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MISSOURI PUBLIC SERVICE COMMISSION

DOCKET NO. EA-2017-0345

DIRECT TESTIMONY

OF

MICHAEL GOGGIN

SUBMITTED ON BEHALF OF:

WIND ON THE WIRES

OCTOBER 6, 2017

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I. INTRODUCTION

A. Witness Background

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 900, Washington DC, 20005.

Q: For whom are you testifying?

A: I am testifying on behalf of Wind on the Wires.

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

A: Yes, I testified in docket nos. EA-2014-0207, EA-2017-0358 and in several transmission proceedings before the Illinois Commerce Commission, the Minnesota Public Utilities Commission and the Public Service Commission of Wisconsin.[1]

[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), Grand Prairie Gateway project (ICC Docket No. 13-0657), and Grain Belt Clean Line project (ICC Docket No. 15-0277), 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).

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

B. Scope of Testimony

Q: What is the purpose of your testimony?

A: I provide testimony supporting Ameren Transmission Company of Illinois' (ATXI) application for a certificate of public convenience and necessity to construct, own and operate a 345 kilovolt (kV) transmission line and proposed substation from Palmyra, Missouri to the Iowa border ("Mark Twain Project" or "Project"). The Mark Twain 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) grid operating area. The Mark Twain Project interconnects with other MISO Multi-Value Projects (that have already been approved by Iowa and Illinois) to serve as a key link for the cost-effective delivery of MISO wind resources that are needed and in the public interest of electricity consumers in Missouri, and other MISO states. In addition, the increased use of renewable energy resources instead of fossil generation provides energy diversity, health

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

benefits from emission reductions, an effective way to meet current and future emission standards, and other benefits.

Q: Please outline your testimony.

A: My testimony will address the need for the project, and how it is in the public interest. First, I explain the wind industry's interest in the Mark Twain line and how it is proposed to deliver energy from wind energy resources across MISO. Second, I discuss Missouri's and other states' needs for the Mark Twain line because it delivers wind energy that: (1) can be used to meet state renewable energy standards (RES) and demand for renewable energy from corporate consumers of electricity; (2) lowers wholesale electric prices; (3) can be a cost effective replacement for energy from retiring generation; (4) provides energy security and a hedge against price volatility of fuel used for conventional generating plants; (5) provides energy at comparable or lower cost than alternative forms of generation; and (6) diversifies the portfolio of generation used to meet energy demands. In addition, the public benefits from wind energy in that it reduces air pollution that harms public health and increases medical costs.

II. THE ROLE OF THE MARK TWAIN PROJECT IN DELIVERING WIND GENERATION TO MISSOURI

Q: What is your understanding of the purpose of the Mark Twain Project?

A: As I understand it, the Project is a 345 kilovolt (kV) electric transmission line that is approximately 96 miles in length from Palmyra, Missouri to a new substation near Kirksville, Missouri, and then continuing north to an interconnection point on the Iowa border. Almost all of the route will utilize the right of way of two existing 161 kV transmission lines. ATXI will co-locate the proposed 345 kV line with the existing 161 kV lines on new transmission structures to be installed by ATXI. The existing 161kV transmission line between Palmyra and Kirksville is owned by Northeast Missouri Electric Power Cooperative (Northeast Power) and the existing 161 kV line between Kirksville and the Iowa border is owned by Union Electric Company d/b/a Ameren Missouri (Ameren Missouri).

The line will provide Missouri consumers with significantly greater access to underutilized wind energy resources in Illinois, Iowa and Missouri, and will improve reliability and alleviate congestion on the electric transmission system managed by MISO.

Q: Can you quantify the amount of wind resources available in Missouri?

A: According to the United States Department of Energy's National Renewable Energy Laboratory's ("NREL") wind resource assessment data, Missouri has

278,694 megawatts ("MW") of developable wind energy resources[3] with wind turbines whose hub height is at 110 meters above ground level. A significant share of this wind resource is in northern Missouri in the vicinity of the Mark Twain line.

Q: What about the wind resources in other MISO states to which the Mark Twain Project will provide greater access?

