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REBUTTAL TESTIMONY

OF

MICHAEL GOGGIN

SUBMITTED ON BEHALF OF:

WIND ON THE WIRES and THE WIND COALITION

JANUARY 24, 2017

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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 Senior 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: Have you testified in proceedings in front of the Public Utilities Commission ("PUC") before?

A: Yes, I testified in docket no. EA-2014-0207 and in several transmission proceedings before the Illinois Commerce Commission, the Minnesota Public Utilities Commission and the Public Service Commission of Wisconsin.[1]

Q: What is your background and educational experience?

A: I have covered transmission and grid integration issues for AWEA since February 2008.[2] Before that, I worked for Sentech, Inc., an energy consulting firm, and for

[1] The Illinois Commerce Commission transmission cases include the Illinois Rivers project (ICC Docket No. 12-0598), Rock Island Clean Line project (Docket No. 12-0560), and Grand Prairie Gateway project (ICC Docket No. 13-0657), the case in Minnesota was the Interstate Transmission Company's Minnesota to Iowa 345 kV line (MN PUC Docket No. ET6675/CN-12-1053) and the case in Wisconsin was American Transmission Company's Badger-Coulee line (WI PSC Docket No. 5-CE-142).

[2] *See* Résumé of Michael Stephen Goggin attached as Schedule MG-1.

two environmental advocacy groups before that. I have an undergraduate degree with honors from Harvard University.

Q: What is the purpose of your testimony?

A: I provide testimony responding to Grain Belt Express witnesses Skelly, Berry, Kelly and Copeland. My testimony supports the finding that the Grain Belt Express Project ("GBE Project" or "Project") will allow greater amounts of low-cost wind energy resources to reach consumers in Missouri as well as other states in the Midcontinent Independent System Operator, Inc. (MISO) and PJM LLC (PJM) grid operating areas. The combination of the GBE Project and the Kansas wind resource yields low cost energy that is needed and in the public interest of electricity consumers in Missouri, MISO and PJM. In addition, the increased use of renewable energy instead of fossil generation provides energy diversity, health benefits from emission reductions, and will be an effective way to meet current and future emission standards.

Q: Please outline your testimony.

A: My testimony will address the need for the project, how it is in the public interest and its economic feasibility. First, I explain the wind industry's interest in developing and delivering wind energy from Kansas. Second, I discuss the need for wind energy in Missouri, PJM and MISO. Third, I discuss the public's interest in the transmission line because it delivers wind energy that: lowers wholesale electric prices; can be a cost effective replacement for energy from retiring

generation; provides energy security and a hedge against price volatility of fuel used for conventional generating plants; provides energy at comparable or lower cost than alternative forms of generation; and diversifies the portfolio of generation used to meet energy demands. In addition, the public benefits from wind energy reducing air pollution that harms public health and increases medical costs.

2. THE GBE PROJECT

Q: What is your understanding of the purpose of the GBE Project?

A: As explained in the direct testimony of GBE witness Skelly and other Grain Belt Express witnesses, the GBE Project is a 780 mile 600kV direct current transmission line capable of transmitting 4,000 megawatts of electricity -- primarily low cost wind energy -- that could be used by consumers in Missouri and the 18+ other states in MISO and PJM. A bi-directional converter station is planned for Ralls County, Missouri that is capable of converting 500 megawatts ("MW") of energy into alternating current for use by Missouri utilities, and allowing Missouri utilities to inject excess power onto the Project that can be sold to PJM. The primary benefit is that it provides Missouri, MISO and PJM states significantly greater access to underutilized and low-cost wind energy resources in Kansas.[3] The secondary benefit is greater access to markets and competition which will result in additional savings to Missouri consumers.

[3] Direct Testimony of Michael P. Skelly on behalf of Grain Belt Express Clean Line LLC, Exh. ___ at 3-4, 15 and 19 (August 30, 2016).

Q: Have similar transmission line projects been developed to connect wind resources to areas of large electricity demand?

A: Yes, the Competitive Renewable Energy Zone, or CREZ, lines in Texas were built to connect remote wind resources primarily in West Texas to load centers located to the East. This transmission expansion has significantly reduced electricity costs for Texas consumers.[4]

Q: Was CREZ effective in interconnecting wind energy resources to areas of large electricity demand?

A: Yes, the CREZ lines were completed in 2014, and have already experienced overwhelming interest from wind developers who would like to interconnect to the new lines. The most recent ERCOT planning report indicates ERCOT now has over 17,500 MW of installed wind capacity, up from 11,000 MW in 2013, with the vast majority of these interconnections occurring in areas that are newly served by the CREZ lines. An additional 6,000 MW of wind projects have signed interconnection agreements and paid deposits to connect to the ERCOT grid over the next several years.[5] In fact, wind developer interest has been so great that ERCOT has already begun further transmission upgrades in the Texas Panhandle region that would allow further wind development to interconnect in that area. As ERCOT notes, "The Panhandle region is currently experiencing

[4] LCG Consulting, "Market Effects of Wind Penetration in ERCOT," October 2016, available at http://www.energyonline.com/Reports/Files/ERCOTWindPenetrationStudy_EXEC.SUMMARY.pdf
[5] ERCOT, "ERCOT Monthly Operational Overview," December 2016, available at http://www.ercot.com/content/wcm/key_documents_lists/27311/ERCOT_Monthly_Operational_Overview_2016-12.pdf, page 19

significantly more interest from wind generation developers than what was initially planned for the area."[6]

3. WIND ENERGY IN KANSAS

Q: What is your understanding of the wind resource in Kansas?

A: Kansas has some of the best wind resources in the country, with much of the best wind resource located in the part of western Kansas that would be served by GBE. One indicator of that is the United States Department of Energy's National Renewable Energy Laboratory's ("NREL") wind resource assessment data, which shows that Kansas has 952,371 megawatts (MW) of developable wind energy resources, as can be seen in Schedule MG-2.

NREL's data indicate that Kansas's wind potential accounts for around 9.4% percent of the total onshore wind energy potential in the United States. Kansas's wind resources could provide enough electricity to meet the equivalent of the current electricity needs of the U.S. at least two times over.

Kansas has some of the best onshore capacity factors of any resources in the United States. Since higher capacity factors translate to lower electricity costs, access to such renewable resources can reduce the cost of electricity from what it would have been with lower capacity wind resources. In markets such as Missouri and PJM, access to such resources has the potential to lower consumer costs.

[6] ERCOT, "Panhandle Renewable Energy Zone (PREZ) Study Report", at I (April 2014).

Q: Are NREL's wind resource assessments accurate?

A: If anything NREL's assessments are likely to be conservative, as they assume the use of wind turbines with a hub height of 80 meters and do not include the use of new low-wind-speed turbines. Many wind turbines being installed today have rotor diameters in excess of 100 meters and hub heights of 100 meters or more, providing access to significantly greater wind energy resources. Large rotor wind turbines are being used in all regions of the country, particularly Kansas and other parts of the Interior region, to increase wind power output and reduce cost.[7] In addition, NREL's database assumes that significant amounts of land would be excluded from wind energy development because it is currently used for other purposes.[8] Regardless, the data is clear that Kansas has great wind energy resources that far exceed the electricity needs of both MISO and PJM.

Transmission lines are a major factor that determine how much of the potential wind energy in the Plains states can be utilized by customers in Missouri and other states. To capitalize on these wind-rich areas, wind energy resources need cost-effective access to transmission lines, such as the GBE Project.

[7] Lawrence Berkeley National Laboratory, 2015 Wind Technologies Market Report, at 30 (August 2016) available at https://emp.lbl.gov/sites/all/files/2015-windtechreport.final_.pdf

[8] NREL, Estimates of Windy Land Area and Wind Energy Potential, by State, for areas >=30% Capacity Factor at 80m ("NREL Wind Energy Estimates"), (April 13, 2011). The document can be found at:

Q: Can you quantify the quality of wind resources in these areas?

A: As indicated in Schedule MG-2, the quality of the wind resources is high across the region, though it is highest in western Kansas. Importantly, the energy available for wind energy production is proportional to the cube of wind speed, so the difference between the orange and purple areas in the wind speed map in schedule MG-2 is actually quite significant. For example, the 8.5-9 meter/second area of the map, which is the dark purple area that covers significant parts of Kansas, has about 76% more energy available from wind than the 7.0-7.5 meter/second dark orange area that covers parts of Missouri, Illinois and Indiana, and 274**%** more energy available from wind than the 6.0-6.5 meter/second brown areas that indicate some of the best wind resources available in PJM.

