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**PUBLIC SERVICE COMMISSION**

**OF THE STATE OF MISSOURI**

**CASE NO. ER-2019-0335**

# REBUTTAL TESTIMONY

**OF**

**TODD SCHATZKI, Ph. D.**

**ON**

**BEHALF OF**

**AMEREN MISSOURI**

**Boston, Massachusetts**
**January, 2020**

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## I. INTRODUCTION AND WITNESS QUALIFICATIONS

**Q. Please state your name, business address and present position.**

A. My name is Todd Schatzki. I am employed by Analysis Group, Inc. ("Analysis Group"), where I am a Principal in the Boston office. Analysis Group is a firm that provides microeconomic, strategy and financial analyses. My business address is 111 Huntington Avenue, 14th Floor, Boston, MA 02199. Analysis Group has more than 1,000 employees and offices in Beijing, Boston, Brussels, Chicago, Dallas, Denver, London, Los Angeles, Menlo Park, Montreal, New York City, Paris, San Francisco and Washington, D.C.

**Q. Please summarize your professional experience and educational background.**

A. I received a Bachelor of Arts in physics from Wesleyan University, a Masters in City Planning, Environmental Policy and Planning from the Massachusetts Institute of Technology, and a Ph.D. in Public Policy from Harvard University. Since receiving my doctorate degree, I have worked with several economic consulting firms, including National Economic Research Associates, Inc., LECG, LLC and now Analysis Group. My professional experience and qualifications are summarized in my curriculum vitae, which is included as **Schedule TS-R1**.

For more than twenty years, I have worked on energy sector economics, regulation, and policy, including work for government agencies, regulators, market operators, non-profit organizations, and private corporations. This work has included: market design; economic and financial analysis of energy and environmental regulations and infrastructure changes; ratemaking design and analysis; design and assessment of environmental regulations affecting the electric power sector; and assessment of market competition and market conduct. My work has appeared in both academic and industry journals such as the *Journal of Environmental Economics and Management*, *The Electricity Journal*, and *Public Utilities Fortnightly*, and in publications associated with institutions such as the AEI-Brooking Joint Center for Regulatory Studies and the Harvard Regulatory Policy Program.

I have extensive experience in wholesale power markets in many regions of the U.S. I have helped in the review and redesign of market rules used in organized wholesale markets, performed economic analysis of the impacts of proposed market rules, evaluated resource performance under existing market designs, and assessed economic damages associated with disputes regarding wholesale power contracts. I have worked for market operators in New England ("ISO-New England") and New York ("NYISO") on a variety of issues related to market design, market monitoring, and the impact of market rule changes under consideration. My work has involved issues in many organized wholesale markets, including Alberta Electric System Operator, California ISO, ISO-New England, Midcontinent Independent System Operator, Inc. ("MISO"), NYISO, PJM Interconnection, and Southwest Power Pool ("SPP"). This work encompasses all of the markets operated in these organized markets, including

markets for capacity, energy, and ancillary services. In these engagements, I have worked on behalf of the system and market operators, market monitors, and market participants. I have submitted testimony to federal, state, and provincial (Canada) regulatory commissions, including testimony before the Missouri Public Service Commission.

**Q. On whose behalf are you testifying in the current proceeding?**

A. I am testifying on behalf of Union Electric Company d/b/a Ameren Missouri (the "Company," "Ameren Missouri," or "Ameren"), a wholly-owned subsidiary of Ameren Corporation, in support of its request to revise its base retail rates for electric service.

## II. PURPOSE, SCOPE, AND SUMMARY OF CONCLUSIONS

**Q. What is the purpose of your testimony?**

A. I have been asked by Ameren Missouri to evaluate the analysis and findings of Sierra Club witness Mr. Avi Allison related to the participation of certain of Ameren Missouri's coal-fired units in the MISO energy markets.[1] In particular, I have been asked to assess Mr. Allison's evaluation of the Company's practices for self-commitment (referred to as "must run" in MISO) of these coal-fired units, and its offers for incremental energy from these units.

**Q. Please summarize your conclusions.**

A. In my testimony, I reach several conclusions:

1. The practice of self-committing so-called long-lead time units, rather than committing these units through economic offers, is economically justified (i.e.,

[1] These issues are discussed in Section 5 of Mr. Allison's testimony. Direct Testimony of Mr. Avi Allison, Public Service Commission of the State of Missouri, File No. ER-2019-0335, December 4, 2019 (hereafter, "Allison Testimony").

can lower costs) given the current design of the MISO energy markets. The current market lacks mechanisms to account for the high start-up and cycling costs associated with these units, as its analysis is timeframe limited to 24 hours and it lacks mechanisms through which all cycling costs can be accounted for.

