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State Corporation Commission
of Kansas

In the Matter of the Petition of The Empire District Electric Company for Approval of Its Customer Savings Plan	))))))	Docket No. 18-EPDE-184-PRE

DIRECT TESTIMONY

PREPARED BY

J. Nicolas Puga

UTILITIES DIVISION

KANSAS CORPORATION COMMISSION

March 1, 2018

I. STATEMENT OF QUALIFICATIONS

Q. What is your name and business address?

A. My name is J. Nicolas Puga. I am a Partner with Bates White, LLC. My business address is 1300 Eye Street N.W., Suite 600, Washington, DC 20005.

Q. On whose behalf are you testifying?

A. I am appearing and presenting testimony on behalf of the Staff of the Kansas Corporation Commission ("KCC"). Mr. Cain's testimony addresses the rationale and economic analyses advanced by Empire to support its proposals to acquire 800 MW of Wind Projects and to retire the Asbury Generating Station.

Q. What is your educational background and professional experience?

A. A. I have a B.Sc. in Electrical Engineering from the Universidad de Guanajuato in Salamanca, Mexico, and a M.Sc. in Energy Systems Engineering from the University of Arizona. I have over 35 years of experience in electric and natural gas market analysis and resource planning, and haves advised electric and gas utilities, generation and transmission project developers and regulatory agencies. Upon receiving my B.Sc. degree in 1975, I worked at the Comisión Federal de Electricidad (CFE), the Mexican Government's vertically integrated utility, then at the Renewable Energy Division of the Instituto de Investigaciones Eléctricas (IIE), the Mexican Government's electric power research institute, where I developed and tested small wind energy conversion systems. In 1981, I left IIE to pursue my M.Sc. Since 1984, I have worked as a utility consultant in the U.S. and other countries. From 1984 to 1990, I served as Vice President of ANCO Engineers, an energy technology consulting firm located in Culver City, California. From 1990 to 1999 I worked at Resource Management International, Inc. (RMI), an international energy consulting firm, as Vice President then Sr. Vice President and remained with the firm after it was merged into Navigant Consulting, Inc., where I worked as a Director through 2005. From 2005 to 2007, I worked as an independent energy industry consultant. In 2007 I joined the energy practice of Bates White, LLC which I currently lead. A copy of my curriculum vitae is attached as Exhibit No. JNP-1.

Q. **Please describe other representative consulting projects relevant to this proceeding that you have worked on.**

A. I have conducted technical and economic due diligence for numerous independent power project developers seeking to build generation facilities and for financial institutions involved in financing privately owned generation projects, including a number of large scale wind energy projects. I have directed production cost and transmission modeling studies for fossil-fired, wind and solar generation project developers in the U.S. and México. I have submitted expert testimony and/or reports in various certification proceedings for transmission lines in front of the Public Utility Commission of Texas, the Virginia State Corporation Commission, the New York State Public Service Commission and the Public Utility Commission of West Virginia. For the Kansas Corporation Commission I testified on the economic viability of the environmental compliance retrofit of the La Cygne coal-fired generation facility. Also, along with Mr. Cain, I advised the MPSC on the review of Entergy Mississippi’s Application to Join the Midwest Independent System Operator, for which my firm conducted extensive and detailed modeling of the generation and transmission systems of Entergy, the Southwest Power Pool (SPP), the Midwest ISO and other regions in the Eastern Interconnect. I am currently engaged by the Mississippi Commission to advise them on the long term planning of transmission to accommodate the large wind and solar capacity in the MISO interconnection queue.

Q. Have you previously testified before the Commission?

A. Yes. I have appeared before to Commission to testify in KCC Docket No. 11-KCPE-581-PRE, on the independent evaluation of the economic viability of the environmental compliance retrofit of the La Cygne coal-fired generation facility conducted by Bates White, LLC for the Staff.

II. INTRODUCTION

Q. Which issues are addressed in your testimony?

A. My testimony addresses the implications of unaccounted for risks in Empire's analysis of the economics of their proposed acquisition and long term ownership of wind projects with a total capacity of 800 MW, and to which Empire's ratepayers would be exposed if the wind projects underperform compared to Empire's expectations. In general, I find some of the assumptions underpinning Empire's economic/financial analysis to be overly optimistic and inconsistent with the U.S. wind industry's prevalent concern with underperformance with respect to expectations. My testimony also questions the fairness of exposing ratepayers to underperformance risks which have historically been mitigated by protections built-into Power Purchase Agreements, and which are not mitigated in Empire's Proposal.

My testimony will describe the nature of common uncertainties in forecasting wind farm economic performance and why these uncertainties are specific to wind farm location and wind turbine choice which were unknown at the time of conducting the analyses in support of Empire's application.

Q. Do you have any recommendations?

A. I have two main recommendations:

1) Until Empire finishes evaluating the wind project sale offers obtained in response to its RFP, it will be impossible for the Commission to evaluate whether the Empire's proposal is in the public interest. The Commission must first weigh the risks of Empire's proposal based on analysis of actual selected projects from Empires RFP process. Moreover, Empire must provide appropriate quantitative assessment of risk associated with factors such as use of different wind turbine sizes/model, and alternative scenarios for production, prices and other associated risks (stage of development, technical and financial wherewithal of developer, track record, etc.).

2) The risk allocation between Empire's shareholders and the ratepayers is asymmetric in favor of the shareholders; who recover the investment and a return whether the project underperforms with respect to expectations or exceeds them. Empire is asking to share on the upside (requesting a share of net sales revenue), but pays no price for underperformance. An option that Empire did not include in its analyses would be for Empire to purchase wind

through a PPA at substantially-reduced risk to the ratepayers, and allocating development and performance risk more appropriately to the developer and its investors and lenders.

III. ANALYSIS

Focus on PPAs, project cost, performance, future value risk

Q. Mr. Puga is the structure of the CSP proposal to develop utility-owned 800 MW of wind generation commonly found in the U.S.?

A. No. Historically, U.S. utilities adding wind energy to their supply portfolios have sought security of supply and price certainty through PPAs with wind energy generators. A relatively recent trend has seen wind projects proposed and constructed on a "merchant/quasi-merchant" basis in which they are financed and built with either a partial PPA or without a PPA entirely, instead selling energy into the wholesale spot markets, typically with a pricing hedge contract. However, as of 2015 these projects represent a minority of cumulative installed wind projects.[1]

A. Can you explain what a PPA is and why, in your opinion, PPAs are still the preferred vehicle to acquire wind energy resources to serve regulated energy load?

A. A PPA is a legal contract between a wind generator (seller) and an energy "offtaker" (typically a utility). A PPA defines all of the commercial terms for the

[1] 2015 Wind Technologies Market Report. Lawrence Berkeley National Laboratory, Report LBNL1005951, 2016. https://emp.lbl.gov/publications/2015-wind-technologies-market-report

sale of electricity between the two parties, including when the project will begin commercial operation, schedule for delivery of electricity, penalties for under delivery, payment terms, and termination. The contractual terms may last anywhere between 5 and 20 years, during which time the utility buys energy, and sometimes also capacity and/or ancillary services, from the seller.

Under a PPA, the seller is an entity that owns the project. In most cases, the seller is organized as a special purpose entity whose main purpose is to facilitate non-recourse project financing, that is, debt is solely secured by the revenue of the project. Thus, the PPA is the principal agreement that defines the revenue and credit quality of a generating project and is thus a key instrument of project finance.

The projected revenues of a wind project are uncertain and thus some guarantee as to quantity purchased and price paid, established in a PPA, is required to make the project financially viable for the seller and its investors and lenders. The price for products delivered under the PPA is set by the developer at a level sufficient to recover the principal contributions of the equity investors (including tax equity), service debt and render a return on investment commensurate with the risk exposure of the equity. From the utility ratepayer perspective, the terms of the PPA provide security of supply and price certainty, limiting the exposure of the ratepayer to a project relying on a type of generation technology with relatively uncertain revenue streams and long debt service periods. In a nutshell, the terms of a well-designed PPA fairly allocate risk and return for the investor while providing value / renewable attributes for the PPA purchaser at lowest cost and with limited risk.