A: As indicated in the wind resource maps in Schedules MG-2 and MG-3, Illinois, Iowa and states north and west of Iowa also have some of the best wind energy resources in the United States. Iowa and Illinois have 279,569 MW[4] and 191,350 MW[5], respectively, of developable wind energy resources, which together are enough to meet the current electricity needs of Missouri more than 20 times over.[6] That same analysis found that North Dakota possesses 296,083 MW[7] of developable wind energy resources, South Dakota has 411,879 MW[8], and Minnesota has 182,825 MW[9]. NREL's data indicates that the combined wind energy potential of North Dakota, South Dakota, Minnesota, Iowa, Illinois, and Missouri is 1,640,400 MW.

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[3] United States Department of Energy's National Renewable Energy Laboratory's ("NREL") wind resource assessment data, available at https://windexchange.energy.gov/states/mo.
[4] Id. available at https://windexchange.energy.gov/states/ia.
[5] Id. available at https://windexchange.energy.gov/states/il.
[6] U.S. Energy Information Administration, Missouri Electricity Profile 2015 available at https://www.eia.gov/electricity/state/missouri/. Missouri retail electricity sales in 2015 was 81,504,081 megawatt-hours.
[7] United States Department of Energy's National Renewable Energy Laboratory's ("NREL") wind resource assessment data, available at https://windexchange.energy.gov/states/nd
[8] Id. available at https://windexchange.energy.gov/states/sd
[9] Id. available at https://windexchange.energy.gov/states/mn

Q. Why are transmission lines important in accessing these resources?

A. Transmission lines are a major factor that determine how much of the potential wind energy in these states can be used. To capitalize on these wind-rich areas, wind plants need cost-effective access to transmission lines. The Mark Twain Project is an essential piece of the MVP project portfolio that will provide Missouri customers with access to a large share of some of the best wind resources in the United States, both in Missouri and in other MISO states.

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

A: On September 25, 2017, Ameren Missouri filed its "2017 Integrated Resource Plan" with the Missouri Public Service Commission. In its recent Integrated Resource Plan (IRP) filing, Ameren Missouri cites data collected in its 2015 Request for Proposals indicating that wind resources developed in Missouri could expect to achieve capacity factors of around 40%, while wind resources in the region could achieve 45% capacity factors.[10] Capacity factor is the amount of electricity produced by a power plant in a typical year divided by the amount of electricity that that power plant could provide if it ran at 100% of its nameplate capacity for all 8,760 hours in that year, and is a commonly used metric for the expected output of wind plants.

[10] Ameren Missouri 2017 IRP, available at https://q9u5x5a2.ssl.hwcdn.net/-/Media/Missouri-Site/Files/environment/2017-IRP/chapter-6-New-Supply-side-resources.pdf?la=en, page 22

Both the Missouri and regional wind resources identified in Ameren Missouri's IRP filing possess high capacity factors. 40% and 45% capacity factors are significantly above the average capacity factor in almost all regions of the country, and in the range of the highest capacity factor wind projects being built in the interior region of the country that includes Missouri.[11] This highlights the value of the Mark Twain Project for accessing these high-quality wind resources, both in Missouri and in other MISO states.

Q: How does capacity factor affect the economics of wind generation?

A: As Ameren Missouri's IRP filing indicates, both Missouri and regional wind are quite competitive due to their high capacity factors. In its IRP, Ameren Missouri finds that Missouri wind would be available at $58/MWh (megawatt-hour) on an unsubsidized basis, versus $51.7/MWh for regional wind. This difference is due to the higher capacity factor, which allows the fixed costs of the wind project to be recovered across a larger amount of energy sold to a customer, thereby lowering the price at which each unit of energy must be sold for the project to be economically viable. Both of these unsubsidized costs are highly competitive, particularly after the value of the $24/MWh federal production tax credit is subtracted from that cost. By providing access to the best wind resources in Missouri and other MISO states, the Mark Twain

[11] Lawrence Berkeley National Laboratories, 2016 Wind Technologies Report, at page 45 (August 2017) available at https://energy.gov/sites/prod/files/2017/08/f35/2016_Wind_Technologies_Market_Report_0.pdf

Project will provide Missouri utilities and their customers with greatly expanded options for procuring wind energy at the lowest possible cost.