2. Mr. Allison's claim that Ameren's self-commitment practices are inappropriate and "led to unnecessary net operational losses" that could "easily be avoided"[2] is flawed because he relies on an inappropriate measure of costs, based on Ameren's accounting costs rather than its marginal cost of producing power. In addition, his analysis is after-the-fact, comparing actual realized prices to costs, rather than expected (forecast) prices.

3. Mr. Allison's related claim that the Company consistently offers incremental energy from its generation units at prices below these units' production costs is also flawed. As with his analysis of self-commitment decisions, he again relies on a measure of costs poorly suited to his purposes, as these offers should reflect the marginal cost of production, rather than the accounting costs he uses in his analysis.

**Q. How is your testimony organized?**

A. In Section III of my testimony, I discuss how costs should be determined for the purposes of making economic decisions in competitive wholesale markets. In Section IV, I discuss issues associated with the economically efficient commitment of long-lead time units in competitive wholesale markets. Finally, in Section V, I assess certain

[2] Allison Testimony, p. 29:16, 33:21-22.

analyses performed by Mr. Allison of Ameren's self-commitment decisions and offers for incremental energy.

## III. OFFERS FOR SUPPLY IN ORGANIZED WHOLESALE ELECTRICITY MARKETS

**Q. What are centralized electricity markets and what questions has Mr. Allison raised about Ameren's participation in these markets?**

A. Centralized wholesale power markets are designed to support the reliable and economically efficient production and transmission of electric power. To this end, system operators, referred to as Regional Transmission Organizations ("RTO's") or Independent System Operators ("ISO's"), such as MISO, operate markets for the various products and services needed to ensure reliable operations and economically efficient production of electric power. Mr. Allison raises concerns about the participation of Ameren's coal units in MISO's wholesale energy (and ancillary service) markets, which use a centralized auction mechanism that clears trades in physical electric power supply while also ensuring reliable and secure power operations. In particular, Mr. Allison is critical of two types of decisions made by Ameren: first, he questions its self-commitment decisions, in which Ameren places these units in an online state at the unit's minimum capacity, and, second, he questions the price at which Ameren offers incremental energy.

**Q. What are the economic principles associated with these decisions?**

A. A central tenet of economics is that social welfare is maximized through competitive markets, in which market participants offer their supply at prices generally consistent with their marginal costs of production. Thus, just like any market, electricity

markets are designed and regulated with the goal of promoting competition through offers for power supply that reflect the marginal costs of power production.[3] These principles are embedded in the design of organized electricity markets, as regulated by the Federal Energy Regulatory Commission ("FERC"). The FERC writes: "The RTO and ISO market structures are designed to encourage competitive, efficient outcomes through resource offers made consistent with marginal cost bidding and the use of least cost centralized dispatch."[4]

**Q. What is the core principle underlying the concept of marginal costs?**

A. As a general matter, marginal costs reflect opportunity costs – that is, the cost of the foregone opportunities when resources are used in production, such as the generation of electricity. When resources are traded in competitive markets, the prices for these resources are generally a good measure of the resource's opportunity costs.[5] When the resources are not traded in a competitive market, opportunity costs reflect tradeoffs posed when using the resource for different purposes.[6]

**Q. What are the marginal costs of the production and supply of electricity?**

A. In general, marginal costs are those economic costs incurred in producing the "next" unit of production. Marginal costs of production include direct variable inputs to

[3] In the context of electricity markets, multiple terms are used to refer to marginal costs and particular subsets of these costs, including short-run marginal costs, variable costs, and incremental costs. For clarity, I assume for present purposes that "marginal costs" refers to all cost elements corresponding to the offer parameters for supply in organized energy markets (acknowledging that the specifics of these parameters differ across markets, although they are all based on marginal or incremental costs).
[4] Federal Energy Regulatory Commission, "Staff Analysis of Energy Offer Mitigation in RTO and ISO Markets," Docket No. AD-14-000, Price Formation in Organized Wholesale Markets, October 2014, p. 1.
[5] *See, e.g.,* Varian, H. (2003), *Intermediate Microeconomics,* 6th edition, W.W. Norton & Company, Inc., New York, New York, 2003, p. 406 (hereafter "Varian 2003").
[6] In the context of electricity markets, "opportunity costs" are often used specifically to refer to the foregone opportunity to sell power, for example, into a different market or at a different time (as with limited energy resources), which can be included as a cost in offers to supply electric power.

production, such as fuel costs, certain operations and maintenance costs, and emissions costs, including pollution control equipment operational costs and/or emission allowances. But, economic costs of producing electricity also include costs associated with bringing a unit online and taking it offline, including start-up costs, intertemporal constraints (e.g., as reflected in minimum run-times and minimum down-times), and "wear-and-tear" costs (representing the risk of a unit experiencing an unplanned outage – and the resulting foregone generation – and increases in future maintenance costs due to placing greater mechanical demands and stress on the generation plant). Determining whether these costs are marginal costs is complicated, depending on many factors, but these factors reflect real physical constraints that increase the economic cost of supplying energy.