Q. How does Empire's proposal differ from the typical PPA transaction?

A. Simply stated, Empire proposes to acquire several yet to be identified windfarms in various stages of development in SPP, with an aggregate capacity of 800 MW. Empire would take on the role of wind farm developer and once constructed, become owner and operator of the wind farms. Each windfarm project will be structured around a project company and a Tax Equity Investor (TE), the latter contributing tax equity to take advantage of the full value of the PTC. Empire as the Sponsor of the Project will contribute 40% of the necessary equity to the TE's 60%, into a holding company (Wind Holdco).[2]

Each Wind Project Company will sell the energy produced by the windfarm in SPP's Integrated Market at the applicable nodal price and distribute the energy revenue net of O&M and A&G (cash) to Empire and to the TE; the Capacity and RECs to Empire; and the PTC and tax losses (MACRS) to the TE, according to a formula that changes over time. All net revenue will go to Empire during the first five years of operation. Over the next five years, the split will be in the range of 50%-75% and 25%-50% to Empire and TE, respectively. Empire will purchase

[2] Empire revised its assumptions for tax equity share down to 54% due to the new tax law. This change does not impact my analyses and conclusions regarding risk exposure or allocation to Empire and Empire's ratepayers (Updated Analysis Results – SUPPLEMENTAL TAX REFORM, James McMahon, January 24, 2018 in response to Missouri PSC Staff DR 2-14.

the 5% residual value of the project at the end of 10 years. The arrangement is very similar to a classic tax equity partnership, with the only difference being that the 40 percent equity contribution from Empire gets put into rate base with a complete assurance of recovery of both the investment and return, as long as the wind farm(s) generates electricity. In contrast to a PPA, in which variations in the volume of production is the seller's problem, in this arrangement the risk of changing project economics is borne exclusively by the ratepayers. Empire, save for a finding of imprudence, will recover both its investment and its allowed return.

Q. While PPAs have historically been the contractual vehicle of choice for regulated utilities to acquire wind resources from independent power producers and to secure financing for these types of projects, is it possible that an alternative model of wind resource development and ownership can exist?

A. In principle yes. In the current low or negative electric consumption growth environment, new investment opportunities in generation are essentially limited to replacement of generating facilities retired due to age, or to more stringent environmental regulations. It is understandable that utilities would be strongly motivated to invest in utility-owned generation on which to earn a return; instead of contracting with an external wind generator and simply passing the cost to the ratepayer. While there is nothing intrinsically wrong with this model, in order to be fair, its formulation would require that the proper reallocation of risk and reward is proposed and tested against a realistic assessment of the increased exposure of the ratepayer to the inherent risks of wind projects. Given the expanded role for the utility, from provider of reliable least-cost electric service to that of investor agent for the ratepayers (in order to reduce their net cost of electric service), the risk/reward allocation must be acceptable to the regulator. [3]

Q. Can you elaborate why you conclude that project risks would be reallocated to the ratepayers by Empire's CSP Proposal compared to traditional procurement of wind power via a PPA?

A. Under a PPA to supply a given annual amount of wind energy at a fixed price, the utility protects the ratepayer from most wind project financial risks. The CSP Proposal, exposes the ratepayers to most risks in the financial performance of the various wind projects.

The history of wind development demonstrates substantial uncertainty in ultimate project costs, plant performance, and future asset value. The Empire analysis either ignores or over-simplifies these uncertainties making its evaluation results unreliable. The completion, successful performance and realization of the value of the relatively complex infrastructure of a wind project, is ultimately subject to uncertainty in future electricity market demand and prices; the evolution of technology and its cost; and the vagaries of yearly weather patterns. The risk that project developers, investors, lenders and consumers of the electricity produced by a wind project are exposed to, will be the result of the

[3] This characterization may seem unfair as many utilities balance their supply portfolio against customer demand by selling excess capacity and/or energy and buying when they are short. However, the low firm capacity recognition of wind resources can produce and outsize excess of energy that must be sold - in this particular case to a market, which exposes the utility to significant merchant price risk.

uncertainty in the future outcomes of these variables, and of the allocation of the resulting risk to each; commensurate with their individual potential reward.

Q. Can you please elaborate on the nature of project development and performance risks?

A. Some risks commonly faced by wind project investors, including Empire's ratepayers under the CSP proposal, include the following:[4]

Project Development Risk. This risk reflects the uncertainty of a project reaching commercial operations at which point it begins generating electricity and the associated revenue. It is important to consider that the time and cost spent developing a project is entirely at risk until successful completion, as an unsuccessfully developed project has minimal asset value and limited or no revenue potential.

Construction Risk. This type of risk is mostly associated with the ultimate acquisition of the wind turbines and balance of plant equipment at the price predicated in the project's financial projections; its successful delivery to the site; and the timely completion of the wind project's construction. While the proper contractual protections and warranties in the construction of wind farms are well understood, delays in equipment delivery and in the erection of ever-larger wind turbines and supporting structures can still occur and hamper the ability of the project to start producing revenue.

[4] Wind Energy Finance in the United States: Current Practice and Opportunities, National Renewable Energy Laboratory, Technical Report NREL/TP-6A20-68227, August 2017

Preconstruction Energy Estimate Risk. Achieving the expected production of energy over the project's lifetime is of critical importance to its ultimate financial viability and success. This is the area of risk most frequently encountered in the operation of wind projects and is currently the focus of an industry-wide effort to close the gap between the predicted amount of energy generation and actual production, both initially and over time, by more accurate forecasting and enhanced O&M processes. Some credit rating agencies typically reduce any pre-construction energy estimate by up to 10% based on a number of project specific factors. Wind production forecasts are assigned probabilities according to their uncertainty. A P50 forecast represents an average level of generation; that is, half of the year's output can be expected to surpass this level while the other half is predicted to fall below it. While a P50 forecast, is perhaps good enough for project sizing and design purposes, lenders and investors often base their investment decisions on P75 or P90 forecasts, whereby production is expected to exceed the predicted level 75 or 90 percent of the time; respectively.

Equipment and Other Production Risks. Many factors can contribute to less than expected energy production and revenue, either temporary or permanent. These factors include weather anomalies; the reliability of the various project technologies; project availability; transmission outages and market operations curtailment; and longer than expected planned and unplanned maintenance events. The selection of proven wind turbine technology and of a capable entity to run and maintain the wind farm can mitigate but not eliminate this category of risks. The cost of maintenance is often predicated on manufacturer estimates and empirically on operators' experience. However, given the rapid evolution of the technology, experience acquired with one turbine model/generation only partially informs on the future cost of maintenance of a different/new turbine model/generation.

Regulatory Risk. This risk, while relatively small and as yet not encountered in the U.S. industry, is associated with the possibility of unexpected changes to regulatory incentive schemes, such as the PTC tax incentive, which must be realized over ten years of project operation.

Market Price Risk. This risk is related to the extent to which the selling price of the project's energy is unknown in advance. "Merchant" projects reliant on selling electricity to a market instead of relying on a fixed price PPA are exposed to this risk.

Q. Is your assertion that Empire has underestimated some of the risks that you describe earlier in your testimony based on a detailed analysis of these risks for the individual projects that Empire proposes to develop, own and operate under the CSP?

A. No. Such analyses could not be conducted as, at the time of Empire's application, the specific number, individual size, location and technical specifications of the wind projects comprising the CSP had not been identified.

Q. What is then the basis for your assessment?

A. My assessment is based on my almost 40 years of experience in wind energy, numerous due diligence advisory engagements for the financing of wind and other renewable projects, and the review of numerous studies and industry journal articles on the evolution of wind technology and the development of wind projects. .

Q. Can you please describe how, in your opinion, each of the risks you described above may affect the actual economic performance of the wind projects developed under Empire's CSP Proposal?

A. As I explained earlier, risks are inherently project-specific. Since the final selection of projects offered in response to Empire's RFP has not yet been completed, the final cost/benefit picture of Empire's proposal is not yet apparent. Nevertheless, I'll comment on the assumptions made by Empire to perform the proforma analysis of the wind resources in its proposal as they pertain to each of the risk categories described above, and explain why the assumptions made by Empire are either not consistent with the industry's experience or are excessively optimistic.