Q: How do wind energy prices from generation in Kansas compare to wind energy prices from generation in MISO and PJM?

A: Power Purchase Agreement ("PPAs") prices (inclusive of the production tax credit) in the Interior region[9] have averaged around $27 per megawatt-hour ("MWh") between 2013 and 2016, versus $40/MWh for the Great Lakes region (between 2013 and 2015) and $57/MWh for the Northeast (for 2012 and 2013). (See schedule MG-3) Recent projects in Kansas have offered some of the lowest-priced wind energy available in the country.

[9] The Interior Region includes: Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas, Wyoming, Montana, Colorado and New Mexico. Lawrence Berkley National Laboratories, "2015 Wind Technologies Report" at 85, Fig. 55 (August 2016).

Differences in PPA prices between the regions is mostly attributable to the higher capacity factors in the Interior region but are also influenced, to a lesser extent, by differences in land and construction costs. As documented in MISO's MVP Report, building wind in a mix of high and low capacity factor regions (See schedule MG-4), relative to building in mostly lower capacity factor regions to be closer to load, achieves the same level of wind energy output with an 11% reduction in the nameplate capacity of wind that must be deployed, with a corresponding 11% reduction in wind energy capital costs.[10]

Q: How easy is it for a wind project in Kansas to deliver its wind to areas outside of the Southwest Power Pool?

A: Transmission is essential, both for allowing wind resources to be developed and enabling already developed wind resources to not have their wind energy output curtailed. In areas where transmission constraints prevent wind energy from being delivered to customers, there is no cost-effective substitute for increasing transmission capacity to alleviate those constraints.

At this time there are no transmission projects comparable to the Grain Belt Express Project being considered by MISO, SPP and PJM. No transmission projects have been built between SPP and MISO since SPP was created in 2004[11], and to my knowledge there have been no other transmission service

[10] MISO Multi Value Project Portfolio: Results and Analyses ("MVP Report") at 66.
[11] International Transmission Co., Comments of International Transmission Company d/b/a ITC Transmission, Michigan Electric Company, LLC, ITC Midwest LLC and ITC Great Plans, LLC, at 2-3 (July 1, 2014), *filed in* Missouri PSC Docket EW-2014-0156.

requests between SPP and MISO. SPP's transmission planning policies are currently structured entirely around planning transmission to meet SPP demand, with no consideration for planning lines to meet export demand. That policy would have to change before SPP would likely even begin planning a transmission line to serve export demand, which means it is extremely unlikely any line of that type would enter service this decade. Transmission is essential if the wind energy resources in Kansas and the Plains states are to be fully utilized in meeting the renewable energy needs of the U.S. As the NREL data in Schedule MG-2 indicates, the western Kansas area and the Plains states' possess wind resources that are many times greater than their local demand for electricity, so transmission is needed to move the energy from these wind energy resources to load centers elsewhere. Kansas is on the western edge of the Eastern Interconnection, making export west exceedingly difficult, and as I discussed above, opportunities to move that energy eastward to load centers over existing transmission are virtually non-existent. Areas north and south of Kansas also have very large wind energy resources and relatively low electricity demand, so delivering the wind energy from Kansas to those states is not a viable solution. Given the large electricity demand in Missouri, MISO and PJM, building transmission to deliver wind energy resources in western Kansas to consumers in those states is an ideal solution.

Q: What level of interest has the wind industry expressed in the Grain Belt Express Project?

A: Grain Belt Express issued a request for information in 2014 to gauge wind generators' interest in buying service on the GBE Project. News articles state that wind developers with over 13,500 megawatts of planned wind power development in western Kansas responded favorably to the request. I'm also aware that Grain Belt Express held an open solicitation in 2015 for bids to purchase capacity of the Project and that the amount of capacity requested by bidders was multiples higher than what is available on the line.

In addition, there is a lot of interest from utilities and corporations to enter into long-term PPAs with wind energy resources. The interest is in part spurred by a desire to secure the output of wind projects before the wind production tax credit (PTC) is phased out in 2020. The PTC phases down in increments of 20 percentage points per year for projects starting construction in 2017 (80% PTC), 2018 (60%), and 2019 (40%). IRS guidance specifies that a wind project has four years to come online after qualifying for the PTC, so projects that qualified for the full value of the PTC in 2016 have until 2020 to come online, though additional time can be available for wind projects that are postponed due to delays in building necessary transmission infrastructure.[12]

[12] IRS, Notice 2016-31, 2016, available at https://www.irs.gov/pub/irs-drop/n-16-31.pdf, page 7

4. THE GBE PROJECT IS NEEDED AND IN THE PUBLIC INTEREST

Q: What are the drivers for wind energy delivered by the GBE?

A: In their testimony the GBE witnesses identified a demand for wind energy in Missouri, MISO and PJM and I agree with that. There are multiple factors in each of the three jurisdictions driving a need for wind energy including: [1] compliance with state renewable energy standards; [2] use of wind energy as a cost effective replacement of generating plants that are retiring; [3] increasing demand for wind energy from corporate purchasers; [4] use of renewable energy for compliance with carbon regulations, such as the current or future form of the U.S. Environmental Protection Agency's Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units (Clean Power Plan) [5] the need for energy that lowers wholesale electric prices; [6] need for energy that lowers retail electric rates; and the [7] need to diversify the portfolio of current electric generation.

A. The Project is Needed to Meet Renewable Energy Standards

Q: How are renewable energy standards a driver for wind delivered via the GBE Project?

A: Wind energy delivered through the GBE Project can be used to cost effectively meet renewable energy standards in Missouri, MISO states, and PJM states. Missouri has a renewable energy standard ("RES") that increases from 2% in 2011 to 15% by 2021. At least 2% of the overall RES requirement shall come

from solar resources. After reviewing the compliance plan reports and compliance plans submitted by Ameren Missouri, Kansas City Power and Light and Kansas City Power and Light -- Greater Missouri Operations, and Empire District Electic Company, I've found that Ameren Missouri is the only one with a need for renewable energy for compliance. It appears that it has a need for approximately 4,000,000 megawatt-hours ("MWh") of non-solar renewable energy RECs, which could be provided by approximately 1,200 MW of wind with a capacity factor of 38%.

Missouri utilities can comply with the RES by either purchasing renewable energy plus their renewable energy credits (RECs) or purchasing renewable energy credits without purchasing the renewable energy from a wind or solar energy resource. In the near future it is possible that Missouri utilities will not be able to use RECs for compliance if their energy is not used in Missouri. Before the Missouri Supreme Court is a case (State of Missouri ex rel. Missouri Coalition for the Environment v. Joint Committee on Administrative Rules, docket no. SC95546) that would reinsert language into the RES rule (4 CSR 240-20.100(2)(B)(2))) allowing a REC to be used for compliance with the RES only if the REC is tied to energy that was sold to Missouri customers. For this certificate case, that would mean that wind energy delivered via the Project would compete with wind energy resources in Missouri and MISO to fulfill any remaining RES requirements. This additional competition benefits Ameren Missouri's ratepayers

by placing pressure on bidders to submit low prices or risk not being selected for a contract.

Q: How can wind energy delivered via the Project be used in MISO and PJM?

A: There are fourteen states and the District of Columbia in MISO and PJM that have renewable energy standards and three that have renewable energy goals. Most states in PJM allow renewable energy delivered anywhere in the PJM footprint to qualify for compliance with their state renewable energy standard. From these states I estimate a need for an incremental addition of around 4,310 MW of wind capacity above their current levels by the year 2025. See schedule MG-5.

B. The Project is Needed to Replace Retiring Generation

Q: How are generation retirements a driver for wind delivered via the GBE Project?

A: A large number of generating plants are either reaching the end of their useful lives or are being found to no longer be economic due to changes in the market or in regulation. This generation will need to be replaced and wind energy offers a low cost replacement for a significant portion of the energy needs those plants provide. Publically available data on energy costs, such as Lazard[13], has wind as the lowest cost form of new electricity generation.