Q: In addition to wind resource quantity and quality, are there other indicators of where future wind development is likely to occur in MISO?

A: Yes. MISO's interconnection queue[12] provides one indicator of wind project developers' interest in developing wind resources in the future. As of September 29, 2017, the MISO interconnection queue includes 30,459 MW of proposed wind projects. Missouri has 1,206 MW of the proposed wind projects in the MISO interconnection queue, Iowa has 7,316 MW and Illinois has 2,397 MW in the MISO queue. To the west of Iowa, South Dakota has 3,204 MW, North Dakota has 3,837 MW and Minnesota has 5,110 MW in the MISO queue. To the east of Illinois, Indiana has 2,586 MW in the queue.

Certain caveats apply when interpreting interconnection queue data. First, many proposed projects in the interconnection queue are unlikely to proceed to final development and be placed in service, as many projects in the queue have not yet passed important project milestones such as obtaining a power purchase agreement or project financing. Second, interconnection applications are partially driven by current transmission constraints, so the

[12] https://www.misoenergy.org/Planning/GeneratorInterconnection/Pages/InterconnectionQueue.aspx (data downloaded on September 29, 2017, and was sorted to remove projects that have been withdrawn or placed in-service, and then sorted by state).

addition of new transmission can drive new interconnection applications in regions that are currently transmission constrained.

Nevertheless, the large quantity of proposed wind energy development in Missouri, Illinois, Iowa, and other parts of MISO indicates that the Mark Twain Project will connect Missouri consumers with large quantities of economically viable wind energy resources and significant developer interest in utilizing those resources. This is further evidence that the Mark Twain Project will enable the delivery of wind energy that will reduce electricity prices in Missouri and also deliver low cost wind resources from Missouri and adjacent states that can be used for compliance with the Missouri RES.

Q: Does MISO develop estimates of where future wind development is likely to occur?

A: Yes, MISO's transmission planning processes identifies areas that are likely to see future wind deployment in the region, based on wind resource data, interconnection queue data, state policy requirements, and other factors.

Even before the MISO MVP Report of 2011, MISO worked with stakeholders in the RGOS process to identify zones where future wind development is likely to occur and would most cost-effectively occur. To identify the most cost-effective wind resource mix, the RGOS analysis carefully balanced generation costs and transmission costs to arrive at the optimal mix of wind

resources.[13] The resulting RGOS zones are identified as the blue ovals in Schedule MG-4. As explained in the MISO MVP Report, "Incremental wind generation was added to the model to satisfy these mandated needs. The amount of incremental generation for each zone was based on the capacity factor, the planned and proposed generation, and existing wind with power purchase agreements to serve non-MISO load ascribed to each zone."[14]

Q: What did MISO estimate to be Missouri's demand for renewable energy to meet its Renewable Energy Standard?

A: The MISO MVP Report analysis estimated Ameren Missouri to have an incremental need for 5,825,834 MWh of renewable generation in 2021 and 6,160,994 MWh in 2026 to meet its Renewable Energy Standard ("RES"). In addition to Ameren Missouri, MISO estimated that Columbia Water and Light would need 122,809 MWh of renewable energy in 2021 and 194,812 MWh of renewable energy in 2026.[15] Additional wind needs in Missouri may arise from stricter environmental standards in the future, possible increases in renewable energy standards, the use of economical wind to displace higher-

[13] MISO, Multi-Value Project Portfolio: Results and Analyses (MISO MVP Report) page 4 (December 2011) available at https://www.misoenergy.org/Library/Repository/Study/Candidate%20MVP%20Analysis/MVP%20Portfolio%20Analysis%20Full%20Report.pdf: "The goal of the RGOS analysis was to design transmission portfolios that would enable RPS mandates to be met at the lowest delivered wholesale energy cost. The cost calculation combined the expenses of the new transmission portfolios with the capital costs of the new renewable generation, balancing the trade-offs of a lower transmission investment to deliver wind from low wind availability areas, typically closer to large load centers; against a larger transmission investment to deliver wind from higher wind availability areas, typically located further from load centers."

[14] MISO MVP Report, page 18.

[15] Id.

cost resources, retirement of existing generators, load growth, or due to increased demand for "greener" energy from customers.