**Q. Are economic costs the same as accounting costs?**

A. No – economic costs and accounting costs differ in important ways. In many circumstances, accounting costs do not reflect opportunity costs, but instead reflect expenditures on a good or service. As discussed above, the economic or opportunity cost of producing a good reflects the cost of using inputs to produce that particular good rather than producing something else. Expenditures on inputs, by contrast, may not reflect opportunity costs because they do not account for changes in the value of the inputs over time, which are driven by changes in the value of alternative uses for the inputs.[7] For example, consider a fuel contract at an agreed upon and fixed price determined many years earlier. In this case, accounting costs would reflect expenditures on the fuel given the contract's price. However, the economic cost of using the fuel now

[7] *Varian 2003*, p. 332.

considers other opportunities available to the company if it does not consume the fuel now, such as re-selling the fuel, or other consequences of a decision not to purchase the fuel, such as contractual payments due to the supplier. Thus, when defining opportunity cost, one economic reference states, "Strictly, costs always refers to opportunity cost and hence accountant and economist may well define the cost of an action quite differently."[8]

**Q. Are there other differences in economic and accounting costs?**

A. Yes. Accounting rules may also cause differences between economic costs and accounting costs. For example, accounting costs for fuel may reflect blended averages of fuel in inventory, purchased at different points in time, whereas the marginal economic costs reflect opportunity costs, which generally depend on the current value of the fuel given current market conditions. As I discuss below, these distinctions lead to significant differences between accounting costs and marginal economic costs for the coal consumed at Ameren's coal plants.

**Q. Should accounting costs be used to construct power supply offers into organized wholesale power markets?**

A. As stated above, organized wholesale power markets are generally designed to achieve competitive market outcomes through offers for power supply that reflect marginal costs. Thus, if accounting costs differ from marginal costs, it would not be appropriate to use them when making decisions about or offers for electric power supply in organized electricity markets.

[8] Pearce, David (ed.), The MIT Dictionary of Modern Economics, 4th edition, MIT Press: Cambridge, Massachusetts, 1992, p. 315.

**Q. What are the adverse consequences to constructing offers for electric power supply based on accounting rather than marginal costs?**

A. When these costs differ, basing offers for electric supply on accounting costs, rather than marginal costs, will lead to inefficient use of resources, such as fuel, or inefficient asset decisions, such as when to commit a unit. In each case, use of accounting costs can raise costs to customers. As a result, organized power markets, including MISO, are generally regulated with the aim of ensuring that market participants submit competitive offers reflective of their marginal costs of production.[9] Section IV of my testimony discusses the adverse consequences that can arise when offers for supply do not reflect marginal costs.

## IV. SELF-COMMITMENT IN ORGANIZED WHOLESALE ELECTRICITY MARKETS

**Q. What is self-commitment?**

A. A power generation plant is "committed" when the unit is brought online so that it is producing electricity. However, power generation plants do not operate like light-switches. For many plants, it requires many hours to bring a plant online, imposes many economic costs (e.g., "start-up fuel"), and puts a strain on the plant's equipment. Self-commitment occurs when a generation plant's owner determines when to bring the plant online (or allows it to remain online) to the plant's minimum level of output. By contrast, "economic commitment" occurs when a plant is brought online (or remains online) because the market's algorithms clear the plant's economic offers to supply power. Even when a unit is self-committed at some minimum level of capacity, unless it

[9] MISO, Market Monitoring and Mitigation, Business Practices Manual, BPM-009-r15, July 9, 2019.

is self-scheduled, its dispatch above that minimum level is determined by the comparison of the unit's incremental energy offers to those of other units in both the day ahead and real time markets.

**Q. Why are some plants self-committed?**

A. For some generation plants, the algorithms used by a wholesale market to clear economic offers do not fully and appropriately account for the plant's economic costs and operational constraints. When this is the case, self-commitment can lower costs and result in more efficient plant operation compared to committing the unit through economic offers that clear in the market. These costs and constraints are particularly important for units that were designed for base-load operations, such as Ameren's coal units. These are sometimes referred to as long-lead time units. Two related factors cause these costs and constraints. First, it takes many hours to bring a long-lead time unit online and entails high start-up costs, including start-up fuel. Second, these plants can face large "cycling" costs when the plant is "cycled" online and offline. Cycling costs arise because bringing a plant online (or taking it offline) imposes physical strain on plant equipment, which creates a risk that a plant unexpectedly breaks ("trips"), and causes physical degradation that both increases the risk of trips at a future time and increases the frequency and magnitude of maintenance costs. Such physical degradation includes turbine fouling, tube leaks, and damage to condensers, feedwater heaters, air heaters, and precipitators.[10]

[10] "Ameren Missouri's Response to Order Opening an Investigation of Missouri Jurisdictional Generator Self-Commitments and Self Scheduling and to Order Directing Comments," File No. EW-2019-0370, July 8, 2019, p. 7 (hereafter "Ameren Missouri July 8, 2019").