Let us examine first the risks in project development. Empire's proforma analysis of its proposal does not explicitly address construction risk. To judge by a preliminary review of some of the project sale offers obtained by Empire in response to its wind RFP, the offered projects span a wide range of developmental stages. Some are late stage projects with extensive site wind measurement studies, nearly complete interconnection facility studies and standing orders for turbines, while others are early stage projects with abbreviated wind speed measurement campaigns, often based on a single low height anemometric tower(s), in some cases aided by SODAR units. Without further due diligence by Empire of the projects offered , there may be significant risk in timely delivery of turbines and associate structures, particularly in light of the rush to complete many other wind farms in

SPP on time to collect the PTC. It is worth noting that the majority of the projects are proposing to use many of the same turbine manufacturers/models (Vestas and General Electric) of new generation large rotor turbines. This may also put a premium on the availability of qualified installation labor, even for the reputable wind developers that responded to Empire's RFP.

While the proper contractual protections and warranties in the construction of wind farms included in all the offers provide some protection for Empire, delays in equipment delivery and in the erection of ever-larger wind turbines and supporting structures can still occur and hamper the ability of the project to start producing revenue and risk not accessing the full PTC. This would have a significant impact on the projects financials.

A widespread problem with the economic performance of wind farms today, is the inability to match the Preconstruction Energy Estimates used during the development and financing stage of the wind farm

The predicted amount of energy production in Empire's analysis is based on hourly capacity factors calculated using wind speeds measured at 60 meters at Elk River extrapolated to a much higher hub height and the manufacturer power curve of a Vestas 116 wind turbine.[5]

If the hourly wind velocities used represent a P50 probability distribution, the predicted net capacity factor (NCF) of 54.1%, while sufficient for design work, cannot be relied upon to ascertain the financial viability of the projects.

[5] Response to KCC Staff DR 3-21.

Furthermore, a review of the responses to Empire's wind projects RFP reveals that not a single offer forecasts as high an NCF at P50 and with turbine hub heights above 100 meters. The highest NCFs offered are at the 49-50% level. Thus, as estimated by Witness Collin Cain in his testimony, the lower capacity factors will have a substantial impact on projected economic benefits and require a significant downward adjustment to the financial results of the Proposal. A possible explanation for the discrepancy may be that Empire's estimate of capacity factor does not take into consideration wake effects present in a wind farm, nor the influence of neighboring wind farms, which the RFP Proposals likely took into account. It is important to point out that even the most thorough wind measurement campaigns and terrain/wake modeling studies can lead to overestimation of production due to late stage design changes which affect the spacing between turbines, last minute changes in turbine models due to unavailability of the model studied, or turbine model replacement due to an opportunity purchase of a different model of turbine.

Even when a rigorous wind resource assessment is executed, the risk of performing below forecast is a relatively common occurrence. Weather risk due to a lack of wind, also known as resource risk, is the most often cited reason for not meeting performance expectations. This points to the need of basing project projections on more stringent wind forecasts such as P75 or P90, where the probability of wind velocities below forecast are reduce to 25% or 10%, respectively. Industry experience has shown that the majority of operating wind farms do not meet their predicted P50 energy values in an average year.[6] Other important factors that contribute to windfarm underperformance are higher-than-expected losses related to wind farm availability and sub-optimum individual turbine performance. Lesser factors include larger-than-modeled wake losses and unrepresentative wind resource data; the latter potentially becoming an issue, given Empire's reliance on proxy wind data in its proforma analyses.

Equipment and Other Production Risk.

Even well maintained wind turbines suffer a certain amount of efficiency degradation over time. A rule of thumb is in the order of 1.6 percent per year. Empire used a 1.7 percent degradation in the energy production estimates used by ABB in its MIDAS market analysis. However, Empire omitted the same adjustment for degradation in its proforma analysis, which contributed to an optimistic economic performance estimate as described by Mr. Cain in his testimony.[7]

In spite of regular maintenance, both preventive and corrective, suboptimal performance of individual turbines can occur due to factors such as blade pitch or yaw misalignments, anemometer calibration drift, and other control setting errors. This loss of performance is now known to be twice as large as originally thought; on average about 4 percent according to some experts. This in addition to current

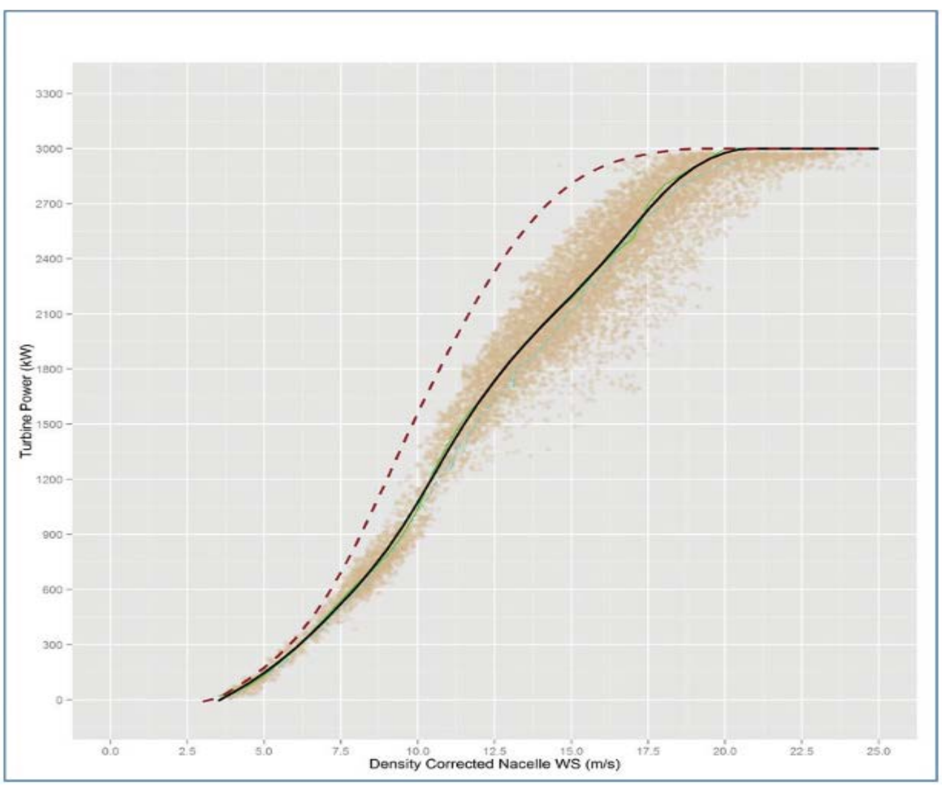
[6] The State of Wind Farm Underperformance Syndrome, Wind Systems Magazine, Bruce H. Bailey, March 2016, p.25.
[7] Testimony of Collin Cain on behalf of the Staff of the Kansas Corporation Commission in Docket No. 18-EPDE-184-PRE, March 1, 2018, p. 30 at 11

estimates for overall windfarm availability losses, based on verified wind farm data, which average around 6 percent for a typical windfarm.[8]

Empire's production estimates were based on wind turbine manufacturer power curves (as new) thus representing an optimistic expectation that no turbines will suffer from commonly experienced blade pitch alignment problems.

Figure 1 illustrates the suboptimal power curve (solid line) of a turbine with a pitch alignment problem compared to that of a well-operating turbine (dashed line).

Figure 1 - Power Curve of a turbine with pitch alignment problem compared to that of a well-operating turbine (dashed line)



Source: Wind Systems Magazine, Bruce H. Bailey, March 2016

[8] Bailey, *supra* note 4, at 25-26.

The fixed O&M costs estimates and ongoing capital expenditure expectations for the proposed wind projects used by Empire in its proforma analysis appear to have been developed internally by Empire Staff "*consistent with its budget and experience with wind plants*". [9] While these estimates, expressed as a Levelized Fixed O&M Cost ($/kW-yr), are much higher than comparable figures in the industry, they are kept constant through the 30-yr analysis horizon. This seems counterintuitive, as O&M increases with time as wind turbines age, component failures become more common, and manufacturer warranties expire. Recent surveys of wind farm O&M costs show increases in fixed O&M of between 11% and 20% after the first 10 years of operation. This increase may be even higher as wind turbines exceed the 20 year mark. On the other hand, most wind owners nowadays plan to refurbish or repower 10-15 years after commercial operation date (COD) to increase output or to reduce O&M costs.[10]

Q: Are there any other risks, beyond those related to the design and construction of the wind farms?