Q: How does MISO's estimate compare to the quantity Ameren Missouri forecasts for its need?

A: MISO's 2011 estimate of Missouri's wind demand is a bit higher than what Ameren Missouri estimates as its need for RES compliance in its recent IRP filing. To comply with the Missouri renewable energy standard, Ameren Missouri estimates that it needs between 4,000,000 and 4,300,000 non-solar RECs. After 2021 it forecasts that it will have used all of its banked RECs and have a need of approximately 2,900,000 MWh of renewable resources.[16]

Ameren Missouri intends to add wind and solar to meet and go beyond its need for compliance with its Missouri RES obligation. Ameren Missouri intends to add 700 MW of wind in 2020 and 100 MW of solar, with the latter split among investments in 2022, 2025 and 2027.[17]

[16] Ameren Missouri, 2017 Integrated Resource Plan at pages 9-4, 9-5, Fig. 9.3, Table 9.2. available at https://www.efis.psc.mo.gov/mpsc/commoncomponents/view_itemno_details.asp?caseno=EO-2018-0038&attach_id=2018003909

[17] Ameren Missouri, 2017 Integrated Resource Plan at pages 10-10, 10-11, 10-14, 10-15 15, 10-17 and Fig. 10.2 available at https://www.efis.psc.mo.gov/mpsc/commoncomponents/view_itemno_details.asp?caseno=EO-2018-0038&attach_id=2018003909.

Q: How do the areas where future wind development is expected to occur correspond to the areas where wind development will be facilitated by the Mark Twain Project?

A: Because the MISO transmission planning process that produced plans for the Mark Twain Project and the other MVP projects was heavily based around facilitating wind energy development in the identified RGOS zones, it is not surprising that the Mark Twain Project is well-positioned to facilitate wind energy development in Missouri as well as in states east, west, and north of Missouri, as that mix of resources was identified as being the optimal solution for meeting the region's public policy requirements. Mark Twain is an integral piece of the MVP network that provides access to some of the best wind resources in MISO and the country. As explained in MISO's MVP Report, the component portions of the Ottumwa to West Adair (Zachary) to Palmyra, Missouri "will provide an outlet for wind generation in the western region to move toward the more densely populated load centers to the east."[18] In addition, the component portions provide reliability benefits.[19]

The Mark Twain Project is needed to reduce economic congestion and curtailment that would prevent low cost wind resources being developed in Missouri, as well as in neighboring states and states north and west of Iowa. MTEP17's forecast for wind resource development in Missouri and those other states is greater than what was forecast in the original MISO MVP

[18] MISO MVP Report, at pages 31 and 33.
[19] Id.

Report increases the need for the Mark Twain Project. These new wind zones are identified by yellow, green and gray ovals in Schedule MG-4 and are forecasted for Missouri, Iowa, Illinois, Minnesota, North Dakota and South Dakota. Congestion, curtailment and reliability issues will be worse than what is estimated by the MISO MVP Report if wind starts to develop in these new wind zones in the absence of the Mark Twain Project.

Q: What is the benefit of providing Missouri utilities access to more wind resources?

A: As explained in more detail below in sections 3.E. and 3.F., the wind resources from Missouri and other states that the Mark Twain Project can deliver to Missouri customers will decrease electricity prices and benefit Missouri consumers by promoting the development of an effectively competitive electricity market that operates efficiently. As the MISO MVP Report indicates, the Mark Twain Project and the broader MVP portfolio greatly reduces consumer energy costs, as "Adjusted Production Cost savings are achieved through reduction of transmission congestion costs and more efficient use of generation resources across the system."[20] Without the Mark Twain line, there is an insurmountable gap between the grid in central Iowa and Missouri-Illinois border, preventing realization of the MVP plan's intended economic and reliability benefits for Missouri and the region.

[20] MISO MVP Report, at page 51.

Q: What role does transmission play in enabling the development of these wind resources?

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 alternative for alleviating those constraints.

Q: What is wind energy curtailment?