[13] Lazard, "Levelized Cost of Energy Analysis 10.0", at 2 (Dec 16, 2016), available at https://www.lazard.com/media/438038/levelized-cost-of-energy-v100.pdf

As of September 30, 2016 PJM had an average installed capacity of 192.9 gigawatts (GW).[14] Of that, 76 GW are coal plants. Of the 76 GW, 51.8 GW are over 40 years old.[15] The forecast is that another 5 GW of generating plants will retire between 2016 and 2020.[16] However, PJM has calculated that carbon regulation could cause as much as 24GW of generating capacity in PJM to retire.[17]

As of Summer 2016, MISO had an average installed capacity of 142.8 GW.[18] Of that, 59 GW are coal plants (unforced capacity).[19] The average age of the coal plants in the North and Central regions of MISO, which includes Missouri, is 40 years. MISO projects that approximately 12 to 18.2 GW of generation will retire in its footprint between 2017 and 2032 due to EPA regulations and age related retirements.[20] Capacity levels have been falling in MISO because of generating plant retirements and capacity exports to PJM.[21] Due to continued retirements "MISO may be short of [generating] capacity as soon as 2018."[22] However, if

[14] Monitoring Analytics, "PJM State of the Market Report - 2016", at 514, Table 12-10 ( ) available at http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2016/2016q3-som-pjm-sec12.pdf.
[15] Id. at 515, Table 12-11.
[16] Id. at 510.
[17] PJM, PJM Regional Transmission Expansion Planning Process, at 2 and 4 (August 2016), available at: http://www.pjm.com/~/media/documents/reports/rtep-plan-documents/2016-pjm-rtep-process-brochure.ashx.
[18] Potomac Economics, "2015 State of the Market Report for the MISO Electricity Market", at 12, Table 2 (Nov. 10, 2016) available at http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2016/2016q3-som-pjm-sec12.pdf.
[19] Id. at 5, Table 1
[20] MISO, MTEP16 - MISO Transmission Expansion Plan, at 97-98 and 158 (Dec. 2016).
[21] Id. at 10.
[22] Id. at 11.

carbon regulation moves forward MISO estimates that it could experience plant retirements in the range of 16 to 21 GW.[23]

C. The Project is Needed to Meet the Demand for Wind Energy by Corporate Purchasers

Q: How are corporate purchasers of renewable energy a driver for wind delivered via the GBE Project?

A. Over the past few years the wind industry has seen a large increase in demand for direct purchase of renewable energy by large retail consumers, many of whom prefer direct purchases of wind energy relative to buying Renewable Energy Credits.[24] The availability of wind energy has become an important factor for many corporations in deciding where to site large facilities, like data centers. For example, Facebook recently chose to site a $1 billion data center in Texas and not Ohio because favorable policies, like the CREZ transmission expansion, provided more access to wind energy in Texas than in Ohio.[25] The availability of low-cost wind energy delivered via the Grain Belt Express would help make Missouri attractive for corporations looking to invest in new facilities.

D. The Project is Needed to Meet Future Carbon Regulation

Q: How is carbon regulation a driver for wind delivered via the GBE Project?

A: The EPA finalized rules for the Clean Power Plan on August 3, 2015. It is created pursuant to section 111(d) of the Clean Air Act. Section 111(d) requires

[23] MISO, "MISO's Analysis of EPA's Final Clean Power Plan Study Report", at 40, 41 (June 2016).
[24] AWEA, Corporate Purchasers of Wind Energy, available at http://www.awea.org/corporate-purchasers
[25] https://www.nrdc.org/media/2015/150708-0

the U.S. EPA to regulate emissions that cause or significantly contribute to air pollution that may endanger public health or welfare. Currently, the rule is the subject of a U.S. Supreme Court stay of its implementation until all of the legal challenges are resolved by the court. While there is uncertainty about the rule's implementation under the Trump Administration, in his confirmation hearing EPA Administrator nominee Scott Pruitt indicated that he would not challenge EPA's finding that carbon dioxide emissions endanger public health or welfare, and stated that there is a role for EPA in regulating carbon dioxide emissions.[26]

Many utilities recognize that stringent carbon regulation is inevitable in the long-term, and are therefore continuing to move to lower-carbon forms of generation. For example, Indiana utility Vectren's recent Integrated Resource Plan filing states that "While future carbon regulations are less certain than prior to the election, it is likely that new administrations will continue to pursue a long term lower carbon future. Vectren's preferred portfolio positions the company to meet that expectation."[27] American Electric Power, Xcel Energy, Southern Company, and other large electric utilities have made similar statements since the election, with the CEO of Southern Company noting "It's clear that the courts have given the EPA the right to deal with carbon in a certain way."[28] Given the long lead time to deploy transmission infrastructure (for example, Grain Belt's expected 2021 in-service date falls after the next Presidential election) and the fact that wind and

[26] https://www.c-span.org/video/?421719-1/epa-nominee-scott-pruitt-testifies-confirmation-hearing&live
[27] https://www.vectren.com/assets/cms/pdfs/2016%20Vectren%20IRP%20Non-Technical%20Summary.pdf
[28] http://blogs.edf.org/climate411/2017/01/04/2016-wrap-up-states-and-power-companies-led-the-way-to-cut-carbon/

transmission investments will continue providing zero emission energy for decades, forward-looking utilities continue to invest in transmission and wind. Under the Clean Power Plan as finalized, states are required to develop a compliance plan for reducing carbon emissions from existing generating plants, or offsetting those emissions with the use of lower carbon emitting sources, such as wind energy sources. The compliance period will run from 2022 to 2030. The Clean Power Plan rule specifically allows for the use of renewable energy as a way to comply with the required carbon emission reduction targets. Thus, the GBE Project provides access to lower cost wind energy that Missouri could use to comply with the Clean Power Plan or other future regulation of carbon dioxide emissions from the electric sector. While this line was not planned in anticipation of U.S. EPA requirements, it provides a hedge against any current or future carbon regulation.

Q: What is Missouri's carbon reduction requirement under EPA's Clean Power Plan?

A: Missouri is required to reduce its emissions rate from 2,008 pounds of CO2/MWh to 1,272 lbs/MWh by 2030, a reduction of 36.67%.[29] New wind generation delivered via the Project would help ensure that Missouri can meet that standard or any future standard at low cost. MISO's recent Clean Power Plan analysis estimated that approximately 12 GW of wind generating capacity would be

[29] "Clean Power Plan - State and Tribal Rate and Mass Goals", available at https://www.epa.gov/cleanpowerplantoolbox; also available at https://www.epa.gov/sites/production/files/2016-09/documents/missouri.pdf

needed in addition to what is needed for RES compliance and for corporate purchaser demand.[30]

Q: Do you foresee Missouri having a need for wind resources to comply with section 111(d) requirements?

A: The degree of need will be dictated by the state implementation plan that is developed, and Missouri has the flexibility to decide which combination of solutions it will use to comply. Missouri has a need for the low-cost wind energy provided by the GBE Project to meet or exceed any current or future emission requirements for the state.

E. The Project is Needed to Deliver Energy that Can Lower Wholesale Electricity Prices

Q: Analysis by GBE Witness Copeland supports the finding that the GBE Project will reduce wholesale electricity prices. What is your view of his analysis?

A: In his direct testimony, GBE witness Copeland calculated the total cost savings and locational marginal price reductions in Missouri in 2022 using the five different business scenarios MISO used for its 2016 transmission expansion plan -- Business as Usual, Limited Growth, High Growth, Generation Shift and Public Policy. I've summarized his findings[31] in the following table:

[30] MISO, "MISO's Analysis of EPA's Final Clean Power Plan Study Report", at 41, Fig. 30. (June 2016).
[31] Direct Testimony of J. Neil Copeland on Behalf of Grain Belt Express Clean Line LLC, Exh. ___, at 10-11 and Sched. JNC-2 (Aug. 30, 2016).

Scenario	Total Cost Savings in 2022 ($M)
Business As Usual	**$40**
Limited Growth	**$16**
High Growth	**$63**
Generation Shift	**$76**
Green Economy	**$223**

The savings Mr. Copeland has identified are generally consistent with savings I have seen in other transmission line cases and in studies I have reviewed regarding the impact wind and transmission have on electricity production costs and prices to ratepayers, as discussed below.

Q: How does transmission ensure competitive electricity markets?

A: Transmission infrastructure is a powerful tool for increasing competition in wholesale power markets and reducing the potential for generators to harm consumers by exercising market power. Just as consumers who have access to one local retailer and lack high-quality roads to provide easy access to stores in other regions would be at the mercy of the prices charged by that retailer, similarly, a weak electric grid makes it possible for generation owners in constrained sections of the electric grid to exert market power and charge excessive prices. In any market, the more supply options that are available to an area, the less likely it is that any one of those suppliers will be in a position to exert market power.