A: Yes. From their commercial operation dates, Empire's wind farms will sell their energy in SPP's Integrated Market (IM) at the Locational Marginal Price (LMP) of the node closest to each wind farm's point of interconnection. The two key risks to the revenue paid to Empire for the wind energy produced, are the increasingly large volume of wind energy generated by other wind farms in the

[9] Confidential Testimony of M. J. McMahon in Docket No. 18-EPDE-184-PRE, March 1, 2018, p. 29
[10] 2017 IHS Markit Wind O&M Benchmarking in North America: Summary of Key Findings

same area of SPP and Empire's being prevented from injecting their full production at a given point in time.

The first risk is driven by the increasing volume of wind offered into the market, as more new wind farms come on line, increased supply will increasingly depress prices, as is already happening in the western area of SPP. It is possible that ABB's MIDAS modeling of the market may have significantly underestimated this effect, as discussed by Mr. Cain in his testimony.[11]

The second type of market risk to Empire's wind farm revenues may come from increased curtailment due to transmission outages or during periods of very high winds when the system operator will be unable to take all wind energy generated. Another threat to Empire's wind energy sales revenue may come in the form of dispatch instructions to lower production for a given period of time. The SPP Staff has recently proposed to convert all renewable resources from non-dispatchable (NDVER) to dispatchable (DVER). Since this measure is intended to eliminate erratic price-following behavior by wind resources in regions with a high concentration of wind farms, it would not immediately affect the wind farms west of the Neosho-Riverton constraint sought out by Empire. Nevertheless, in the long-run, if new lower wind velocity turbine technology spurs the entry of increasing amounts of wind west of the constraint, the full output of Empire's wind farms may not be taken in the real time (RT) market, and other than partial

[11] Testimony of Collin Cain on behalf of the Staff of the Kansas Corporation Commission in Docket No. 18-EPDE-184-PRE, March 1, 2018, pp. 22-23

compensation from sales to ancillary service markets (regulation down, other products), Empire may experience a net reduction in wind farm revenue.[12]

Q: What evidence is there to conclude that wind project underperformance with respect to expectations is widespread in the wind industry?

A: Renewable development risk associated with cost and performance is not trivial as demonstrated historically. In 2015, an assessment of 350 wind farm years of wind farm performance from over 50 wind farms indicated that the tendency for large magnitude wind farm production under-performance is mainly driven by:[13]

- Curtailment, or larger than expected curtailment;
- Major mechanical or structural defects/low plant total availability; and,
- Large power curve under-performance.

Other studies have identified below-forecast weather and mechanical risks as the first and second highest cause of windfarm underperformance. The negative impact of too little wind has been directly cited in the financial results of utilities and wind farm portfolio owners.[14]

Another major study, recently conducted by IHS Markit, has identified a growing need for maintenance in the U.S. wind industry. The IHS Markit report comprises data from nearly 300 wind projects, representing 30,000 megawatts (MW) of

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[12] SPP Revision Request Recommendation Report, RR #: 272, RR Title: NDVER to DVER Conversion, February 6, 2018

[13] The Most Important Factors in Wind Farm Under-Performance, Gregory S. Poulos, AWEA Wind Resource & Project Energy Assessment Seminar 2015

[14] In 2015 Form 10-K Annual Report, NextEra Energy, one of the largest U.S. wind farm operators reported '*lower results from wind assets of $122 million primarily due to weaker wind resource*…"

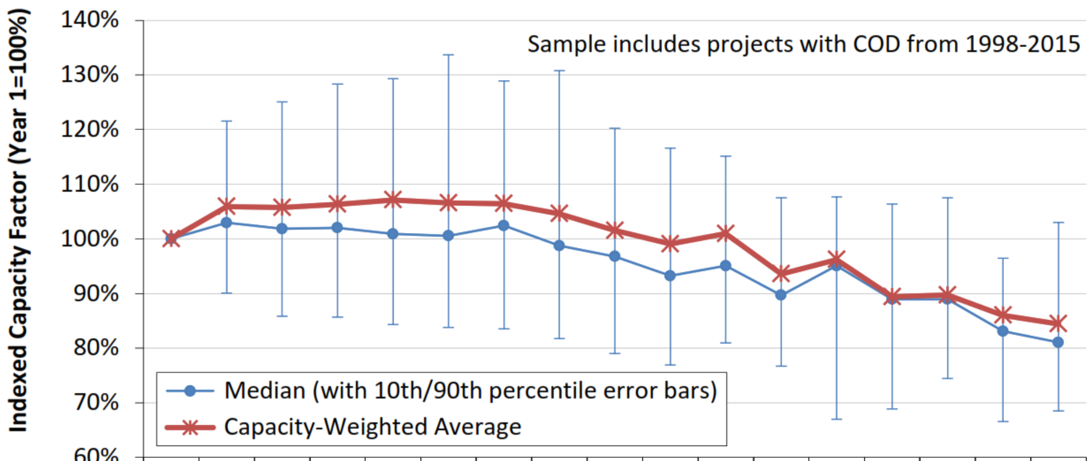
capacity and nearly 20,000 turbines installed in North America (about one-third of the market) with project start dates ranging from 1994 to 2016. The data represents more than 115,000 turbine-years of operational history, and gives study participants the ability to track projects and turbine performance over time. The IHS Markit study includes data on wind turbines manufactured by more than 15 wind turbine original equipment manufacturers.

The study found that the average age of the North American wind fleet will rise from 5.5 years in 2015 to 7 years in 2020, and to 14 years in 2030. Along with the aging of the wind fleet, equipment maintenance and operating costs are increasing significantly, leading operators to focus on performance optimization and cost management. The IHS study also points out that O&M costs are generally stable between three and twelve years of operation, with a pronounced spike between twelve and fourteen years as generators and gearboxes are replaced; with a quarter of all turbine gearboxes needed replacing within ten years of operation.

Although wind turbines are designed with lifespans of between 20 and 25 years, the aging of components such as blades and gearboxes, as well as blade pitch or yaw misalignments, anemometer calibration drift, and other control setting errors, ultimately result in individual turbine diminished efficiency and contribute to reduce wind farm availability.

Figure 2, illustrates the performance degradation of a large group of windfarms across the U.S. over time, showing how capacity factors decline with the number of years wind farms have been in operation.

Figure 2 - Wind Farm Performance Degradation with Time



Years post-COD:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Sample GW:	71.9	63.7	58.7	57.7	44.0	37.9	33.2	23.5	15.1	9.7	8.0	4.9	4.3	2.8	2.3	0.6	0.6
Sample projects:	819	754	715	681	545	462	400	282	200	141	118	91	83	61	36	12	9

Source: Berkeley Lab

Q. In your opinion, are Empire's reasons for proposing to invest in windpower valid?

A. Empire gives a number of reasons for preferring direct investment in wind assets over entering into a PPA, these include:

1. The ability to monetize the PTC through an equity investor and thus get to own the wind assets for forty cents on the dollar; [15]

2. Empire's experience as wind operator in SPP;

3. The advantages associated with being in a position of control; [16]

[15] Empire's response to APSC_001-04_837
[16] Empire's response to APSC_001-05_912

4. Lower wind energy cost than available through a PPA because Empire's cost of capital is lower than that of any merchant wind owners; [17]
5. The ability to net the revenue of selling the wind output in the IM against Empire's revenue requirement thus lowering customers' utility bills.
6. Under a PPA, Empire would be responsible for the PTC not generated during curtailments; [18]
7. Deriving benefits of owning the wind assets beyond the typical PPA's term (20yrs)

In my opinion, some of these reasons are more credible than others. Let me elaborate.