A: Wind energy curtailment occurs when the output of operating wind projects exceeds the transmission capacity that is locally available to deliver that energy to customers. When this occurs, wind plants receive a market signal or grid operator instruction to reduce their output to the level that can be carried on the transmission system. Wind turbines can rapidly reduce their output on command by pitching their blades to an angle where they capture less or zero of the energy available in the wind. Of course, there is a significant economic cost to wind owners, wind purchasers, and consumers, to “throwing away” zero-emission, zero-fuel cost energy that could have been used by consumers if sufficient transmission capacity were available.

Q: How extensive is wind energy curtailment in MISO currently?

A: If wind resources continue to be built in or near the RGOS wind zones, MISO calculated 63% of the RES renewable energy requirement in 2026 would be curtailed in the absence of the MVP lines.[21]

Curtailment has reduced wind resources capacity factors in recent years. From 2008 to 2016 annual curtailment has ranged from approximately 2.5% to approximately 5.5%.[22]

The Mark Twain Project is an integral part of the MVP portfolio, as the portfolio will not provide the full set of intended benefits without it. MISO's MVP Report found that the overall MVP portfolio of projects was essential for reducing curtailment of planned wind development, stating:

> The algorithm found that 10,885 MW of dispatched wind would be curtailed. As a connected capacity, this equates to 12,095 MW as the wind is modeled at 90% of its nameplate. A MISO-wide per-unit capacity factor was averaged from the 2026 incremental wind zone capacities to 32.8%. The curtailed energy was calculated to be 34,711,578 MWh from the connected capacity times the capacity factor times 8,760 hours of the year. Comparatively, the full 2026 RPS energy is 55,010,629 MWh. As a percentage of the 2026 full RPS energy, 63% would be curtailed in lieu of the MVP portfolio.[23]

[21] MISO MVP Report, at page 47.
[22] Lawrence Berkeley National Laboratories, 2016 Wind Technologies Report, at page 38 Figure 32 (August 2017) available at https://energy.gov/sites/prod/files/2017/08/f35/2016_Wind_Technologies_Market_Report_0.pdf
[23] MISO MVP Report, at page 47.

MISO is required to perform annual reviews of the benefits of the MVP lines approved in 2011. MISO recently finished its 2017 review of the 2011 MVP portfolio. That analysis supports the findings in the MISO MVP Report, finding that 60.5% of the renewable energy needed for state RES compliance would be curtailed in the absence of the 2011 MVP Projects being built.[24]

The 2017 MVP Triennial Review Report also examined the amount of wind energy, in excess of the 2031 requirements, that would be enabled by the recommended MVP portfolio. In total, "When the results from the curtailment analyses and the wind-enabled analyses are combined, MTEP17 results show the MVP portfolio enables a total of 52.8 million MWhs of renewable energy to meet the renewable energy mandates through 2031"[25], which is 12 million MWhs more than what was forecasted by MISO in the 2011 MISO MVP Report.

Q: What level of interest has the wind industry expressed in the Mark Twain Project?

A: MISO's queue as of October 1, 2017, has 30,459 MW of wind. Of that volume, 19,467 MW is north and west of Missouri, nearly 5,000 MW is in Illinois and Indiana, and 700 MW of wind is in Missouri and planned to interconnect into this Project. In addition, there is a lot of interest from utilities and other customers to enter into long-term PPAs or other arrangements

[24] MISO, 2017 MVP Triennial Review Report, at page 21, §5.1.
[25] Id. page 22.

involving 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.[26]

III. THE MARK TWAIN PROJECT IS NEEDED AND IN THE PUBLIC INTEREST

Q: What are the drivers for wind energy delivered by the Mark Twain Project?

A: There are multiple factors driving a need for wind energy in Missouri and across MISO 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 consumers; [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

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

that lowers retail electric rates; and the [7] need to diversify the portfolio of current electric generation.

A. The Mark Twain Project is Needed to Meet Renewable Energy Standards

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

A: Wind energy delivered through the Mark Twain Project can be used to cost effectively meet renewable energy standards in Missouri and other MISO 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. Ameren Missouri has a gross need for approximately 4,300,000 megawatt-hours ("MWh") of non-solar renewable energy RECs by and continuing after 2021. Ameren Missouri currently has 1,400,000 RECs per year under contract, which means that Ameren Missouri will have a need for 2,900,000 non-solar RECs per year starting in 2021.[27] That need could be met by approximately 870 MW of wind operating at a capacity factor of 38%.