In Order 890, FERC explained how transmission constraints can restrict electricity market competition, discussing how those with incumbent generating assets

> can have a disincentive to remedy transmission congestion when doing so reduces the value of their generation or otherwise stimulates new entry or greater competition in their area. For example, a transmission provider does not have an incentive to relieve local congestion that restricts the output of a competing merchant generator if doing so will make the transmission provider's own generation less competitive.[32]

Q: What studies have documented the tendency of wind energy to reduce electricity market prices?

A: A European literature review identified a number of studies that have found wind energy tends to drive electricity market prices downward. As that report explains,

> Wind power normally has a low marginal cost (zero fuel costs) and therefore enters near the bottom of the supply curve. Graphically, this shifts the supply curve to the right, resulting in a lower power price, depending on the price elasticity of the power demand…. When wind power reduces the spot power price, it has a significant influence on the price of power for consumers. When the spot price is lowered, this is beneficial to all power consumers, since the reduction in price applies to all electricity traded – not only to electricity generated by wind power.[33]

A recent report by the American Wind Energy Association summarizes 15 studies by state governments, grid operators, and academics that have documented wind energy's role in reducing electricity prices.[34] For example, an analysis in Massachusetts found that the state's renewable initiatives have

[32] FERC Order 890 at ¶422, *available at* http://www.ferc.gov/whats-new/comm-meet/2007/021507/E-1.pdf
[33] PÖyry, Wind Energy and Electricity Prices, at pages 11 and 12 http://www.ewea.org/fileadmin/ewea_documents/documents/publications/reports/MeritOrder.pdf.
[34] http://awea.files.cms-plus.com/AWEA%20White%20Paper-Consumer%20Benefits%20final.pdf, at page 4

annual net benefits of $219 million.[35] Finally, analysis in PJM found that doubling the use of wind energy beyond existing RPS requirements would produce net savings for consumers of $6.9 billion per year.[36]

Several analyses by Charles River Associates ("CRA"), International have quantified the value of these broad-based benefits. One study looked at an investment in a high-voltage transmission overlay to access wind resources in Kansas, Oklahoma, and Texas. It concluded the transmission investment would provide economic benefits of around $2 billion per year for the region, more than four times the $400-500 million annual cost of the transmission investment.[37] $900 million of these benefits would be in the form of direct consumer savings on their electric bills, with $100 million of these savings coming from the significantly higher efficiency of high-voltage transmission, which would reduce electricity losses by 1,600 gigawatt-hours ("GWh") each year. The remainder would stem from reduced congestion on the grid allowing customers to obtain access to cheaper power.

Similarly, CRA's analysis of the proposed Green Power Express, which would connect 17 GW of wind to the grid in the MISO region, found that the

[35] Recent Electricity Market Reforms in Massachusetts: A Report of Benefits and Costs (July 2011), *available at* http://www.mass.gov/eea/docs/doer/publications/electricity-report-jul12-2011.pdf.
[36] Synapse Energy Economics, The Net Benefits of Increased Wind Power in PJM, (May 2013), *available at* http://cleanenergytransmission.org/uploads/EFC%20PJM%20Final%20Report%20May%209%202013.pdf.
[37] CRA International, First Two Loops of SPP EHV Overlay Transmission Expansion: Analysis of Benefits and Costs (September 26, 2008) *available at* https://www.spp.org/documents/8272/analysis_of_benefits_two_loop_sppfinal.pdf

transmission plan would yield benefits of $4.4 to $6.5 billion per year for the region (in 2008 dollars), well above the annualized cost of the transmission, estimated to be between $1.2 billion and $1.44 billion.[38] In his FERC affidavit presenting those results, Mr. Stoddard with CRA noted that "I have confirmed with Dr. Shavel that these energy cost savings are widely dispersed through the study Region, but this conclusion is logically necessary: considering the small amount of load located in the upper Great Plains, savings of this order of magnitude could only be realized if the combination of lowered energy prices in the major load centers to the east."[39]

In addition, a May 2012 report by Synapse Energy Economics found that adding 20 to 40 GW of wind energy and the accompanying transmission in the MISO region would reduce the cost of the wholesale electricity needed to serve a typical home by between $63 and $200 per year.[40] As illustrated in schedule MG-6, this report found that electricity market prices decrease drastically as more wind capacity is added to the MISO system. As the report explains, "Since wind energy 'fuel' is free, once built, wind power plants displace fossil-fueled

[38] FERC Docket ER09-1431, Protest of NextEra Energy Resources, LLC, Iberdrola Renewables, Inc., Mesa Power Group, LLC, Horizon Wind Energy LLC, Enxco, Inc., Acciona Wind Energy USA LLC, GE Energy, Vestas Americas and the National Resources Defense Council. Affidavit of Robert Stoddard, page 4, *available at* http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=12111601.
[39] Id.
[40] Synapse Energy Economics, Inc., The Potential Rate Effects of Wind Energy and Transmission in the Midwest ISO Region, at page 3 (May 22, 2012) http://cleanenergytransmission.org/wp-content/uploads/2012/05/Full-Report-The-Potential-Rate-Effects-of-Wind-Energy-and-Transmission-in-the-Midwest-ISO-Region.pdf.

generation and lower the price of marginal supply—thus lowering the energy market clearing price."[41]

Q: Have other utilities noted the consumer benefits of wind energy?

A: Yes, the AWEA report discussed above documents a number of quotes from utilities and state regulators confirming the savings wind energy is providing to their ratepayers.[42] Notable examples include statements made when American Electric Power subsidiary Southwestern Electric Power Co. ("SWEPCO") signed long-term power purchase agreements for a total of 358.65 MW from wind projects in Texas, Oklahoma and Kansas. SWEPCO said in a news release that it estimated an average decrease in cost to its customers of about 0.1 cents per kilowatt-hour over a 10-year period starting in 2013.[43]

As another example, Oklahoma Gas and Electric estimates that a single wind project will save Arkansas customers $46 million.[44]

As a final example, Alabama Power, a subsidiary of Southern Company, has made several recent wind power purchases. John Kelley, Director of Forecasting and Resource Planning, explained that "These agreements are good for our

[41] Id.
[42] http://awea.files.cms-plus.com/AWEA%20White%20Paper-Consumer%20Benefits%20final.pdf at page 5
[43] AEP Southwestern Electric Power Company, AEP SWEPCO Signs Wind Power Purchase Agreements for 359 Megawatts, (1/25/2012), *available at* https://www.swepco.com/info/news/ViewRelease.aspx?releaseID=1183
[44] Direct Testimony of Gregory W. Tillman before the Arkansas Public Service Commission, (August 2012), *available at* http://www.apscservices.info/pdf/12/12-067-u_2_1.pdf.

customers for one very basic reason, and that is, they save our customers money."[45]

F. The Project Can Deliver Energy that is Comparable or Lower Cost than Alternative forms of Generation

Q: GBE Witness Berry's analysis supports the finding that the GBE Project can deliver energy at rates comparable to other generation. What is your view of his analysis?

A: In his direct testimony, GBE witness Berry calculated the levelized cost of energy (LCOE) for the Project. The LCOE takes into account all costs of generating wind energy, including capital costs, operating costs, taxes, cost of debt, return on equity, available subsidies, and the necessary transmission additions. It serves as a proxy for a power purchase agreement price that a utility would enter into. The LCOE for the wind energy delivered by the GBE project would be in the range of 2.2 to 2.8 cents per kWh.[46] That is less than the levelized cost of a new combined cycle natural gas plant.[47] It is also less than the generation weighted average levelized wind power purchase agreement price for the Great Lakes region of 3.8 cents per kWh in 2015, as indicated in schedule MG-3 and confirmed by the project-specific data for MISO discussed above. Wind energy transferred through the GBE Project would provide access to lower-cost renewable energy.

[45] Alabama Power, Alabama Power among leaders in SE in wind power, (October 2012), *available at* http://www.youtube.com/watch?v=6q6Q0_C1SX0 at 2:25.
[46] Direct Testimony of David Berry on Behalf of Grain Belt Express Clean Line LLC, Exh. ___ at 27:16 - 31:2 (Aug. 30, 2016).
[47] Lazard, "Lazard's Levelized Cost of Energy Analysis - Version 10", at 2 (December 2016) available at https://www.lazard.com/media/438038/levelized-cost-of-energy-v100.pdf

Q: Based on the data presented by GBE do you believe the project is economically feasible?

