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Witness: Michael Goggin
Sponsoring Party: Wind on the Wires &
The Wind Coalition
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MISSOURI PUBLIC SERVICE COMMISSION

DOCKET NO. EA-2014-0207

CROSS REBUTTAL TESTIMONY

OF

MICHAEL GOGGIN

SUBMITTED ON BEHALF OF:

WIND ON THE WIRES and THE WIND COALITION

OCTOBER 14, 2014

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1. INTRODUCTION

Q: Please state your name, job title, and business address.

A: My name is Michael Goggin, and I am the Director of Research for the American Wind Energy Association ("AWEA"). My business address is 1501 M St NW, Suite 1000, Washington DC, 20005.

Q: For whom are you testifying?

A: I am testifying on behalf of Wind on the Wires and The Wind Coalition (collectively referred to as 'Clean Energy Intervenors').

Q: Are you the same Michael Goggin who previously testified in this proceeding on behalf of Wind on the Wires and The Wind Coalition?

A: Yes.

Q: What is the purpose of your testimony?

A: The purpose of my cross rebuttal testimony is to respond to the rebuttal testimony of Missouri Public Service Commission Staff witness Sarah L. Kliethermes and Show-Me Concerned Land owners' witness Michael Proctor. My testimony responds to Ms. Kliethermes's comments on the impact wind energy delivered to Missouri via the Grain Belt Express direct current transmission line ("GBE Project" or "Project") would have on ancillary services costs and conventional generator cycling costs, and to Mr. Proctor's comments about Missouri's ability to meet its renewable energy needs from MISO states at a cost lower than the cost of wind from Kansas via the GBE Project.

Q: Please summarize your recommendation and findings.

A: I explain why Ms. Kliethermes's concerns about costs and other impacts associated with integrating wind energy are unfounded. I also explain why significant transmission congestion would prevent Mr. Proctor's assumed alternative, the development of wind generation in other parts of MISO, from being a viable alternative to the Project.

2. RESPONSE TO STAFF OF THE MISSOURI PUBLIC SERVICE COMMISSION

Q: Staff witness Sarah Kliethermes, on pages 19-31 of her rebuttal testimony, argues that the production cost, fuel use, and emissions savings benefits of the GBE Project may be mitigated by two factors related to wind energy's variability: Increased utilization of less efficient simple cycle gas combustion turbines, and operation of thermal units outside of their most efficient load levels due to increased cycling. Are you aware of studies that have analyzed the impact of these factors?

A: Yes, a number of wind integration studies have examined the impact of wind variability on the operation of other generators, including their production costs, fuel use and emissions. The impact of wind on gas combustion turbine usage and fossil generator cycling were included in the National Renewable Energy Laboratory's Western Wind and Solar Integration Study Phase 2, which was released last year. That study found that with 25% wind energy and 8% solar energy on the Western U.S. power system, renewable energy variability had a "negligible" impact on wind's emissions and fuel savings benefits, with cycling reducing wind's fuel use and emissions savings by 0.2% so that wind produces 99.8% of the expected emissions savings after cycling is taken into account.[1] The study also found that adding wind generation reduces simple cycle gas generation and cycling, noting that "Wind causes a

[1] "Negligible" terminology included in study fact sheet, available here: http://www.nrel.gov/docs/fy13osti/57874.pdf Full study available here: http://www.nrel.gov/docs/fy13osti/55588.pdf

significant reduction in CT cycling (and generation)."[2] Similar results were found in PJM's renewable integration study, with higher levels of renewable generation producing the expected emissions reductions, consistent with the lbs/MWh of emissions reductions achieved at lower penetrations of renewable energy. O&M costs associated with cycling conventional generation were analyzed in the NREL Western study and another study conducted by Xcel Energy in Colorado, and these costs were found to be a very small fraction of the total production cost savings provided by wind energy.[3] Regardless, as NREL has documented, the introduction of any low-cost generator to the power system would similarly increase the cycling of existing generators.[4] As a result there is no compelling case that wind generators should be viewed as "causing" these cycling costs, and a more compelling case could be made that these costs are caused by and should be attributed to the inflexibility of the existing generators.