[27] Ameren Missouri, 2017 Integrated Resource Plan, at pages 9-4, 9-5, Fig. 9.3, Table 9.2.

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

A: There are three states in MISO that have renewable energy standards that can be met with resources from outside of their state -- Missouri, Illinois and Minnesota. From these states I estimate a need for an incremental addition of around 1,530 MW of wind capacity above their current levels by the year 2025. See Schedule MG-5.

B. The Mark Twain Project is Needed to Replace Retiring Generation

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

A: A large number of generating plants are either reaching the end of their useful lives or are no longer economically competitive due to changes in the market or in regulation. Old or uncompetitive generation will need to be replaced. Wind energy offers a low cost replacement for a significant portion of the energy needs and some of the capacity those plants provide. Publicly available data on energy costs, such as Lazard[28], shows wind as the lowest cost form of new electricity generation.

As of Summer 2016, MISO had an average installed capacity of 142.7 GW.[29] Of that, 59 GW are coal plants (unforced capacity).[30] The average age of the

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

[29] Potomac Economics, 2016 State of the Market Report for the MISO Electricity Market, at page 18, Table A3 (June 2017) available at https://www.misoenergy.org/Library/Repository/Report/IMM/2016%20State%20of%20the%20Market%20Analytical%20Appendix.pdf.

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.[31] However, if carbon regulation moves forward MISO estimates that it could experience plant retirements in the range of 16 to 21 GW.[32]

C. The Mark Twain Project is Needed to Meet the Demand for Wind Energy by Corporate Consumers of Electricity

Q: How are corporate consumers of renewable energy a driver for wind delivered via the Mark Twain Project?

A. Over the last several years there has been a large increase in demand for wind energy from large retail consumers, many of whom prefer direct purchases of wind energy, including through "green tariffs" with utilities that in turn contract with new wind capacity to meet their demand, relative to buying Renewable Energy Credits.[33] Thirty-nine percent of the megawatts contracted for in 2016 were purchased by coporate or other non-utility customers. 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

[30] Id. at page 6, Table A1
[31] MISO, MTEP16 - MISO Transmission Expansion Plan, at pages 97-98 and 158 (Dec. 2016).
[32] MISO, MISO's Analysis of EPA's Final Clean Power Plan Study Report, at pages 40, 41 (July 2016) available at https://www.misoenergy.org/Library/Repository/Meeting%20Material/Stakeholder/PAC/2016/20160720/20160720%20PAC%20Item%2002a%20Clean%20Power%20Plan%20Study%20Report.pdf.
[33] AWEA, Corporate Purchasers of Wind Energy, available at http://www.awea.org/corporate-purchasers

in Texas and not Ohio because favorable policies, like the CREZ transmission expansion, provided more access to wind energy in Texas than in Ohio.[34] The availability of low-cost wind energy delivered via the Mark Twain Project would help make Missouri attractive for corporations looking to invest in new facilities.

D. The Mark Twain Project is Needed to Meet Future Carbon Regulation

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

A: The EPA finalized rules for the Clean Power Plan on August 3, 2015, pursuant to section 111(d) of the Clean Air Act. Section 111(d) requires 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, there are recent indications that the EPA will issue a modified Clean Power Plan.

Regardless of the specifics regarding the Clean Power Plan, many utilities recognize that regulation of carbon pollution from the electric sector is inevitable in the long-term, as required under the 2007 Massachusetts versus EPA Supreme Court decision and EPA's subsequent endangerment finding,

[34] https://www.nrdc.org/media/2015/150708-0

and are therefore continuing to move to lower-carbon forms of generation. For example, Vectren's 2016 Integrated Resource Plan 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."[35] 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."[36] Given the long lead time to deploy transmission infrastructure and the fact that wind and transmission investments will continue providing zero emission energy for decades, forward-looking utilities continue to invest in transmission and wind. Under the August 2015 version of the Clean Power Plan, 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 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 Mark Twain 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

[35] https://www.vectren.com/assets/cms/pdfs/2016%20Vectren%20IRP%20Non-Technical%20Summary.pdf
[36] http://blogs.edf.org/climate411/2017/01/04/2016-wrap-up-states-and-power-companies-led-the-way-to-cut-carbon/

anticipation of U.S. EPA requirements, it provides a hedge against any current or future carbon regulation.