**Q. Does MISO's energy market provide a means for fully accounting for these costs through economic commitment?**

A. No. At present, MISO's markets do not provide a way for market participants to fully account for these costs through economic commitment. The MISO market does include market offer parameters aimed at capturing these costs and constraints, including start-up costs, minimum down-time (i.e., a minimum time the plant must remain idle between periods of operation), and a minimum run-time (i.e., a minimum period time the plant must run once operating). But, MISO's energy market algorithms cannot fully account for the costs of long-lead time units through its current economic commitments. These limitations are recognized by MISO, which states: "MISO's processes are not designed to forecast **economic*** commitments beyond the next day. This results in the inability to economically commit long-lead time units and can cause uneconomic cycling of certain units when looking across multiple days."[11] As a result, nearly all long-lead time units in MISO are self-committed; for example, in 2015, 96% of long-lead time units in MISO were self-committed.[12] While MISO and its stakeholders are evaluating potential market changes that would allow more long-lead time units to commit through economic offers, these changes are not currently in place.[13]

[11] MISO, Market Subcommittee, "Introduce Multi-Day Financial Commitments," Market Roadmap ID: 31, Issue ID: MR031, May 3, 2016, slide 10 ("hereafter "MISO Market Subcommittee, 2016").
[12] MISO Market Subcommittee, 2016, slide 7.
[13] For example, *see* MISO, Market Subcommittee, "Multi–Day Financial Commitments," Market Roadmap ID: 31, February 8, 2018, slide 4.

**Q. Why doesn't MISO's current energy market fully account for long-lead time unit costs and constraints?**

A. A key limitation of MISO's current algorithms is that it identifies the least-cost offers for supply over a 24-hour period, which is too short to capture the start-up and cycling costs associated with long-lead time units. As a result, it is not economically efficient to commit long lead-time units in MISO through economic commitment.

**Q. Why does the current MISO energy market structure cause long-lead time units that submit economic offers to be cycled uneconomically?**

A. The algorithms used in MISO's energy market to clear economic commitment and dispatch offers selects the offers that minimize costs based on analysis over a 24-hour window. However, for long-lead time units, this period of analysis is too short to fully account for a long-lead time unit's start-up costs or cycling costs through economic offers. The start-up costs for long-lead time units are typically large relative to their dispatch costs over a 24-hour period.[14,15] When determining whether to commit a long-lead time unit through an economic offer, the algorithms thus must recover all of these start-up costs within the 24-hour window being evaluated if the unit is committed.[16]

[14] In response to Data Request 1.023, Ameren proffered that the average cold startup cost for Labadie unit 3 is $79,350.49. Spread across all the power that would be supplied across a 24-hour window if the unit were dispatched at full output, these costs are conservatively estimated at $5.32 per MWh and would be $13.78 per MWh if the unit were dispatched at the unit's minimum load. This calculation assumes a maximum capacity of 621 MW for the unit (per Ameren response to Data Request 1.15) and minimum economic capacity of 240 MW (the minimum economic output bid in MISO's energy market for Labadie unit 3 for a majority of hours in 2018, per Ameren response to Data Request 1.21). Because of the time needed for the unit to come online at full capacity from an offline status, this calculation overstates the total quantity of MWh the plant could generate over a 24-hour period from an offline status, thus understating the implied cost per MWh (see, Ameren Missouri Response to Data Request No. SC 001.23, October 10, 2019; Ameren Missouri Response to Data Request No. SC 001.15, October 23, 2019; Ameren Missouri Response to Data Request No. SC 001.21, October 10, 2019).

[15] Ameren Missouri Response July 8, 2019 provides further details on other problems that result from MISO's 24-hour optimization window.

[16] MISO, Energy and Operating Reserve Markets, Business Practices Manual, BPM-002-r20, August 15, 2019.

However, if the unit will operate for many days (or weeks), an analysis that incurs these one-time costs over a short time period will tend to conclude that it is not efficient to commit the unit, when it may be efficient to commit the unit if the costs were spread over a longer time period of operation. Long-lead time units typically operate for extended periods of time (e.g., weeks or months) once on-line, because their incremental costs are low relative to market-clearing prices. Thus, the impact of assuming that start-up costs must be recovered in one day can be very large. As a result, costs would increase if these plants were committed through economic offers, because more costly units would need to be relied on for power supply.