Q: On page 22 of her testimony, Kliethermes states that with the additional wind generation delivered by GBE, "I would expect the simple cycle combustion gas turbines to generate significantly more often. These resource types will be necessary to accommodate for real-time deviations in the amount of wind energy delivered into northeast Missouri, as well as to provide regulation and ramping services through the ancillary services markets." Have wind integration studies examined how greater use of wind energy and its associated variability affects the quantity of generation from simple cycle gas combustion turbines?

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[2] http://www.nrel.gov/docs/fy13osti/55588.pdf, at page xix
[3] *Ibid.*, and http://variablegen.org/wp-content/uploads/2013/01/11M-710E_WindInducedCoalPlantCycling.pdf
[4] http://www.nrel.gov/docs/fy11osti/51860.pdf, pages 11-16

A: Yes. All studies I'm aware of that have examined that issue have found greatly reduced utilization of gas combustion turbines at higher wind penetrations. PJM's renewable integration study[5] shows Simple Cycle Gas Turbine (SCGT) generation significantly decreasing as the use of renewable energy increases. A California renewable integration study[6] shows gas turbine generation declining (moving down the y-axis) as renewable generation increases (moving from the pink and yellow lines to the blue lines). The New England Wind Integration Study[7] also shows Gas Turbine (GT) generation declining as wind generation increases. My understanding is that the forthcoming Minnesota wind integration study, which modeled MISO power system operations, found similarly reduced generation from gas combustion turbines.

Q: What is the impact of wind generation on the need for, and cost of, ancillary services?

A: A number of wind integration studies have examined wind's integration cost and wind's impact on the need for ancillary services. The PJM wind integration study found that increasing renewable generation from 2% to 14% of PJM's electricity supply by adding 28,000 MW of wind generation would only increase the need for regulation reserves by 340 MW, or about 1.2 MW of reserves for every 100 MW of added wind capacity. For comparison, PJM currently holds 3,350 MW of expensive, fast-acting contingency reserves 24/7 to ensure that it can keep the lights on in case a large fossil or nuclear power plant unexpectedly breaks down.[8] Similarly, ERCOT data indicate that around 10,000 MW of wind capacity have increased ERCOT's regulation reserve needs by less than 50 MW

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[5] http://www.pjm.com/~/media/committees-groups/task-forces/irtf/postings/pjm-pris-final-project-review.ashx, at slide 55
[6] http://variablegen.org/wp-content/uploads/2013/01/CEC-500-2007-081-APB.pdf, page 98
[7] http://variablegen.org/wp-content/uploads/2013/01/newis_report.pdf, at page 213

on average.[9] I used ERCOT reserve pricing information to calculate that the cost of wind's incremental reserve need is only 4.3 cents per typical Texas electric bill, about 1/17 of the cost of reserves used to accommodate conventional power plant failures.[10] Studies in MISO and SPP have produced similar results. The Nebraska Power Association wind integration study, conducted by NREL, found that up to 40% wind energy could be accommodated SPP-wide with an integration cost of around $2/MWh of wind energy. A Minnesota wind integration study found that reaching 25% wind energy would only increase regulation reserve needs by about 20 MW and load following reserves by 24 MW.[11]

Q: Why does wind generation have such low integration costs and reserve needs?

A: Several factors explain why wind's variability has such a small impact. It is important to understand that grid operators only have to accommodate the aggregate variability of all sources of supply and demand on the power system and do not care about the variability of any one source of supply. Because wind plants are spread over large areas, it is common for the output of one project to increase while another's is decreasing, canceling out the total wind variability. Because wind variability is typically uncorrelated with load variability and other sources of supply variability at sub-hourly time scales, these different sources of variability tend to cancel each other out through the statistical principle that their combined variability is equal to the square root of the sum of their squares. This calculation has the effect that smaller sources of variability, such as wind,

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[8] http://www.pjm.com/~/media/committees-groups/committees/mic/20140303/20140303-pjm-pris-final-project-review.ashx, page 111

[9] http://variablegen.org/wp-content/uploads/2012/12/Maggio-Reserve_Calculation_Methodology_Discussion.pdf

[10] http://aweablog.org/blog/post/fact-check-winds-integration-costs-are-lower-than-those-for-other-energy-sources

[11] http://variablegen.org/wp-content/uploads/2013/01/windrpt_vol-1.pdf, page xvii

have a trivial impact on total variability relative to larger sources of variability, such as load.