MISO analyzed the Clean Power Plan and estimated that approximately 12 GW of wind generating capacity would be needed in addition to what is needed for RES compliance and for corporate purchaser demand.[37]

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

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 local 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.

[37] MISO, MISO's Analysis of EPA's Final Clean Power Plan Study Report, at page 41, Fig. 30. (July 2016) available at https://www.misoenergy.org/Library/Repository/Meeting%20Material/Stakeholder/PAC/2016/20160720/20160720%20PAC%20Item%2002a%20Clean%20Power%20Plan%20Study%20Report.pdf.

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.[38]

Q: What findings have MISO's MVP Reports made regarding the benefits of the MVP portfolio?

A: MISO's MVP Report concluded that "The recommended MVP portfolio allows for a more efficient dispatch of generation resources, opening markets to competition and spreading the benefits of low-cost generation throughout the MISO footprint."[39] As explained in the MISO MVP Report, the total package of MVP projects will "Provide an average annual value of $1,279 million over the first 40 years of service, at an average annual revenue requirement of $624 million."[40] The MISO MVP Report explains that benefits were found to exceed costs by a factor of 1.8 to 3.0.

The 2017 MVP Triennial Review Report shows that the benefits and net benefits of the portfolio continue to increase, with a benefit-cost ratio range of 2.2:1 to 3.4:1. The update found gross net present benefits of between $22

[38] FERC Order 890 at ¶422, available at http://www.ferc.gov/whats-new/comm-meet/2007/021507/E-1.pdf
[39] MISO MVP Report, page 49.
[40] Id. at page 1.

billion and $75 billion, and net benefits of between $12 billion and $53 billion in 20- to 40-years, respectively.[41]

The largest component of the savings from the portfolio of transmission lines is attributed to "Congestion and Fuel Savings."[42] This category captures the benefits of providing access to lower cost energy resources. Due to its zero fuel cost, wind energy bids into electricity markets at or near zero, driving the market clearing price down by displacing the most expensive generator that is currently dispatched. The benefit can be quite large, as many parts of the generation supply curve are quite steep.[43]

As explained in the MISO MVP Report, "These benefits were outlined through a series of production cost analyses, which captured the economic benefits of the recommended MVP transmission and the wind it enables. These benefits reflect the savings achieved through the reduction of transmission congestion costs and through more efficient use of generation resources."[44]

Q: Did MISO develop a benefit-to-cost ratio for Missouri?

A: For Missouri, the 2017 MVP analysis update found a benefit-cost ratio of 1.5:1 to 2.6:1.[45]

[41] MTEP17 MVP Triennial Review, fig. E1 at 6 (September 2017), available at https://www.misoenergy.org/Library/Repository/Study/Candidate%20MVP%20Analysis/MTEP17%20MVP%20Triennial%20Review%20Report.pdf

[42] Sched. MG-6 -- MISO MVP Report, page 49 Figure 8.1; *see also* 2011 MVP Second Triennial Review, at page 23 Figure 6-1.

[43] PÖyry, Wind Energy and Electricity Prices, at pages 11 and 12 http://www.ewea.org/fileadmin/ewea_documents/documents/publications/reports/MeritOrder.pdf.

[44] MISO MVP Report, at page 49.

[45] Id. at page 6.

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.[46]

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.[47] For example, an analysis in Massachusetts found that the state's renewable initiatives have annual net benefits of $219 million.[48] Finally, analysis in PJM found that doubling the use of wind energy beyond existing RES/RPS requirements would produce net savings for consumers of $6.9 billion per year.[49]

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[46] PÖyry, Wind Energy and Electricity Prices, at pages 11 and 12 http://www.ewea.org/fileadmin/ewea_documents/documents/publications/reports/MeritOrder.pdf.
[47] http://awea.files.cms-plus.com/AWEA%20White%20Paper-Consumer%20Benefits%20final.pdf, at page 4
[48] 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.
[49] 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.