A: Yes I do. GBE witness Berry estimated the energy cost plus transmission cost to deliver wind energy via the GBE project and found it to be in the range of 2.2 to 2.8 cents per kWh[48] for the normal customer, which is below the average cost of PPAs for Missouri, MISO and PJM over the last three years, as reflected in schedule MG-3.

G. The Project Can Act as a Hedge Against Fuel Price Volatility

Q: Does transmission help to hedge against uncertainty and protect consumer from risk?

A: Yes. Transmission is an important mechanism to protect consumers against unpredictable volatility in the price of fuels used to produce electricity, particularly natural gas. Transmission can alleviate the negative impact of fuel price fluctuations on consumers by making it possible to buy power from other regions and move it efficiently on the grid. This increased flexibility helps to modulate swings in fuel price, as it makes demand for fuels more responsive to price as utilities are able to respond to price signals by decreasing use an expensive fuel and instead importing cheaper power made from other sources.

[48] Direct Testimony of David Berry on Behalf of Grain Belt Express Clean Line LLC, Exh. ___ at 27:16 - 31:2 (Aug. 30, 2016).

Wind generation itself also provides significant hedging value against fuel price fluctuations, so the hedging benefit of transmission is even larger for transmission that connects new wind generation, such as the GBE project. A recent Lawrence Berkeley National Laboratory report concluded that

> Comparing the wind PPA sample to the range of long-term gas price projections reveals that even in today's low gas price environment, and with the promise of shale gas having driven down future gas price expectations, wind power can still provide long-term protection against many of the higher-priced natural gas scenarios contemplated by the EIA [United States Energy Information Administration]."[49]

An example of the long term value of wind as a hedge against uncertain natural gas prices is presented in schedule MG-7. This graph compares the future stream of wind PPA prices (based on contracts executed in 2014, 2015 and 2016) against EIA's latest projections of the fuel costs of natural-gas fired generation. The conclusion I draw from the chart is that the wind PPA prices are highly likely to be lower than the cost of natural gas generation over the life of a 20 year PPA contract.

Going forward, a robust transmission grid can provide valuable protection against a variety of uncertainties in the electricity market. Fluctuations in the price of fossil fuels are likely to continue, particularly as the electric sector becomes more reliant on natural gas. Further price risk associated with the potential enactment of environmental policies, including carbon regulations, place a further premium

[49] Lawrence Berkeley National Laboratory, Revisiting the Long-Term Hedge Value of Wind Power in an Era of Low Natural Gas Prices, page i,(March 2013) *available at* http://emp.lbl.gov/sites/all/files/lbnl-6103e.pdf.

on the flexibility and choice provided by a robust transmission grid. As a result, transmission should be viewed as a valuable hedge against uncertainty and future price fluctuations for all consumers.

H. Environmental Benefits

Q: What are some of the environmental benefits the line provides?

A: GBE witness Copeland's analysis indicates that the wind energy transmitted by the GBE Project would reduce overall production costs by displacing fossil fueled generation.[50] Wind energy injected into Missouri via the GBE Project would displace generation from the state's fossil-fired power plants. EIA's Missouri data shows that roughly 80% of the electricity generated within the state is from coal plants.[51] Coal plants consume water and emit CO_2, SO_2, NO_x, and other harmful pollutants, and more generally the production and consumption of fossil fuels for electricity generation is a large source of negative environmental and public health impacts.[52] Thus, Missouri's environment and public health would benefit from the Project.

Wind energy requires virtually zero water to produce electricity, while most conventional forms of electricity generation consume hundreds of gallons of water per MWh produced. The DOE has found that producing 20% of America's electricity from wind energy would conserve 4 trillion gallons of water

[50] Direct Testimony of J. Neil Copeland on Behalf of Grain Belt Express Clean Line LLC, Exh. ___, sched. At 10-11 and Sched. JNC-2 (Aug. 30, 2016).
[51] EIA, "Missouri - State Profile and Energy Estimates" for October 2016, available at http://www.eia.gov/state/?sid=MO#tabs-4
[52] National Research Council, Hidden Costs of Energy, (2010), available at http://www.nap.edu/catalog.php?record_id=12794

cumulatively through the year 2030.[53] These water savings would produce broadly spread benefits across the PJM and MISO footprints, because those RTOs would have less demand for electricity from conventional generation plants that rely on water for its production as a result of the delivery of wind energy via the GBE Project. These benefits would be particularly large in an agricultural state like Missouri, and the benefit of reduced costs for producing food and other agricultural products would benefit all consumers.

Results I obtained using EPA's AVoided Emissions and geneRation Tool (AVERT)[54], which uses empirical power system data and a statistical algorithm to identify which of a region's power plants will have their output displaced by the addition of wind energy, confirms the value of the Grain Belt Express for reducing air pollution. I used the model to calculate the average emissions reduction for each MWh of wind energy produced in or physically delivered to AVERT's Lower Midwest region, which includes most of SPP, to be 2.33 lbs of SO_2/MWh of wind, 1.65 lbs of NOx/MWh, and 1,675 lbs of CO_2/MWh.[55] An average MWh of wind produced in or physically delivered to AVERT's Great Lakes/MidAtlantic region, which is roughly consistent with the PJM region, yields savings of 3.70 lbs of SO_2/MWh, 1.36 lbs of NOx/MWh, and 1,545 lbs/MWh of CO_2.

[53] U.S. Dep't of Energy, 20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply at 16 (Executive Summary) (2008), *available at* http://www.20percentwind.org/ .
[54] AVERT available at http://epa.gov/statelocalclimate/resources/avert/index.html; I used the "Upper Midwest" Regional Data File and modeled the addition of the amount of wind capacity necessary to produce 41 million MWh of wind energy annually.
[55] http://awea.files.cms-plus.com/FileDownloads/pdfs/AWEA_Clean_Air_Benefits_WhitePaper%20Final.pdf

I. There Are not Reasonable Alternatives to the GBE Project

Q: Can SPP wind resources be accessed through the existing AC grid?

A: There are several challenges to accessing wind generation from SPP by those in Missouri and PJM, including a lack of available transmission capacity from western SPP to Missouri. Severe transmission congestion inhibits the delivery of wind generation from western SPP to Missouri by imposing congestion costs that in many cases exceed the price of wind energy.[56] Delivery to PJM would require cooperation among several regions that currently does not exist. Further, the cost of crossing SPP, MISO and into PJM would likely be quite large due to rate pancaking of charges, as described below.

Q: Please explain.

A: First of all moving power from SPP to PJM requires transmission service across SPP, MISO and PJM. Transmission service across these interfaces would result in significant wheeling and congestion costs, as discussed below. Transmission upgrades could also be required for interconnections in SPP, and those costs would likely be added to the cost of service. These studies are notorious for delays and the need for restudy as those requesting service drop out.

The challenges associated with inter-regional transmission planning and cost allocation to resolve this congestion and allow greater inter-regional delivery of wind energy via the AC power system are a long way from being resolved.

[56] SPP Market Monitoring Unit, "2015 State of the Market," August 2016, available at https://www.spp.org/documents/41597/spp_mmu_state_of_the_market_report_2015.pdf, pages 100-102

FERC acknowledged the need to have regions develop interregional cost allocation and planning in Order 1000. From a practical standpoint, however, a myriad of problems still exist. Inter-regional filings on cost allocation have not yet been finalized and litigation can be expected to continue. Finally, while SPP and MISO are engaged in a joint planning effort, they are only examining a business as usual case that does not include an analysis of either region~~s~~ using wind resources beyond what is called for in the BAU case. There is no ongoing transmission study directly involving PJM, SPP and MISO looking at bringing wind energy into PJM from SPP on AC lines. In the near term the GBE Project is the only realistic option for transmitting wind power from SPP to PJM.

Q: Are there other hurdles that would interfere with access to SPP wind power by PJM?