Another factor is that wind's variability is slower than other sources of variability, with wind typically showing little change in output from minute to minute and typically only seeing significant changes over the course of 30 minutes or more. In contrast, the contingency reserves that are held to accommodate the forced outages of large generators are far more expensive because they are faster-acting. Moreover, changes in wind output can be forecast with a relatively high degree of accuracy using wind energy forecasting techniques, while conventional generator forced outages cannot be predicted. Advanced wind energy forecasting techniques are in use in MISO and SPP.[12]

By causing conventional generators to have their output dispatched down, wind generation also tends to reduce the price of ancillary services. At least one study has shown that at high levels of wind penetration, even though the total quantity of operating reserves can increase modestly, the total cost of operating reserves is actually reduced.[13]

Q: Ms. Kliethermes, on page 40 of her rebuttal testimony, suggests that the GBE should perform a detailed study of ancillary service cost impacts of the GBE Project. What is your reaction to this proposal?

A: Virtually all wind integration studies to date have been conducted by ISOs, utilities, or government entities working closely with ISOs or utilities. A primary reason is that, as explained above, all sources of supply and demand variability must be accounted for. Some of the variability associated with wind generation transmitted via the GBE Project would be canceled out by variability at other wind plants in the region, while much of

[12] http://variablegen.org/wp-content/uploads/2012/11/windinmarketstableOct2011.pdf

the remaining variability would be canceled out by uncorrelated load and conventional generation variability. It is more appropriate to do such studies on a grid operator-wide basis so that all sources of variability and all flexible resources that could be utilized are considered, as has been done in the numerous studies discussed above. On a more practical level, grid operators are often the only ones that have the detailed information, such as generator-specific dispatch patterns and ramp-rate limits and transmission system topology, required to conduct such an in-depth wind integration analysis.

3. RESPONSE TO SHOW ME CONCERNED LAND OWNERS

Q: Show Me Concerned Land Owners' witness Proctor, on page 26 of his rebuttal testimony, suggests that the GBE Project may not be needed because it is more economical to purchase wind from high wind regions in northwestern MISO. What is your response?

A: Due to severe transmission congestion in northwestern MISO that has greatly limited wind deliverability and is causing widespread wind curtailment, the development of renewable energy in northwestern MISO is not a viable alternative to the construction of GBE. Mr. Proctor's analysis of Financial Transmission Rights looks at the price of these congestion rights MISO-wide, and finds that the average cost across the MISO footprint is relatively low. However, his MISO-wide analysis does not answer the more relevant question of the pricing of FTRs in the parts of northwestern MISO where new wind development would occur, and thus the amount of transmission congestion in that area.

Data from the 2013 Annual Wind Technologies Market Report, prepared by the Department of Energy and Lawrence Berkeley National Laboratory

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[13] http://www.nrel.gov/docs/fy13osti/58491.pdf, page 31

and released in August 2014, shows that in 2013 wind curtailment increased significantly in MISO as transmission congestion grew. Specifically, 4.6% of all wind generation that would have been produced in MISO was curtailed in 2013, and in the Northern States Power footprint in Minnesota that number was even higher at 5.9%. These figures are up drastically from the 2.5% and 3%, respectively, seen in 2012. The MISO level of curtailment is significantly higher than the levels seen in all other regions examined in the report, all of which were below 2% in 2013.[14]

As explained in my Direct testimony, there is no viable alternative other than new transmission for delivering the high-quality wind resources in areas to the west of Missouri to Missouri and other points eastward. What little west-east transmission existed in that area has been fully subscribed and is now heavily congested, preventing the economic delivery of further wind generation over those lines. The GBE Project is critical for enabling further wind development to occur and for additional low-cost wind to be delivered to Missouri. As I explained in my Direct testimony, transmission congestion and wind curtailment impose a major economic cost on wind developers and utilities purchasing wind energy, and are a major impediment to further wind development in congested areas. As such, the development of renewable energy in northwestern MISO, or any other area, is not a viable alternative to the construction of GBE

Q: Does this conclude your testimony?

A: Yes.

[14] http://emp.lbl.gov/sites/all/files/2013_Wind_Technologies_Market_Report_Final3.pdf, page 51