**Q. Does the current MISO energy market structure provide a way to fully account for cycling costs?**

A. No. MISO's algorithms currently do not have an effective mechanism to allow a company to account for cycling costs. As a result, commitment of long-lead time units through economic offers can lead to uneconomic cycling. For example, the 24-hour horizon evaluated by MISO is too short to accurately account for the potential consequences of taking a unit offline because the algorithms do not account for the possibility that the unit could economically supply in the following days. Thus, two problems can emerge. One problem occurs if a unit is brought offline but cannot come back online because of a minimum down-time requirement. The consequences of this minimum down-time, which limit potentially profitable operations beyond the 24-hour window, are not foreseen by MISO's algorithm given the limited time horizon. A second problem emerges if the plant is brought offline and immediately brought back online the following day, thus inefficiently incurring additional startup and cycling costs

that the algorithm does not account for. The minimum down-time parameters aim to address these costs, but fail to optimally account for them compared to a multi-day analysis, such as the one performed by Ameren when self-committing its plants. Thus, in general, by optimizing over a 24-hour window, the algorithms fail to optimally account for one-time costs associated with cycling the plant, potentially leading to inefficiently frequent cycling.

**Q. Has the Commission evaluated these issues?**

A. Yes. Commission Staff undertook an investigation into the self-commitment and self-scheduling[17] practices of generation units in MISO and SPP. At the conclusion of the investigation, Staff concluded: "Staff has not found any evidence that customers are being actively harmed by the IOU's market strategy regarding self-committing units since revenues seem to exceed costs and should subsequently flow through the FAC – Rider tariff."[18]

**Q. Have self-commitment issues been evaluated in the context of the federally regulated wholesale electric power markets?**

A. Yes, and generally the conclusion is the same: under current market designs, economic commitment of long-lead time units under current market rules is less efficient than self-commitment. As noted above, this was the conclusion reached by MISO regarding self-commitment. The SPP Market Monitor also investigated this issue and

[17] Self-scheduling occurs when the plant's operator specifies the exact level of unit output, not only whether or not the unit will be committed (i.e., self-committed). Self-scheduling is not an issue for Ameren's operations as, I understand, it does not self-schedule its coal units except in limited circumstances.
[18] Missouri Public Service Commission Staff Report, "In the Matter of an Investigation of Missouri Jurisdictional Generator Self-Commitments into SPP and MISO Day-Ahead Energy Markets," File No. EW-2019.0370, August 23, 2019, p. 3 (hereafter "Missouri Public Service Commission Staff, August 23, 2019").

came to a similar conclusion: "However, as we presented in our simulations, simply eliminating self-commitment without any additional changes could result in an increase in total production costs. This would not necessarily be an improvement when compared to today's results."[19] In reaching this conclusion, the Market Monitor relied on the type of analysis contemplated in the Staff Report for the Commission's investigation of self-commitment and self-scheduling.[20]

**Q. Does Mr. Allison provide evidence that Ameren's plants should be economically committed rather than self-committed?**

A. No. While Mr. Allison raises questions about Ameren's decisions to self-commit particular units at particular points in time, he does not opine that Ameren should economically commit, rather than self-commit, these units.

**Q. Do you agree with Mr. Allison's opinion that Ameren's self-commitment is "largely ungoverned by market forces"?**

A. No. Mr. Allison has no basis for concluding that Ameren's self-commitment decisions are "not governed by market forces."[21] While Ameren self-commits certain units, this does not imply that these decisions are not made in response to and subject to "market forces." Ameren's self-commitment decisions are based on analyses of the profitability of committing the units over a 10-day horizon based on expected market

[19] SPP's Market Monitoring unit performed simulations in which the day-ahead market was "re-solved" with the assumption that self-committed units were instead committed based on economic offers. This analysis found that production costs were higher using economic offers compared to actual self-commitment decisions under SPP's current 24-hour optimization window (the same window used by MISO). SPP Market Monitoring Unit, "Self-committing in SPP markets: Overview, impacts and recommendations," December 2019.

[20] "In order to determine the level of benefit or detriment to ratepayers, Staff would need to run a simulation of a historical period, changing the must-run status for day ahead and real time markets while making sure all ancillary services are met… Staff does not have the tools to complete such a task." Missouri Public Service Commission Staff, August 23, 2019, p. 12.

[21] Allison Testimony, p. 26:5.

conditions.[22] Thus, Ameren's decisions regarding when to operate its units clearly reflect "market forces," although they are done by the Company based on its assessment of profitability, rather than through the centralized market. This is the usual approach taken to production in most industries outside the electric power sector, and as is the case in those industries, these decisions, based on expected profitability, clearly reflect market forces.