A: Yes. Transmission service across multiple regions will incur pancaked rates that have significant cost risk for either the generator or end use customer. To deliver electricity from western SPP to PJM there are two main costs -- firm point-to-point transmission and congestion. Firm transmission rates to the SPP/MISO border and from there to the PJM/MISO border are known; however, they are volatile over extended periods of time. For SPP, the cost of firm transmission rights has continuously increased since 2005, sometimes dramatically. Since most power purchase agreements for wind are for twenty years, trying to estimate the increase in price of firm transmission rights in two RTOs and still produce a competitive price for your product is extremely difficult. Moreover,

there is no mechanism for a generator to hedge its financial exposure to these costs.

The congestion cost is the difference in price between the wind farm and the SPP/MISO border and from the SPP/MISO border to the MISO/PJM border. This cost can be hedged by utilizing financial transmission rights ("FTRs"), but usually the nameplate capacity of your project cannot be completely hedged via the free allocation of FTRs that comes with a firm transmission path. So a wind generator will be left with some financial risk exposure with regards to both the unhedged portion and the variable cost of purchasing additional FTRs. Further risk related to congestion is knowing what congestion will look like along the route for the twenty year duration of the power purchase agreement. This changes as new transmission lines are built and new generation interconnects to the system. Like firm transmission rights, properly assessing the potential future costs of congestion is extremely difficult to nearly impossible.

In comparison, the GBE Project removes these uncertainties by providing a known cost for transmission capacity for a fixed term without any congestion risk on the line. Therefore, a wind generator does not need to worry about changes to the firm transmission right or congestion costs.

J. The Project Provides Diversity of Wind Generation

Q: Please explain wind geographic diversity.

A: Wind geographic diversity refers to having wind energy resources across a large area interconnected into a single grid balancing authority. -- Because weather events move slowly across a large area, the variability of wind output decreases and the availability of wind resources for meeting peak electric demand increases as wind resources with different output profiles are aggregated.[57]

Q: How does the GBE Project provide wind geographic diversity?

A: Wind energy resources delivered to Missouri, MISO, and PJM from Kansas via the GBE Project will be at a significant distance from the other wind energy resources connected to the MISO and PJM power systems. Those wind energy resources will have output profiles that are less correlated, which provides a more constant amount of wind energy being purchased by the utility over a given period of time. This is especially beneficial for the RTO, because it is responsible for balancing all of the energy being injected into the grid from generating resources in its footprint.

Q: If a certificate of convenience and need is denied, what would be the negative consequence or results for the wind industry?

A: The benefit of the GBE Project is it delivers wind energy from one of the best wind resource locations to some of the highest need markets for renewable energy -- MISO and PJM. The need for wind energy resources for compliance with RESs or for economic reasons is not as great in and around Kansas, mainly

[57] See, for example, Handschy et al., "Reduction of wind power variability through geographic diversity," August 2016, available at https://arxiv.org/abs/1608.06257

because Kansas has lower electricity demand than states to the east. If a certificate of convenience and necessity is not granted the GBE Project, then the development of 3,500 to 4,000 MW of wind farms, or potentially even more, in western Kansas will likely be lost. I am not aware of other proposed transmission lines that could take the place of serving that prospective wind development, and even if there were, the wind development would be additive and not mutually exclusive with that driven by GBE. Therefore, the tens of thousands of jobs, and the billions of dollars of direct project expenditures and millions of dollars of supply chain benefits for Missouri, would be lost.

The bottom line is that the GBE Project gives Missouri, and the states in MISO and PJM access to low cost wind energy from Kansas that: [1] can help Missouri utilities and utilities in MISO and PJM comply with state renewable energy standards; [2] allows municipal and cooperative electric suppliers in Missouri meet the renewable energy needs of their customers; [3] can cost effectively replace generation from power plants that are retiring; [4] can meet the increasing demand for wind energy from corporate purchasers; [5] can be used for compliance with current or future regulation of carbon emissions, including under the U.S. Environmental Protection Agency's Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units (Clean Power Plan); [6] can lower wholesale electric prices; [7] provides low cost energy that is comparable or lower in cost than alternatie forms of generation; [8]

provides a long term hedge against fuel price volatility; and [9] can diversify the portfolio of current electric generation.

Q: Does this conclude your testimony?

A: Yes.

Schedule MG-1

Michael Goggin

Education:

Harvard University class of 2004, B.A.

- Graduated *cum laude* in Social Studies
- Wrote thesis "Is it Time for a Change? Science, Policy, and Climate Change"

Experience:

AWEA Senior Research Director, other titles February 2008-present

- Provide analytical support and advocacy on transmission and grid integration and issues related to wind energy's impact on markets
- Communicate with the press, the public, and policymakers about wind energy
- Work with AWEA members to develop the organization's policy positions

Sentech, Inc. Research Analyst October 2005-February 2008

- Author white papers, feasibility studies, and economic analyses of solar, wind, geothermal, and energy storage technologies for Department of Energy officials
- Model performance and economics of innovative renewable energy and energy storage technologies
- Research and write fact sheets and presentations for DOE clients
- Provide analytical support for DOE's selection of recipients for renewable energy technology R&D funding

Union of Concerned Scientists Clean Energy Intern May 2005-October 2005

- Worked with the legislative and field staff to promote the inclusion of pro-renewable energy measures in the Energy Policy Act of 2005
- Mobilized clean energy businesspeople and advocates to lobby elected officials
- Prepared fact sheets to support passage of pro-renewable policies

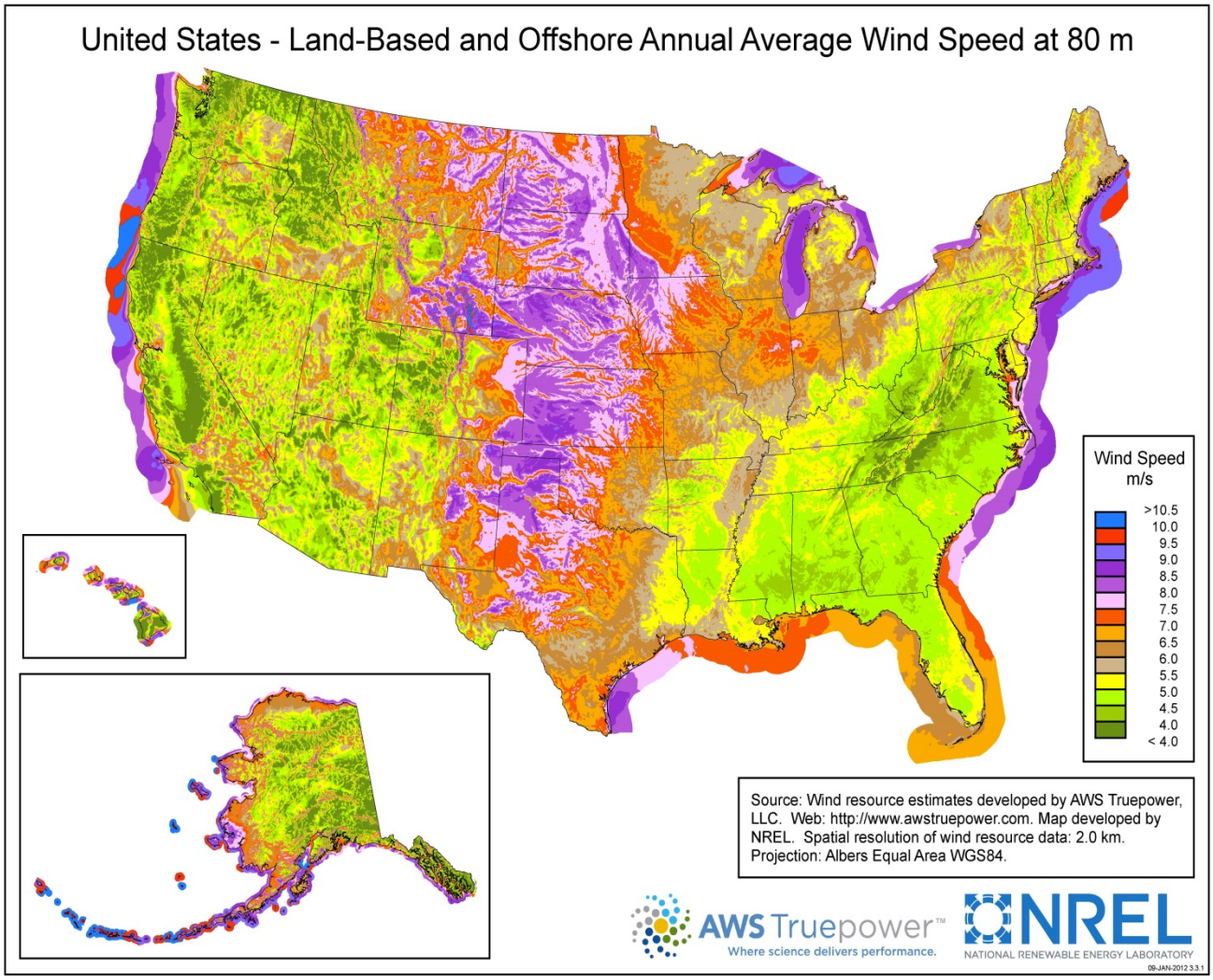
State Public Interest Research Groups Policy Analyst August 2004-May 2005