The availability of the PTC has undeniable value, but there are other means by which Empire could access that value other than through direct ownership. The generous tax incentive in the PTC has in fact been one of the most potent drivers behind the growth of the U.S. wind industry, producing consistent returns to many tax equity investors, wind project sponsors and operators of successfully built and operated wind farms. However, not all projects make it happily to the finish line. The risks in the development and operation of wind farm are significant, as I have described in earlier sections of my testimony, and the PTC, a policy-based incentive to promote the adoption of a rapidly improving technology with a rapidly declining cost curve, essentially guarantees obsolescence. The high returns made possible by

[17] Ibid., note 1
[18] Ibid

the PTC come with risks that are more appropriately borne by competitive entities not by regulated utilities and their customers.

According to Empire, a position of control, where they own, operate, and control strategic decisions related to the facility, would ensure that business decisions such as equipment upgrades, are based on Empire's goals and not an independent wind owners need to maximize profits and recoup their investment within the 20-year term of the PPA.[19]

Empire also posits that current windfarm equipment and technology results in lifespans in excess of 30-years for these assets, and that by owning, operating, and making strategic decisions as it relates to capital investments with these assets, Empire can ensure long-term, least cost benefits to Empire's customers. I see two problems with these conclusions. First, it is not clear what equipment upgrade costs (if any) were considered in Empire's O&M estimates, as no separate line item for "upgrades" is included in Empire's proforma analysis of the wind assets. If Empire expects that equipment upgrades will be necessary during the life of the assets, these costs should have been included in the CSP proforma analysis, as those expenditures would reduce the net benefits of the proposal. Second, as discussed elsewhere in my testimony, due to both normal performance degradation of wind turbines and the rapid decline in new turbine cost, independent wind owners often upgrade their facilities while under a PPA, to avoid higher maintenance costs, and

[19] Empire's response to APSC_001-05_912.

in order to extract additional production out of their windfarm. The result is the derivation of additional revenue over and above that provided by the existing PPA. So, while it is true that having control of already "permitted" land, with a good wind resource, and access to transmission will represent significant value twenty years from now, extracting this value will likely require significant additional investment over that period in order to own a reliable and competitive source of power. Empire has not built a clear case for the net benefit of such a long-run proposition.

Empire is also correct in pointing out that its cost of capital is lower than that of a merchant wind owner, thus making the cost of wind energy owned by the utility lower that it would be through a PPA. This lower cost of capital is related to the lower business risks, relative to a merchant provider, to which a regulated utility business is exposed, which is related to its ability to recover costs from captive ratepayers. Empire's proposal, by virtue of exposing ratepayers to the volatility of electricity market prices beyond that necessary to serve load, may benefit from the perception of the credit rating agencies that assured recovery of the investment and its associated return represents a low risk business, but it only does so by transferring price risk to the ratepayers. This, as I pointed out earlier in my testimony, would only be acceptable if the regulator accepts that having the ratepayer exposed to market price risk of the magnitude proposed by Empire through owning and operating 800 MW of wind generation, even with the resulting drop in customer utility bills, is in the public interest.

Empire has stated that when a PPA controlled intermittent resource has a take-or-pay clause and is curtailed within the SPP Integrated Market, Empire would be responsible for the value of the PTC for each MWh curtailed

It is true that historically, as the parties to a wind PPA decided who would bear the financial risk for losses occurring when the purchaser, transmission owner or transmission authority curtailed the output of the facilities, the sponsor and tax equity investor would often insist on making the PPA a "take-or-pay" agreement. That meant that the purchaser would pay the seller for wind energy actually delivered to the point of delivery, and for energy that would have been delivered but for the curtailment. If the offtaker were unable to accept the energy contracted, the seller would still want to be compensated. Also, as instances of reliability driven curtailment rose due to additional wind capacity coming online and the failure of transmission capacity expansion to keep up with these wind additions, the terms in the PPAs started to change incorporating a greater sharing of risk between the generator and the off-taker.

Today, compensation to the seller for curtailment varies as the purchasers have pushed back against the requirement to pay the seller both the agreed price for the available output and an additional "grossed up" amount reflecting the federal production tax credit ("PTC") value. Utilities increasingly insist on including a negotiated amount of uncompensated hours in their PPAs or place limits on the total amount of such compensation. And, some organized markets like SPP and

MISO, sometimes offer compensation through make whole payments when curtailed from scheduled delivery.[20]

While Empire's legacy PPAs may include onerous PTC compensation language, a newly negotiated contract would not necessarily be equally onerous. Furthermore, the tax equity investor(s) in Empire's proposal may require to be kept whole in the collection of the PTC if curtailment starts climbing again as more wind comes on line.

Q. Do you have any other concerns regarding the outright ownership of wind projects vis-à-vis purchasing wind energy through a PPA?

A: Yes. While a given technology may have an expected functional life of 20 years or more, economic life may be much shorter. Higher efficiency and declining cost curves continue such that today's wind turbine technology is almost certain to be relatively costly 20 years from now, with respect to future alternatives.

Wind technology has a history of rapid advances with taller towers, larger and more efficient rotors, and variable speed generators, which have allowed the exploitation of lower wind speed sites and generally higher capacity factors.

To address an aging wind turbine fleet and its increasing O&M expenditures, project owners are increasingly turning to repowering -- replacing obsolete turbines with new more powerful turbines at the same project site, replacing select

[20] Non-dispatchable Variable Energy Resources (NDVERs) cannot be dispatched down by SPP but can be curtailed via manual dispatches. SPP only issues such manual dispatches for reliability purposes, not economic purposes, and NDVERs are not compensated for these curtailments. However, Dispatchable Variable Energy Resources (DVERs) can be dispatched down by SPP to provide regulation down service, and like any other resource, are paid for the energy and/or reg down service they provide.

components such as blades or gearboxes on existing turbines, or even increasing hub heights and rotor diameters to produce more energy. In announcing the release of its Annual Electric Generator Report, EIA cited data from GE, which reported having already repowered some 300 wind turbines, indicating that repowering can increase wind turbine fleet output by 25 percent and add 20 years to the life of the turbine. The National Renewable Energy Laboratory (NREL) has indicated that annual U.S. wind repowering investment has the potential to grow to $25 billion by 2030.[21]

One of the salient benefits of wind farm ownership over entering into a PPA advanced by Empire in its proposal, is that after 20 years, Empire will still own the wind assets. However, there is evidence that the risk of technological obsolescence and higher O&M costs due to aging are prompting many wind owners to plan to refurbish or repower as early as 10-15 years after start up to increase windfarm output or to reduce O&M costs.

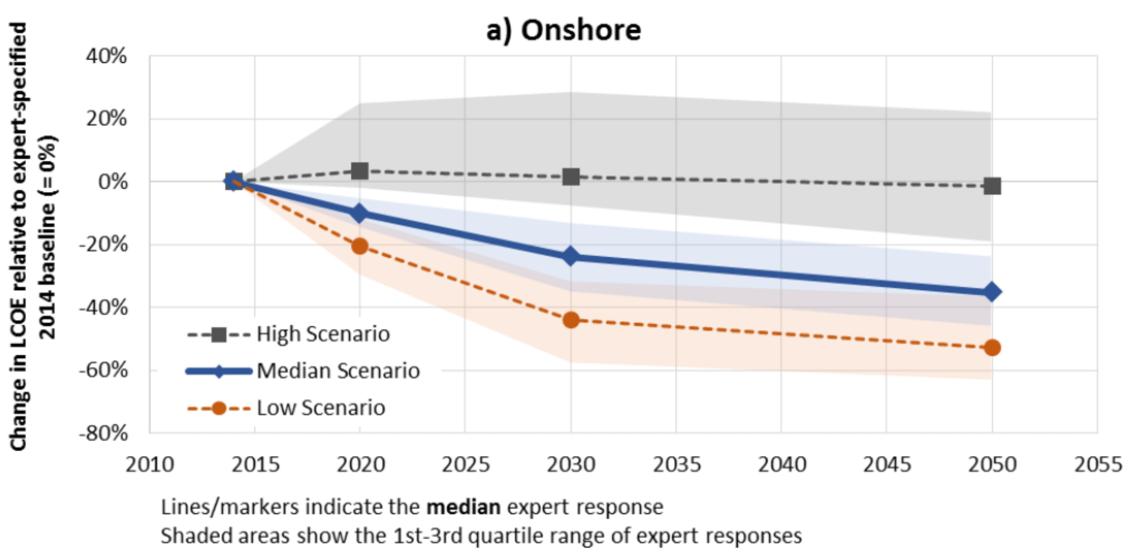
It is not clear whether Empire has assessed the impact of potential partial repowering costs in its economic feasibility analysis of owning and operating 800 MW of wind farms. Nor is it clear whether Empire has considered that ownership of the assets, predicated on economic benefits accrued over 30 years, forecloses the option of cheaper and more reliable wind generation as it becomes available.

