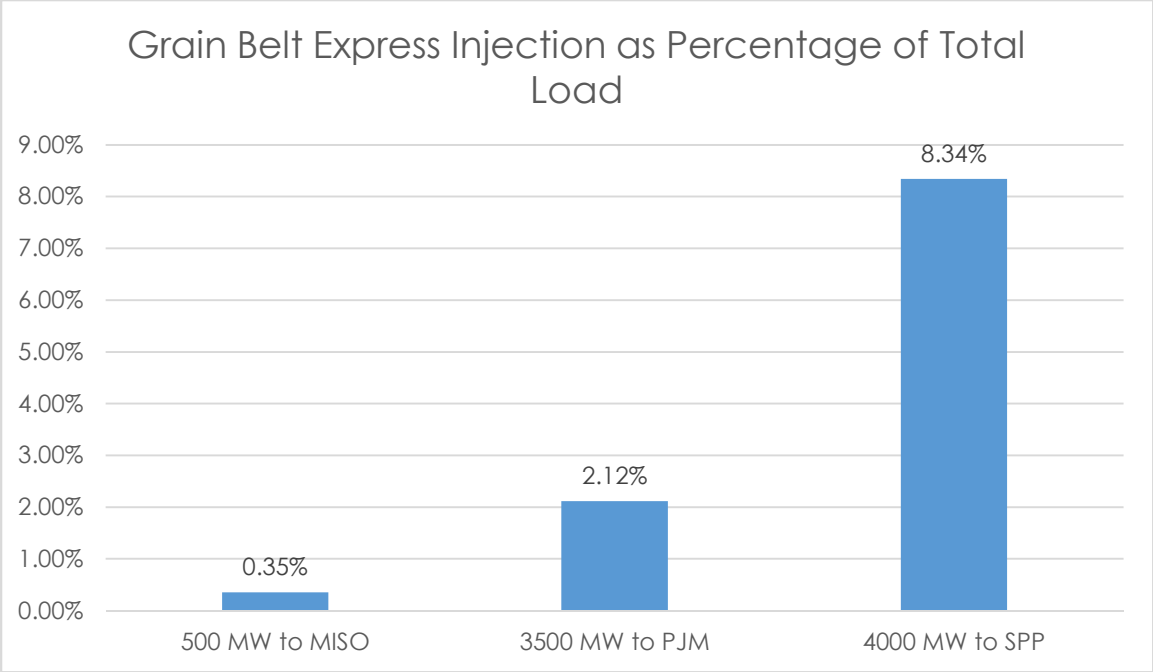
[1] SPP Priority Projects Phase II Final Report (April 27, 2010) ("Priority Projects Report"), p. 11; *available at http://www.spp.org/publications/Priority%20Projects%20Phase%20II%20Final%20Report%20-%204-27-10.pdf*.

energy without an extensive system of energy storage, which would be very expensive. At the other extreme, if wind energy were only to be a small percentage of the overall energy mix, its variability is unlikely to drive significant changes in how the system must operate—and therefore will not incur additional costs.

Because of the high capacity factors of wind generators in western Kansas, the Project will be able to transmit approximately 20 million MWh of wind per year. PJM's current annual electrical demand is approximately 797 million MWh.[2] MISO's current annual electrical demand is about 690 million MWh (including the addition of MISO South), while SPP's is about 231 million MWh.[3]

The graph below shows the size of the Project's injection in the following cases: (1) 4,000 MW[4] of wind power is delivered to SPP to manage the variability, (2) as planned, Grain Belt Express delivers 500 MW to MISO, (3) as planned, Grain Belt Express delivers 3,500 MW to PJM.[5]

[2] PJM load data is available at https://www.pjm.com/markets-and-operations/ops-analysis/historical-load-data.aspx (last accessed April 11, 2015).
[3] MISO Load Forecast *available at* *https://www.misoenergy.org/Planning/Pages/IndependentLoadForecasts.aspx* (last accessed April 12, 2015). SPP 2013 State of the Market Report; available at http://www.spp.org/publications/2013%20SPP%20State%20of%20the%20Market%20Report.pdf (last accessed April 11, 2015).
[4] The actual amount of wind generation will be higher due to electric losses and some level of overbuild relative to firm transmission capacity, but 4,000 MW was used so the energy absorbed was kept constant between Scenario 1 vs. Scenario 2.
[5] A 55% capacity factor on the delivered energy is used.



While the contemplated deliveries to MISO and PJM are a small percentage of system load, the hypothetical delivery to SPP to manage variability would be a very large percentage of SPP's load. Further, these are annual average figures. In certain hours, the percentage will rise due to higher wind and lower load conditions. For example, if SPP load were at 50% of its peak and 4,000 MW of wind generation was producing at an 80% capacity factor, the Project's wind generation would amount to about 24% of SPP load.

The other important issue to consider is that SPP already has a large amount of wind generation installed and planned with electrical outputs that are largely coincident in its times of production with the Project's wind generation. As of December 31, 2014, over 2,900 MW of wind turbines were installed in Kansas. An even higher number, 3,782 MW were installed in Oklahoma.[6] Wind in western Kansas, the Oklahoma Panhandle and the Texas Panhandle is all significantly coincident, meaning it will tend to produce at the same time. SPP noted this in its most recent wind integration study, finding correlation coefficients in the range of 0.8 to 1.0.[7] This means that wind output will tend to coincide across the western part of the SPP system, placing a strain on the system's response.

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[6] U.S. Department of Energy. Installed Wind Capacity. Available at http://apps2.eere.energy.gov/wind/windexchange/wind_installed_capacity.asp (last accessed April 12, 2015)

[7] SPP Wind Integration Task Force Report, p. 3-19. Available at http://www.uwig.org/CRA_SPP_WITF_Wind_Integration_Study_Final_Report.pdf (last accessed April 12, 2015).

By delivering western Kansas wind to the MISO and PJM systems, Grain Belt Express actually makes it easier to manage the wind variability. Wind resources in MISO and PJM states have a low correlation with western Kansas resources, meaning they tend to produce at different times and yield a combined, steadier shape of output. Grain Belt Express hired the Brattle Group to study the Project's impact on ancillary services, and they found that the geographic diversity of the wind generation delivered by the Project would actually reduce ancillary service costs. See Supp. Ex. 14.

A final advantage of managing wind variability in the MISO and PJM systems is the strength of their transmission systems. The substation nearest the Project's interconnection point in MISO (Ralls County, Missouri) has five 345 kV outlets, one more than the point of interconnection in Kansas. The Project's interconnection with PJM's system provides direct access to the PJM 765 kV system enabling higher power flows than are possible in a 345 kV system. Given the strength of their transmission systems, MISO and PJM are better positioned than SPP to receive the output and manage the variability of the Project's connected wind generation.