- Wrote reports advocating pro-renewable energy policies at the state, regional, and federal level
- Gathered and analyzed data to be included in advocacy reports

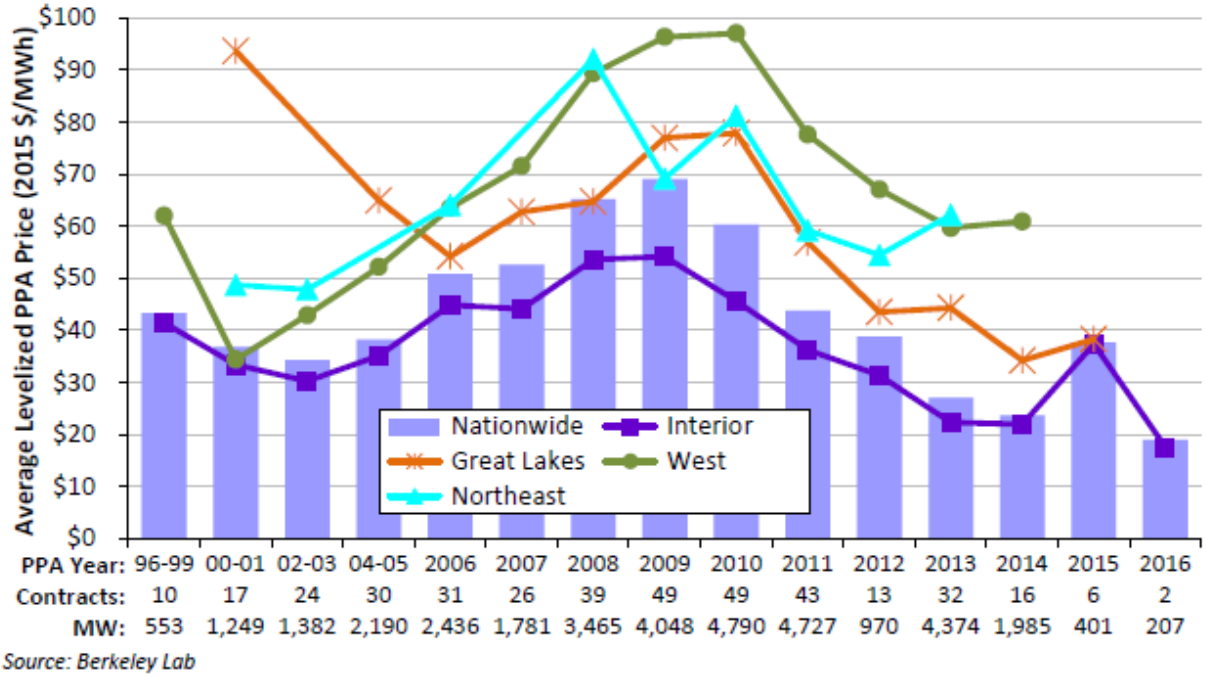
Publications:

- R. Gramlich and M. Goggin, "The Ability of Current U.S. Electric Industry Structure and Transmission Rules to Accommodate High Wind Energy Penetration," October 2008, presented at 7th International Workshop on Large Scale Integration of Wind Power and on Transmission Networks for Offshore Wind Farms
- M. Milligan, et al., "Impact of Electric Industry Structure on High Wind Penetration Potential," July 2009, NREL Technical Report TP-550-46273
- R. Gramlich and M. Goggin, "What's Next for Wind Power," March 2013, Electricity Journal
- Michael Goggin, "Wind Energy's Emissions Reductions: A Statistical Analysis," July 2013, presented at IEEE PES annual conference

NREL wind resource assessment map of the U.S. as of March 26, 2013, *available at* http://www.nrel.gov/wind/resource_assessment.html, downloaded by Michael S. Goggin.



Capacity factor by region, from Lawrence Berkeley National Laboratories, 2015 Wind Technologies Report, Fig. 48 at 63 (August 2016), https://emp.lbl.gov/sites/all/files/2015-windtechreport.final_.pdf

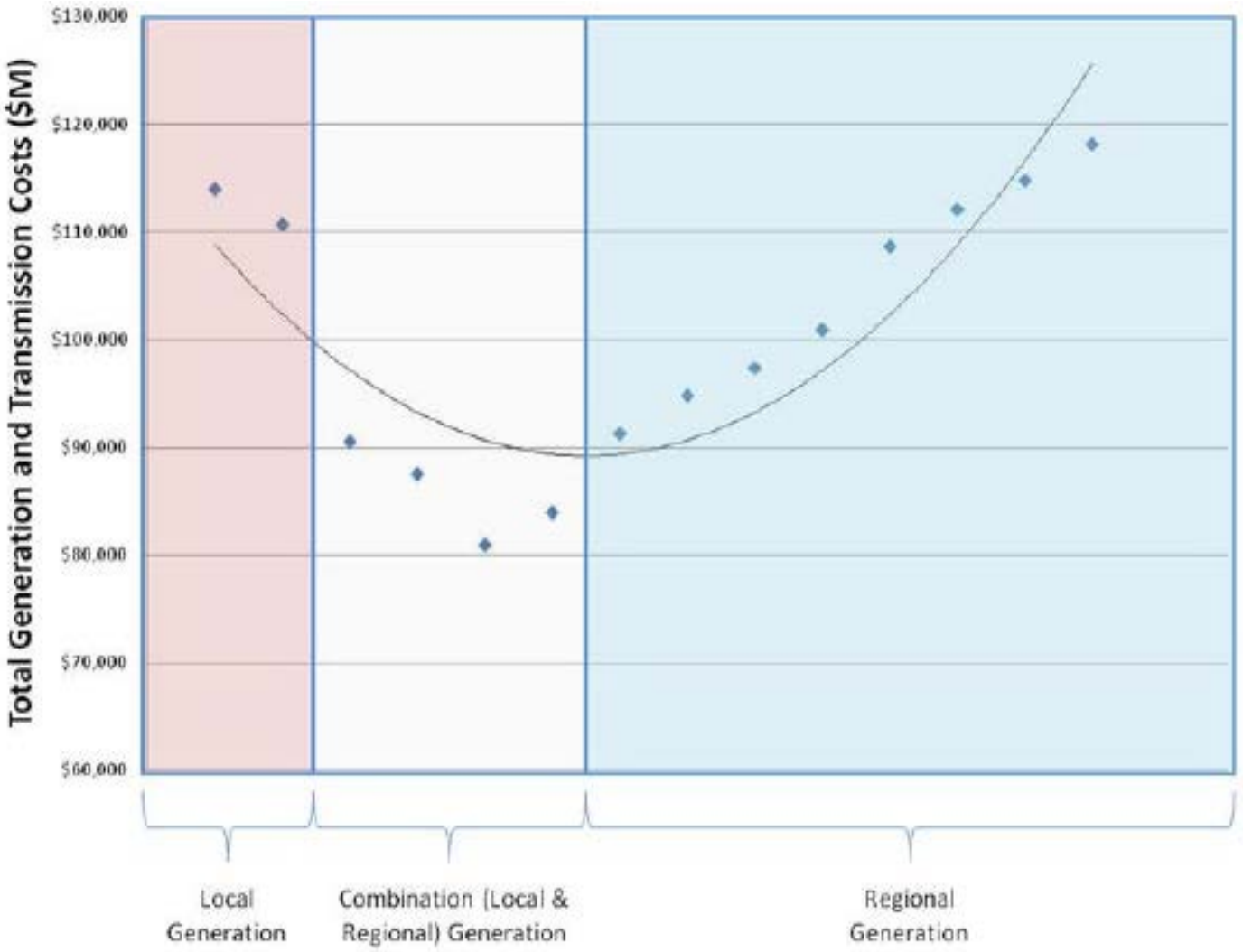


Source: Berkeley Lab

Figure 48. Generation-weighted average levelized wind PPA prices by PPA execution date and region