[21] Repowering wind turbines adds generating capacity at existing sites, November 6, 2017. https://www.eia.gov/todayinenergy/detail.php?id=33632

Q: Why do you believe that wind technology will continue to improve at an accelerated pace ultimately rendering current wind technology obsolete?

A: Recent assessments of the current status of wind technology and priority research areas suggest that levelized costs (LCOE) could come down significantly from today's costs. In 2016, a study authored by the Lawrence Berkeley National Laboratory, NREL, the University of Massachusetts and the International Energy Agency, reported that mostly due to further increases in size: "LCOE is anticipated to decline by 24 percent to 30 percent in 2030 and by 35 percent to 41 percent in 2050, relative to 2014 baseline values". The study polled 163 wind energy experts from industry and academia.[22] Figure 3 depicts a graph showing the trends identified in the study.

Figure 3 - Expected change in wind LCOE according to survey of industry experts



Source: Forecasting Wind Energy Costs & Cost Drivers: The Views of the World's Leading Experts, LBNL, NREL, Insight Decisions, LLC, University of Massachusetts—Amherst, LBNL- 1005717, June 2016

[22] Forecasting Wind Energy Costs & Cost Drivers: The Views of the World's Leading Experts, LBNL, NREL, Insight Decisions, LLC, University of Massachusetts—Amherst, LBNL- 1005717, June 2016.

A more recent (August 2017) report by the wind R&D program at NREL reports that wind LCOE could come down roughly 50 percent by 2030 from today's wind power cost through continued development of technologies and practices aimed at the key areas that limit the efficiency of current wind systems. According to the report, next-generation wind farms will be able to produce more energy, more reliably, for more hours of the day, through continued innovation in four key areas:[23]

1. Better predicting performance through better modeling of local wind conditions;
2. Better design and control at the plant level by using sensors and real-time monitoring of wind flows as they move through the turbines;
3. Better design and control at the turbine level through "innovative rotor and drivetrain technology" and scale (taller towers and bigger blades); and
4. Smarter grid integration by giving each turbine the ability to communicate directly with the grid operator, play a role in its "stability and operational planning," and offer it various extra services like voltage regulation.

These reductions, even at the lower levels brought about by larger size alone, are likely to exist in 2030; well within the assumed useful life of Empire's projects.

[23] Enabling the SMART Wind Power Plant of the Future Through Science-Based Innovation, NREL, Allegheny Science and Technology, Technical Report NREL/TP-5000-68123, August 2017

This reduction in costs will happen incrementally, prompting the gradual entry of new more efficient wind projects capable of generating electricity at lower prices than those offered by today's projects.

While policies by the current U.S. federal administration are to reduce funding levels to applied R&D in renewables, possibly delaying the development of advanced wind technologies in the U.S., the largest wind technology companies are not U.S. based and will continue to push wind turbines towards larger capacities, taller hub heights and larger rotors. This is particularly apparent in offshore wind turbines, which are now reaching 10 MW (in 9 m/s wind regimes). The largest of these new turbines have rotors as large as 180 meters sitting atop 200 plus meter structures. Just as the new IEC Class III turbines, developed for low wind regimes, featuring larger rotors and lower specific power ratings (smaller generator capacities for the rotor size) are now being pressed into service at medium wind velocity sites, technologies developed for offshore use will be adapted to onshore applications. A possible limit to much larger sizes for onshore turbine rotors may ultimately be imposed by the logistics of their transportation and installation.

Beyond the current administration, a renewed recognition of the value of wind energy in combating climate change and its ability to generate at a cost lower than almost any other technology will likely see a restoration of U.S. government funding for wind technology R&D and some form of fiscal incentive to promote its adoption.

IV. CONCLUSIONS

Q. Please summarize your recommendations.

A. 1) Until Empire finishes evaluating the wind project sale offers obtained in response to its RFP, it will be impossible for the Commission to evaluate whether the Empire's proposal is in the public interest. The Commission must first weigh the risks of projects in different locations, proposing to use different wind turbine sizes/model, and forecasting different production forecasts, prices and other associated risks (stage of development, technical and financial wherewithal of developer, track record, etc.),

2) The risk allocation between Empire's shareholders and the ratepayers seems, in my opinion, asymmetric in favor of the shareholders; who recover the investment and a return whether the project underperforms with respect to expectations or exceeds them. Empire is asking to share on the upside (reduction in revenue), but pays no price for underperformance. An option for Empire would be to purchase wind through a PPA at no risk to the ratepayers, leaving the risk and the potential rewards to the developer and its investors and lenders, commensurate with their exposure to underperformance risk.

Q. Does this conclude your testimony?

A. Yes, thank you.

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NICOLÁS PUGA, MSC
Partner

AREAS OF EXPERTISE

- Power generation
- Transmission modeling
- Regulatory and tariff analysis
- Feasibility and siting studies
- Renewable energy
- Supply-demand assessment

SUMMARY OF EXPERIENCE

Nicolás Puga has □□ years of experience as an energy advisor to generation, transmission and distribution companies, project developers and lenders in the analysis of electric power and natural gas markets, generation and transmission project development, utility supply resource planning, and renewable energy. He has testified as an expert in several state transmission line and power plant certification and abandonment proceedings in California, Kansas, New York, Texas, Virginia, West Virginia and the FERC. Mr. Puga has conducted technical, market and economic due diligence in numerous wind, solar, and hydroelectric generation projects for developers, equity investors and lenders. He has been an advisor to the Mississippi Public Service Commission and Mississippi Public Utility Staff since □□1□ on a broad range of issues related to resource and transmission planning and operations within the MISO. Mr. Puga has worked in most major organized energy markets in North and South America as well as in Australia and the Philippines. He has co-authored several studies on US-Mexico cross border energy trade and testified on the development of renewable energy resources along the US-México border. Mr. Puga has an MSc in Energy Systems from the Nuclear Engineering Department of the University of Arizona and a BSc in Electrical Engineering from the Universidad de Guanajuato, Salamanca, México.

SELECTED INDUSTRY, GOVERNMENT, AND BUSINESS CONSULTING EXPERIENCE

Engineering, market, economic, and financial advisory

- Conducted market and commercial due diligence in the acquisition of a large combined cycle facility under construction and advised investors on the risks in the existing long-term energy and capacity PPA with CFE. The long-term analysis of the plant's commercial viability required the development of a □□-yr generation and transmission expansion plan for the regional transmission system in which the plant will operate, and an analysis of the long term availability of natural gas to fuel the generating facility.
- Conducted a valuation of a run-of-river hydroelectric facility under development in Mexico. The valuation considered the potential revenue from the sale of Clean Energy Certificates during the economic life of the project.

- For two Canadian pension funds, conducted market and regulatory due diligence on a portfolio of greenfield hydroelectric and wind generation projects in various stages of development, including the feasibility of transmission access and the risk of security and social unrest. Evaluated the economic viability of early development stage projects in the portfolio under restructured electric market conditions and the projects competitiveness in future renewable energy auctions.
- Led the market and regulatory due diligence for the acquisition of a series of run-of-the-river mini-hydro generating facilities with an aggregate capacity of 1[illegible] MW in Colombia. The DD review of the projects included the analyses of the legal and regulatory framework of the Colombian energy sector, its energy demand/supply balance, the planned expansion of its infrastructure, the structure and operation of its electricity market and the mechanics of electricity price formation. An econometric model was developed to forecast the spot market price of electricity over the life of the project.
- For Macquarie Capital (Mexico), carried out electric power market price and regulatory risk analyses in support of the acquisition of the [illegible]-MW Mareña Renovables wind farm project in Oaxaca, México. The project was acquired by the Macquarie Mexican Infrastructure Fund (MMIF), MacCap and PEMS, from Preneal, a Spanish wind farm developer.
- Developed zonal and nodal market price forecasting models of México's interconnected electric power grid using the using ABB's MarketPower and PROMOD IV simulation platforms for dispatch analysis and economic determination of long-term capacity additions. The models have been used in the independent market and economic analysis of several natural gas and renewable energy generating facilities, as well as in the economic analysis of US-México cross-border electricity trade.
- Developed a comprehensive briefing on the laws, regulations and electric market rules for a Canadian generation project developer and operator considering entry into the Mexican electric market auctions. The briefing explored available business opportunities and associated risks for bilaterally contracted and merchant generation projects.
- Retained by México's largest cinema chain to advise on the acquisition of renewable electricity supply for its cinemas. Developed an electric load model for the chain to accurately reflect the unique load patterns of the business and applied it to compare the cost of energy and capacity supply, from several candidate renewable energy suppliers, to that of the Mexican government utility. Assisted in evaluating the disparate terms and conditions of various competing supply offers on a comparable basis.
- Conducted a due diligence review of generation- and transmission-related risk for a wind electric generation project owned by multiple remote industrial offtakers. On behalf of the project's lenders, studied numerous issues related to a unique Mexican interconnection and energy value banking contract that enables intermittent renewable generators to firm-up supply to their offtakers.