**Q. Are Ameren's self-commitment decisions "not governed"?**

A. For the purposes of clarity, Ameren's decisions are "governed," as its conduct in the MISO wholesale markets is overseen by an Independent Market Monitor that assesses all supply offers for potential market manipulation. To my knowledge, the market monitor has not identified any concerns about Ameren's self-commitment decisions or the self-commitment decisions made by other plant owners within MISO.[23]

## V. ASSESSMENT OF MR. ALLISON'S EVALUATION OF AMEREN'S WHOLESALE MARKET OFFERS AND PARTICIPATION

**Q. Please describe the two tests Mr. Allison performs related to the participation of certain of Ameren's coal plants in the MISO energy markets.[24]**

A. In the first test, Mr. Allison evaluates Ameren's self-commitment decisions by comparing the hourly revenues earned in the MISO market to an estimate of what he

[22] Ameren Missouri Response to Data Request No.: SC 001.24, October 28, 2019.
[23] MISO's independent market monitor does not identify self-commitment (or self-scheduling) as a factor affecting the competitiveness of MISO's energy markets and does not include MISO's Multi-Day Market projects, aimed at improving the efficiency of participation of long-lead time units in MISO's markets, as one of its recommendations to improve market performance. Potomac Economics, "2018 State of the Markets Report for the MISO Electricity Markets," June 2019. Similarly, the Missouri Commission Staff found that: "...the MISO-IMM indicated that market forces will likely discipline the market. Therefore, the MISO-IMM looks for abuses of market power and whether behavior is justified." Missouri Public Service Commission Staff, Report, August 23, 2019, p. 9.
[24] These plants include Sioux Units 1 and 2, Rush Island Units 1 and 2, and Labadie Units 1, 2, 3, and 4.

characterizes as their production costs, concluding that "Ameren's unit commitment practices led to unnecessary net operational losses in 2018."[25] In the second test, he evaluates Ameren's offers for incremental energy (above minimum output), comparing the level of these offers to a different estimate of production costs, concluding that "Ameren consistently offers its coal units into the MISO market at prices below their production cost."[26]

**Q. Do you have concerns with Mr. Allison's approach to performing these tests?**

A. Yes. In both tests, Mr. Allison estimates production costs based on Ameren's accounting costs; that is, its actual expenditures entered into its books of account under its accounting procedures.[27] But, Ameren's self-commitment decisions and its incremental energy offers reflect *marginal costs*, not accounting costs, as should be the case for offers into the MISO wholesale markets. Thus, Mr. Allison tests are performed using the wrong cost data, thus making his conclusions invalid.

**Q. Why do Ameren's accounting costs differ from its marginal costs?**

A. One reason why Mr. Allison's estimated costs differ from marginal costs is the cost of fuel. Ameren's coal is purchased under contracts with "failure-to-accept" provisions. As discussed by Mr. Meyer in his rebuttal testimony, because of these failure-to-accept provisions, the marginal cost for fuel reflects current market prices for fuel, which can (and during the period examined usually did) differ from the price agreed to under the contracts. When a contract is signed at an earlier point in time,

[25] Allison Testimony, p. 29:13.
[26] Allison Testimony, p. 38:1-2.
[27] Allison Testimony, p. 34:9-10, fn 60, and p. 39:10, fn 68. Mr. Allison relies on the accounting costs provided by Ameren in its response to Data Request No. MPSC 48.

which I understand is the case for Ameren's contracts, the current market price and the contract's price can materially differ.

**Q. Why does Ameren's marginal cost for fuel reflect current market prices under this failure-to-accept provision?**

A. Under this provision, if Ameren fails to accept delivery of the contracted quantity of coal, it must pay its supplier the difference between the contract price and the market price for that quantity of coal not delivered. Thus, from Ameren's standpoint, if it does not consume the contracted-for coal, the financial outcome is essentially equivalent to taking delivery of the coal at the contract price and selling the coal at the current market price. Given this contract structure, the marginal (or incremental) cost to Ameren of its coal purchases reflects the market price of coal, not the price paid for coal under its contracts. Consequently, when making commitment decisions and constructing incremental energy offers, Ameren properly sets the marginal costs of fuel consumed based on the current market price for coal.[28]

**Q. Can you provide a simple example to show why a company's offers should be based on market prices when it has a failure-to-accept provision in its fuel contract?**

A. Yes. Assume the company contracts to buy coal at a delivered price of $30 per ton, one ton of coal is needed to generate one MWh of power and there are no other costs to generating power. Assume, also, that after signing the contract, the market price declines to $27 per ton. Thus, if the company does not consume the coal, it must pay the difference between the contract price and the market price – in this case, $3 per ton (i.e.,

[28] Specifically, I understand that the offers are set based on the one-month forward price for coal.