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.[50] $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 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.[51] In his FERC affidavit presenting those results, Mr. Stoddard with CRA noted that "I have confirmed

[50] 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

[51] 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.

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."[52]

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.[53] As illustrated in Schedule MG-7, 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 generation and lower the price of marginal supply—thus lowering the energy market clearing price."[54]

Q: Are other states and utilities taking steps to realize the consumer benefits of wind energy and transmission?

A: In July, American Electric Power's two Oklahoma utilities announced they were moving forward with building 2,000 MW of wind and a 765-kilovolt

[52] Id.
[53] Synapse Energy Economics, Inc., The Potential Rate Effects of Wind Energy and Transmission in the Midwest ISO Region, at page 3 (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.
[54] Id.

transmission line to deliver that power. In August, Alliant announced it was buying an additional 500 MW of wind, in addition to an earlier commitment for 500 MW. Appalachian Power recently included 1,350 MW of new wind included in its IRP and 225 MW of additional wind it expects to be online in 2019. Kansas City Power and Light announced a 500 MW wind PPA last year. MidAmerican Energy recently announced a $3.6 billion, 2,000 MW investment in wind in Iowa. Xcel Energy has also recently announced a number of wind and transmission investments across its three utilities. These utilities and others have documented in extensive regulatory filings and public quotes that these investments provide large net benefits to their ratepayers.

F. The Mark Twain Project Can Act as a Hedge Against Fuel Price Volatility

Q: Does transmission help to hedge against uncertainty and protect consumers 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.

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 Mark Twain 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]."[55]

An example of the long-term value of wind as a hedge against uncertain natural gas prices is presented in Schedule MG-8. This graph compares the future stream of wind PPA prices (based on contracts executed in 2014-2017) 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

[55] 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.

potential enactment of environmental policies, including carbon regulations, place a further premium 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.

G. Environmental Benefits

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

A: Wind energy injected into Missouri via the Mark Twain Project would displace generation from the state's fossil-fired power plants. EIA's Missouri data shows that roughly 77% of the electricity generated within the state is from coal plants in 2016.[56] 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.[57] 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

[56] EIA, Missouri - State Profile and Energy Estimates for June 2017, available at http://www.eia.gov/state/?sid=MO#tabs-4

[57] National Research Council, Hidden Costs of Energy, (2010), available at http://www.nap.edu/catalog.php?record_id=12794 and http://www.ourenergypolicy.org/wp-content/uploads/2012/06/hidden.pdf

water cumulatively through the year 2030.[58] These water savings would produce broadly spread benefits across the MISO states, because they 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 Mark Twain 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)[59], 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 Mark Twain Project 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.[60] 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.

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[58] 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/ .
[59] 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 53 million MWh of wind energy annually.
[60] http://awea.files.cms-plus.com/FileDownloads/pdfs/AWEA_Clean_Air_Benefits_WhitePaper%20Final.pdf

H. The Mark Twain 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.[61]

Q: How does the Mark Twain Project provide wind geographic diversity?

A: As explained, the Mark Twain Project will improve access to wind energy resources in Missouri and throughout the region. The energy output of wind energy resources across a larger region tends to exhibit greater geographic diversity, with changes in output in one area having less correlation with changes elsewhere. As a result, the Mark Twain Project will help provide a more constant amount of wind energy being delivered over a given period of time. This is beneficial for all customers in the RTO, because it is responsible for balancing all of the energy being injected into the grid from generating resources in its footprint.

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

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

A: One of the major benefits of the Mark Twain Project is that it delivers high-quality wind to Ameren Missouri customers and some of the high-need markets for renewable energy. In addition, the Project will enable wind development in northern Missouri. If a certificate of convenience and necessity is not granted then wind farms in these areas may either not be developed or be subject to substantial curtailment. The large net benefits for Missouri ratepayers identified by MISO's MVP analysis will not be realized if this integral piece of the network is not constructed.

The bottom line is that the Mark Twain Project gives Missouri, and the states in MISO access to low cost wind energy that: [1] can help Missouri utilities and utilities in MISO 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 a long term hedge

against fuel price volatility; and [8] can diversify the portfolio of current electric generation.

Q: Does this conclude your testimony?

A: Yes.