- Conducted a historical and prospecti□e analysis o□marginal prices o□electricity in the □S and M□xico States o□ Texas□ Ne□ M□xico□ □ri□ona□ Sonora and Chihuahua □or a leading □S independent transmission de□eloper. Locational marginal prices □LMPs□in the □S markets o□interest □ere modeled using □□ROR□xmp□a multi-area□transmission-constrained chronological economic dispatch model de□eloped by EPIS□Inc. Short-term load-□eighted LMPs □ere modeled □or loads and □uel prices forecasted using "frozen" transmission and generation topologies □no expansion□
- □s transmission ad□isor to a ma□or Spanish energy company□ad□ised on the technical and economic aspects o□a proposed □□□-M□ □ind □arm located in the northern Ba□a Cali□ornia□M□xico. □d□ised the pro□ect de□eloper in negotiations □ith potential pro□ect o□□takers and transmission o□ners□and supported its applications □or interconnection □ith the Cali□ornia ISO and □or certi□cation as an in-state rene□able resource □ith the Cali□ornia Energy Commission. □acilitated communications bet□een the Mexican and Cali□ornia energy policy and regulatory authorities and grid operators. Carried out a comparati□e analysis o□en□ironmental and other siting regulations applicable to □ind po□er pro□ects in the □S and M□xico.
- Carried out a due diligence re□ie□ o□transmission-related risk □or a □ind electric generation pro□ect o□ned by multiple remote industrial o□□takers. On behalf of the project's lenders, studied numerous issues related to grid risk□including □1□the incidence o□interruptions at the interconnection point due to system emergencies□□□potential grid instability due to rapidly gro□ing □ind capacity interconnecting to the same area o□the grid□□□the incidence o□ser□ce interruptions in the deli□ery points□4□the condition and maintenance practices associated □ith local reception □acilities□□□uncertainty in utility interconnection re□uirements and cost□and □□the □uture stability o□the pricing pro□sions in the project's transmission contract.
- Carried out market□regulatory□and commercial due-diligence as independent market consultant to senior lenders in the □nancing o□the 1□□-M□ La □entosa–El□ctrica del □alle de M□xico □ind □arm in Oaxaca□M□xico □SII□Credit □gricole Indosue□□ One o□the □rst large-scale □ind □arms in M□xico□this pro□ect presented the lenders □ith □arious types o□pro□ect risks ne□er addressed be□ore in M□xico. □ssessed the technical□market□and regulatory risks o□the pro□ect and □ormulated potential mitigation measures. The e□□ort resulted in the □rst-time recognition by the Mexican go□ernment o□the need to rein□orce the grid to accommodate the large □ind po□er potential in the La □entosa□Oaxaca region.
- Conducted market□regulatory□and tari□□analyses □or □nancing due diligence o□a □□□-M□ gas-□red combined-cycle plant independently o□ned and operated in M□xico. □s one o□the □e□ IPP plants in M□xico to sell po□er to C□E □ithout a □uel price □arranty □rom the go□ernment□the plant □as sub□ect to dispatch risk during periods o□high natural gas prices and relati□ely lo□ residual oil prices. De□eloped analysis o□the impact o□high natural gas prices on plant dispatch. This analysis contributed to the Mexican government's renegotiation of the plant's natural gas supply contract.

- Led an independent due diligence analysis o□the Interim □inancial Model supporting the non-recourse financing o□a 11□-M□ □ind electric project in Oaxaca□M□xico. The purpose o□the analysis □as to assess the integrity of the model's performance in pro□ding reported results for the financing plan as implicitly designated in the Model□ and as generally described in the Preliminary Information Memorandum □PIM□ for the Project. This □as primarily a re□ie□ o□the model logic and calculations. The assessment looked at the model's performance with respect to a number o□determinati□e factors□ including□total project costs and disbursement o□e□uity and debt during the construction period□ expected re□enue during operations□expected costs during operations□debt ser□ice per the described loan and hedging arrangements□debt ser□ice co□erage ratios□debt ser□ice reser□es□and net earnings and return on e□uity for the sponsor.

  □ ith respect to the determination o□project costs□re□enues and operating costs□the model □ere checked for consistency with the Technical Consultant's draft report prepared by a wind technology firm retained by the project sponsors.

- De□eloped a GIS-based project-siting methodology for utility-scale solar photo□oltaic generation facilities. The methodology considers the location o□transmission and sub-transmission infrastructure along □ith kno□n siting constraints□ including county land-use plans□ utility and conser□ation easements□en□ironmentally sensiti□e areas and critical habitats□state and national parks□and military bases. Parcel o□nership GIS-data enables the project de□eloper to expedite the ac□uisition o□project land and right o□□ay for project access and interconnection infrastructure.

- Developed a comprehensive market price forecasting model of México's interconnected electric power grid. Capable o□analy□ing system dispatch and pricing at the regional le□el□the model represents the Mexican power grid as a network of seven distinct "market areas." The model uses Ventyx's MarketPo□er□ simulation platform for dispatch analysis and economic determination o□long-term capacity additions. The model's inputs describe the regional demand forecasts□ capacity additions/retirements□ fuel price forecasts□ and transmission capacity. □dditional inputs for each generation plant in M□xico□ current and planned□ describe key thermal□ electric and economic characteristics □capacity□fuel□type o□prime mo□er□heat rate□O□M□forced outage rates□maintenance□ and availability). The model simulates generation dispatch given individual generator's projected cost o□operations and inter-area transmission system limitations. The model has been used to support the financial analysis o□se□eral natural gas and □ind po□er plants□as □ell as in the economic analysis o□ □S-M□xico cross-border electricity trade.

- □or a leading solar photo□oltaic manufacturer□de□eloped a comprehensi□e geo-referenced primer on the electric po□er markets o□California□□ri□ona□Ne□ada□and Ne□ M□xico. This extensi□e reference □olume makes use o□hyperlinked geo-referenced maps to pro□ide optional depth understanding o□the South □ estern □S solar resources□electricity demand□generation and transmission infrastructure□and policies and regulations regarding rene□able portfolio standards and interconnection to the electric po□er grid. This hyperlinked primer is used by upper le□el management in the firm.

- Coordinated collaboration between the California Energy Commission (CEC) and Mexican Government energy agencies to implement border policy options defined in the CEC's 2005 Integrated Energy Policy Report. Utilized long-established working relationships with senior management and staff at Mexican energy agencies to address the practical economic and political implications of coordinating cross-border energy policymaking.
- Performed a market assessment of energy efficiency technologies and combined heat and power for industries in the California/Baja California cross-border region for the California Energy Commission (CEC). Designed an innovative market research framework using field surveys (and other resources) and GIS techniques to collect and deliver market data that enabled US technology and project development companies to better target potential customers. To improve survey response rates, arranged survey collaborations with key industrial chambers of the three major cities and the Baja California state government.
- Performed energy supply and demand assessment for the California/Baja California Border region in response to the California Energy Commission's (CEC) need for new statewide energy policies. Reported on the energy demand and supply situation in the region of Baja California, México. Compiled information on electric generation and transmission expansion plans, government demand-side management programs, and liquefied natural gas regasification supply plans.
- Developed a fuel-purchasing risk-management strategy, organizational structure, and IT systems design for the new risk-management department of México's Comisión Federal de Electricidad (fifth largest electric utility in the world). Participated in various capacities in developing an overall strategic plan for fuel risk management and in the design of the necessary organizational structure, business processes, and systems to establish a fuel procurement and risk management organization to address all risks associated with fuel markets, foreign exchange, and interest rates.
- In connection with a project sponsored by the World Bank, studied electric outage costs for the Secretaría de Energía y Minas. Formed a strategic alliance with a local firm and retained one of the world's foremost experts in outage costs. (Argentina's financial crisis precluded the completion of this work.)