$30 per ton minus $27 per ton). Consider the outcomes to the company when offers to sell power are based on contract costs versus market prices. When based on contract costs, offers to sell power are $30 per MWh. If the market clearing price for power is $29 per MWh, the plant does not generate electricity (as its offer is above the market clearing price) and the plant owner must pay $3 per the failure-to-accept provision (equivalent to selling the delivered coal at the market price and taking a $3 loss). If, however, offers to sell power are $27 per MWh, based on the market price for coal, the owner will earn revenues of $29 per MWh while paying $30 per ton of coal. In this case, the plant owner loses only $1, as compared to losing $3 when the offer is based on the contract cost. Thus, the company (and its customers) is better off offering power at a price based on the market price for coal, rather than the contract price for coal. This example illustrates how it is in the company's and its customers' best interests to offer power supply based on the current market price, rather than its contracted price. Furthermore, this contract structure is consistent with the operation of an efficient wholesale market, as Ameren's offers reflect the marginal cost from society's perspective.

**Q. Is it your understanding that the accounting fuel costs recorded on Ameren's books differ from market prices during 2018, the period analyzed by Mr. Allison?**

A. Yes. I understand that the accounting cost for fuel can reflect a blended or weighted average of the stock of coal currently in inventory. This inventory includes fuel purchased at different points in time under different contracts, including periods of

time when prices did not reflect the market conditions when the fuel was later consumed.

**Q. Does Mr. Allison account for these failure-to-accept payments in his analysis?**

A. No, he does not account for the payments Ameren must make if it fails to accept coal amounts agreed to under its contracts. In effect, Mr. Allison concludes that Ameren (and its customers) are better off if Ameren does not consume coal to generate electric power. But, in reaching this conclusion, he assumes that the savings to the Company from opting not to consume fuel reflects only the fuel's accounting cost. Thus, by failing to account for the additional payments Ameren must make if it opts not to consume the fuel, his estimate of net revenue is inaccurate.

**Q. Is this the only reason why it is efficient for Ameren's commitment decisions and incremental energy offers to be based on marginal costs?**

A. No. Even if Ameren's coal contracts did not have failure-to-accept provisions, it would still be in the Company's best interest to make its market decisions based on marginal costs, not accounting costs. Marginal costs will always reflect the opportunity cost of using the fuel given other ways the fuel could be used, such as sale of the fuel to other market participants (at market prices, not contract prices), deferring use to another point in time (when the fuel's value can be fully realized), and the consequences of the need to purchase additional inventory once current contracts have been fulfilled.

**Q. Do you have other concerns with Mr. Allison's tests?**

A. Yes. In his analysis of Ameren's commitment decisions and incremental energy offers, Mr. Allison compares *actual* market revenues to his estimate of production costs.

However, Ameren makes its commitment decisions and incremental energy offers before market prices are known and thus compares *expected* market revenues to *expected* production costs when making decisions to commit its units. Therefore, Mr. Allison's conclusions are based on information not knowable to the Company at the time its decisions were made.

**Q. Please summarize your conclusions.**

A. Mr. Allison's claim that Ameren's self-commitment practices are inappropriate and "led to unnecessary losses" that could "easily be avoided"[29] is flawed because he inappropriately bases his claims on analyses using accounting costs instead of the marginal cost of producing power. Further, his after-the-fact analysis relies on actual realized prices, not known to Ameren when making commitment decisions, rather than the expected prices. Mr. Allison's related claim that the Company consistently offers incremental energy from its units at prices below its production costs is also flawed because again he is inappropriately using accounting costs that do not reflect the marginal cost of production.

**Q. Does this conclude your direct testimony?**

A. Yes, it does.

[29] Allison Testimony, p. 29:16, 33:21-22.

**BEFORE THE PUBLIC SERVICE COMMISSION**
**OF THE STATE OF MISSOURI**

| | | |
|---|---|---|
| In the Matter of Union Electric Company d/b/a Ameren Missouri's Tariffs to Decrease Its Revenues for Electric Service. | ) ) ) | File No. ER-2019-0335 |

**AFFIDAVIT OF TODD SCHATZKI**

**STATE OF MISSOURI** )
) **ss**
**CITY OF ST. LOUIS** )

COMES NOW Todd Schatzki, and on his oath declares that he is of sound mind and lawful age; that he has prepared the foregoing *Rebuttal Testimony*; and that the same is true and correct according to his best knowledge and belief.

Further the Affiant sayeth not.

Todd Schatzki

Subscribed and sworn to before me this 21 day of January, 2020.

Notary Public

My commission expires: 9/3/2021

CATHERINE J. HAWES
Notary Public
Commonwealth of Massachusetts
My Commission Expires
September 3, 2021

**TODD SCHATZKI, PH.D.**
**Principal**

Phone: 617 425 8250
Fax: 617 425 8001
todd.schatzki@analysisgroup.com

111 Huntington Avenue
14th Floor
Boston, MA 02199

Dr. Schatzki has a broad range of expertise in energy, environment, finance, and competition matters. He supports clients in a range of contexts, including strategic and financial advice, policy analysis, regulatory and rulemaking proceedings, and litigation.