Schedule MG-4

Renewable Generation and Transmission Infrastructure Costs Dependent Generation's Proximity to End User (Local, Regional of Combination); from MISO Multi Value Project Portfolio: Results and Analyses ("MVP Report"), fig. 4.8 at 18 (January 10, 2012)



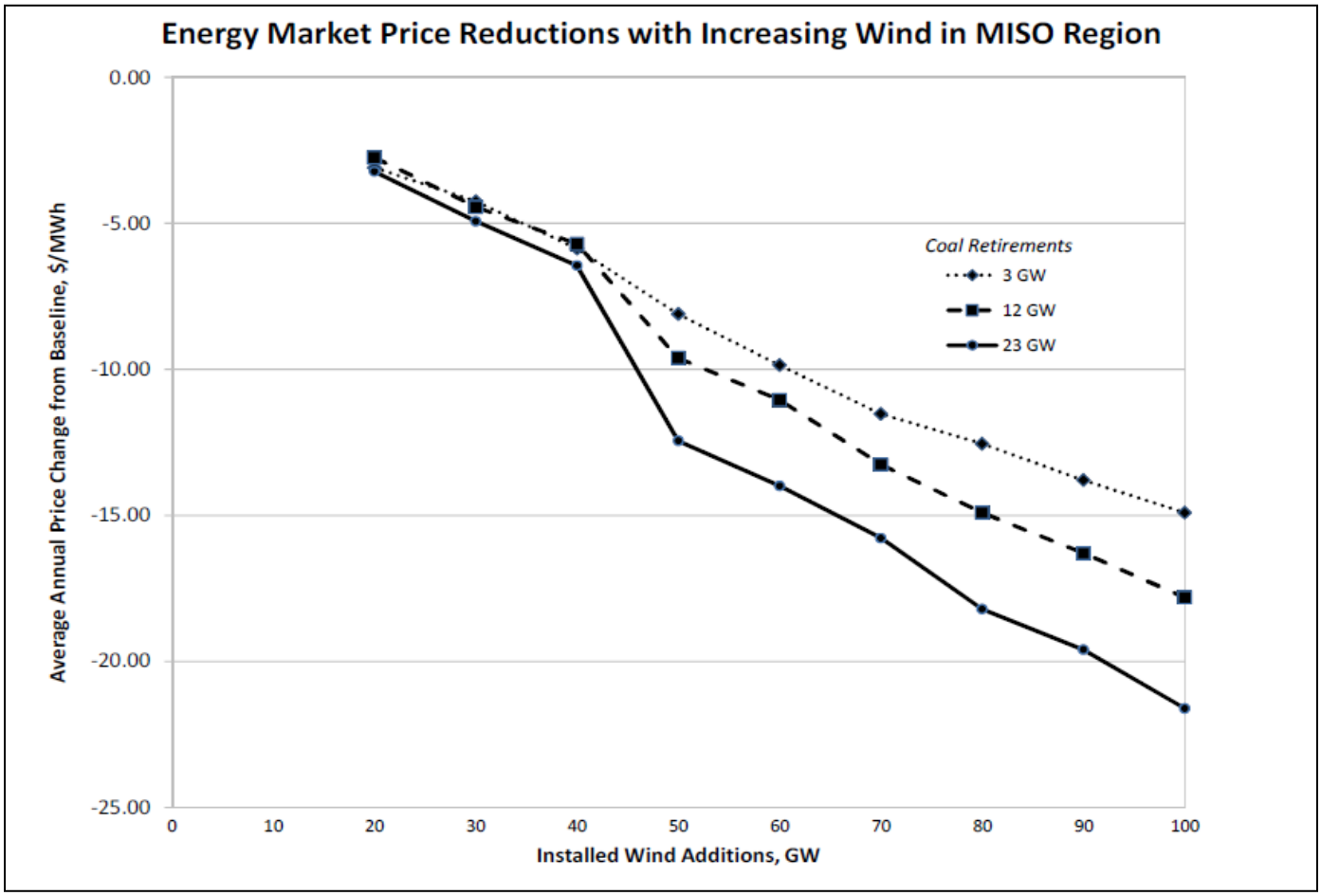
Schedule MG-5

AWEA's Estimate of Incremental Wind Capacity (MW) (beyond current levels) that will be used to meet state RPS requirements through the year 2025, by state

State	Estimate
DC	320
DE	80
MD	880
MO	770
MN	110
NJ	1,120
PA	1,030

Schedule MG-6

Electricity Market Prices Decline as Wind Capacity is Added, from *Synapse Energy Economics, Inc.*, The Potential Rate Effects of Wind Energy and Transmission in the Midwest ISO Region, at 4 (May 22, 2012), *available at* http://cleanenergytransmission.org/wp-content/uploads/2012/05/Full-Report-The-Potential-Rate-Effects-of-Wind-Energy-and-Transmission-in-the-Midwest-ISO-Region.pdf.



Schedule MG-7

Schedule MG-7

Wind PPA Prices over the life of their contract compared to natural gas fuel cost projected over time using EIA forecast, from Lawrence Berkeley National Laboratories, 2015 Wind Technologies Report, Fig. 50 at 66 (August 2016),
https://emp.lbl.gov/sites/all/files/2015-windtechreport.final_.pdf

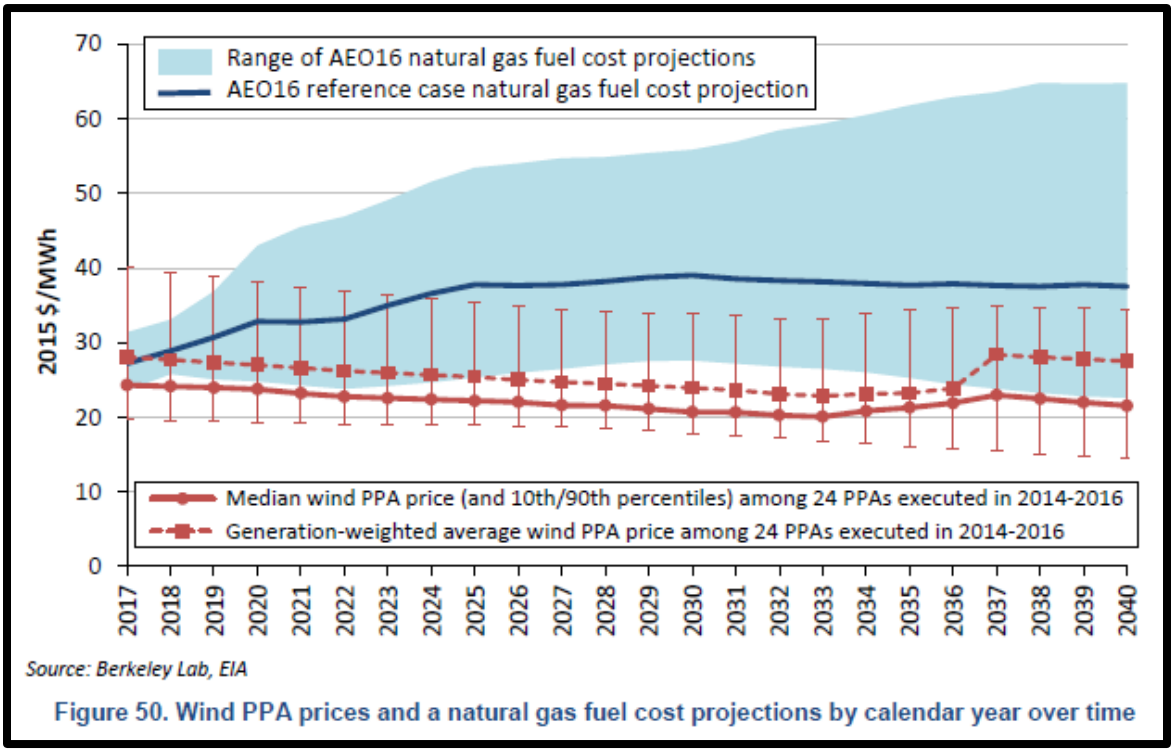


Figure 50. Wind PPA prices and a natural gas fuel cost projections by calendar year over time