Regulatory and litigation support

- Retained by an independent power producer in México as subject matter expert in an international arbitration proceeding subject to the International Court of Arbitration of the International Chamber of Commerce. The subject of the dispute involves the payment for damages claimed by the CFE resulting from an alleged contract breach related to the IPP failure to maintain the generating facility's demonstrated capacity during a certain period of time.

- □d□sor to the Mississippi Public Ser□ce Commission in state regulator □orking groups assessing the capacity bene□t metrics o□ne□ transmission to□ards lo□ering the Planning Reser□e Margin used in establishing Resource □de□uacy in MISO.
- Expert □itness on behal□ o□ Mississippi Public Ser□ce Commission in *Louisiana Public Service Commission v. Entergy Services, Inc.* □□ERC□Docket No. EL11-□□-□□□□□on the appropriate treatment o□po□er plant cancelation costs under the Entergy System □greement □ES□□
- On behal□o□the Mississippi Public Ser□ce Commission□lead a team o□experts in electric po□er markets in an independent e□aluation o□the bene□ts to Mississippi electricity consumers deri□ed □om Entergy □oining the Mid□est ISO.
- Led a team o□experts in economics□po□er plant emissions control□and po□er market modeling in the e□aluation o□the economic □easibility o□retro□tting the LaCygne coal-□red generating □acility□an aging coal □red generating plant in Kansas□to meet recently adopted and proposed en□ronmental regulations. Testi□ed in □ont o□the Kansas Corporation Commission on the key assumptions and uncertainties dri□ng the □uture prices o□natural gas and lo□-sul□ur □estern coal □hich that □ill likely determine the long-term □uture competiti□eness o□coal □red plants.
- E□aluated technical aspects o□the proposed spin-merge of Entergy's transmission assets to ITC Holdings Corp.□and ad□sed the MPSC on alternati□e paths to achie□e the same planning and operational excellence claimed to be achie□able only through the proposed transaction.
- □or the Mississippi Public □tilities Sta□□conducted a re□e□ o□the □pplications □or Certi□cates o□Public Con□enience and Necessity and the associated Po□er Purchase □greements □led □ith respect to t□o solar generation pro□ects in Mississippi in order to assess both the economics o□the proposed pro□ects and the risks that the generator and its ratepayers □ould be exposed to by entering into these agreements.
- □or the Mississippi Public □tilities Sta□□re□e□ed a regulated utility's Transmission and Distribution Expansion and Moderni□ation Plan. The re□e□ assessed □hether the Plan pro□ded a complete picture o□the utility's T□D planning and expenditures□purpose o□T□D spending□the proper determination and prioriti□ation o□total spending le□els□and the establishment o□measures o□progress to□ard speci□ed goals o□er time.
- Expert □itness in the independent reliability needs assessment and economic impact analysis □or the proposed □□□k□ Potomac □llegheny Transmission Highline □P□TH□□or the Public □tility Commission o□□ est □irginia □On-going□
- Testi□ed on behal□o□the □irginia State Corporation Commission Sta□□about the use o□Smart Meters in a utility Conser□ation □oltage Reduction □C□R□program designed to reduce electric distribution losses and to conser□e energy at customer □acilities. The analysis compared the cost o□relying on □d□ance Metering In□astructure to that o□traditional C□R technology.

- Served as expert witness appearing in licensing proceedings of the New York Public Service Commission (NYPSC) with respect to the application of New York Regional Interconnect, Inc. (NYRI) to construct and maintain a 1[illegible]-mile, 1[illegible]-MW HVDC transmission line. The main focus of the testimony was the inferiority of energy efficiency and demand-response programs as a fully equivalent alternative to the proposed transmission line, and the line's ability to bring upstate NY wind generation to the Hudson Valley and NYC.
- Managed the independent reliability needs assessment of the proposed [illegible]-mile [illegible] Junction-Mt. Storm-Meadow Brook-Loudoun [illegible] kV Transmission Line for the Virginia State Corporation Commission. The work involved load flow modeling of multiple transmission, generation, and demand response alternatives scenarios capable of reliably serving the forecast load. Prepared and presented testimony as to the ability of PJM's RPM demand response programs to provide the same level of long-term reliability as that of the proposed line.
- Analyzed the necessary conditions to deliver renewable energy from northern Baja California to California, evaluating the status of existing and anticipated energy infrastructure on the México side of the California-Baja California border. Developed growth projections and analyzed energy infrastructure options for Baja California, including the potential for development of renewable energy generation, treatment of out-of-country renewable resources under the California RPS eligibility guidelines, and the eligibility of energy-for-export wind generation projects in México for Clean Development Mechanism (CDM) certification.
- Supported a major wind project developer in the evaluation of transmission options to wheel several hundred megawatts from Northern Baja California, México, to California utilities. Supported project developer in challenging the timeliness and results of the interconnection feasibility study performed by the transmission owner under the CAISO Large Generator Interconnection Process and represented the developer in the Generator Interconnection Process Reform (GIPR) stakeholder meetings. The GIPR led to the current FERC-endorsed project cluster analysis approach to managing the CAISO interconnection queue.
- Expert witness in the permitting of Texas/Northeast México's first high voltage direct current open access transmission interconnection (Sharyland Utilities/Hunt Power). The Public Utility Commission of Texas (PUCT) found no justification for investing ratepayer's funds in the construction of a 300-MW DC tie between Texas and México's transmission systems. Proponents raised the project to the consideration of an Administrative Law Judge to seek public funding approval. The Texas ALJ was persuaded by what he said was "particularly persuasive" testimony and recommended the PUCT approve the projects. The tie became operational during the summer of [illegible].

PROFESSIONAL EXPERIENCE

- Bates □ hite Economic Consulting□□ ashington□DC
  - Partner□□□□8–present
  - Principal□□□□□–□□□8
- Energy □d□sor to Na□igant Consulting□Inc.□□ ashington□DC□□□□□–□□□□
- Director General□Na□igant Consulting de M□xico□Na□igant Consulting□Inc.□□□□□–□□□□
- Director□International Management Consulting Ser□ices□Na□igant Consulting□Inc.□□ ashington□DC□1□□□–□□□□
- Resource Management International□Inc.
  - Senior □ice President□□ ashington□DC□1□□□
  - □ice President□Resource Planning Di□sion□Manila□Philippines□1□□□–1□□8
  - □ice President□Demand-Side Management□Sacramento□C□□1□□1–1□□□
- □ice President□Demand-Side Management□□NCO Engineers□Inc.□Cul□er City□C□□1□84–1□□1
- Research □ssociate□□ni□ersity o□□ri□ona□Department o□Nuclear and Energy Engineering□Tucson□□□□1□81–1□84
- Research Engineer□□lternati□e Sources o□Energy Di□sion□Instituto de In□estigaciones El□ctricas□Cuerna□aca□M□xico□1□□□–1□8□
- Design Engineer□Special Pro□ects□Comisi□n □ederal de Electricidad□Celaya□M□xico□1□□□–1□□□

EDUCATION

- MSc□Energy Engineering□□ni□ersity o□□ri□ona
- BSc□Electrical Engineering□□ni□ersidad de Guana□uato□Salamanca□M□xico

CERTIFICATE OF SERVICE

18-EPDE-184-PRE

I, the undersigned, certify that a true and correct copy of the above and foregoing Direct Testimony of J. Nicholas Puga on Behalf of the Kansas Corporation Commission was served via electronic service this 1st day of March, 2018, to the following:

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