Dr. Schatzki has deep experience in electricity, natural gas, petroleum, and renewable energy. His expertise in the electricity sector includes wholesale energy and capacity market design; utility regulation and ratemaking; economic impact analysis of new market rules, regulations, and generation and transmission investments; contract analysis and disputes; financial valuation; and options analysis. Dr. Schatzki has testified before US state and federal, as well as Canadian provincial, regulatory commissions. He has supported the analysis of alleged market manipulation and damages in high-profile litigations such as *FERC v. Barclays* and lawsuits following the California electricity crisis.

Dr. Schatzki works extensively on environmental economics, policy, and regulation. Recently, he has focused on the intersection of climate policy and energy markets, and disputes involving water resources and environmental contamination. His research has been published in distinguished energy- and environment-related publications, and he has provided research for prominent organizations such as the Electric Power Research Institute, the Edison Electric Institute, and the Federal Energy Regulatory Commission.

In finance and competition matters, Dr. Schatzki has worked with clients on litigation and non-litigation projects in many sectors, including energy, financial instruments, foreign exchange, insurance, airlines, and retail products.

## EDUCATION

| | |
|---|---|
| 1998 | Ph.D., public policy, Harvard University<br>Specialized fields: Microeconomics, econometrics, industrial organization, natural resources, and environmental economics<br>- Doctoral Fellow, Harvard University (1993–1995)<br>- Crump Fellowship, Harvard University (1995–1996)<br>- Pre-doctoral Fellow, Harvard Environmental Economics Program |
| 1993 | M.C.P., environmental policy and planning (urban studies and planning), Massachusetts Institute of Technology |
| 1986 | B.A., physics, Wesleyan University |

## PROFESSIONAL EXPERIENCE

| | |
|---|---|
| 2005–Present | Analysis Group, Inc.<br>*Principal* |
| 2001–2005 | LECG, LLC<br>*Managing Economist* |

| | |
|---|---|
| 1998–2001 | National Economic Research Associates, Inc.<br>*Senior Consultant* |
| 1997–1998 | Harvard Institute for International Development<br>*Consultant* |
| 1996–1997 | Department of Economics, Harvard University<br>*Teaching Fellow and Research Assistant* |
| 1994 | International Institute for Applied Systems Analysis (IIASA) |
| 1992 | Toxics Reduction Institute, University of Massachusetts |
| 1987–1991 | Tellus Institute<br>*Research Associate* |

## SELECTED CONSULTING EXPERIENCE

### Energy

- **ISO New England**
  Analysis of costs of securing energy inventory, including forward LNG contracts, for purposes of establishing the rate for ISO New England's inventoried energy program.
- **Capital Power**
  Analysis of design of proposed capacity market for Alberta, Canada.
- **New England Electricity Markets**
  Confidential analyses related to natural gas supply contracts, including contracts from liquefied natural gas terminals, and market rules to mitigate fuel security challenges.
- **Global Crude Oil Producer**
  Analysis of alternative approaches and contractual structures for marketing crude oil, including econometric analysis of customer price responsiveness.
- **New York Independent System Operator (New York ISO)**
  Evaluation of performance issues associated with capacity market resources and potential changes to market designs.
- ***Merced v. Barclays***
  Analysis of alleged monopolization of western US electric power markets.
- **ISO New England**
  For the New England Power Pool (NEPOOL) 2016 Economic Analysis, analysis of Forward Capacity Market implications of alternative scenarios with varying assumptions about retirements and clean energy resources.
- **New England Electricity Markets**
  Confidential assessment of interactions between state policies affecting electric power resources, including long-term contracts, and wholesale electricity markets.
- ***FERC v. Barclays***
  Analysis of alleged manipulation of western US electric power exchange markets.
- **New York ISO**
  Demand curve reset for the New York ISO ICAP market including development annual updating process between resets and ICAP Demand Curve parameters.
- **Confidential Client**
  Analysis of factors contributing to assessment of fines associated with an operational incident in the context of a shareholder derivative suit.

- **ISO New England**
  Assessment of framework for evaluating capacity market offers from elective transmission projects for market mitigation.
- **Southwest Power Pool Power Suppliers**
  Analysis and testimony related to the types of costs are appropriately short-run marginal costs and thereby should be incorporated into energy market resource offers.
- **New York ISO**
  Evaluation of capacity market rule changes including a forward market structure and multi-year price lock-in, including quantitative economic analysis of changes in market outcomes under alternative market structures.
- **Ameren Missouri**
  Analysis of the economic impact of the Mark Twain Project, a new transmission project designed to support renewable energy requirements and other objectives (using PROMOD).
- **ISO New England**
  Assistance to the ISO New England market monitor in the development of a de-list offer model consistent with new market rules.
- ***Zaremba v. Encana***
  Evaluate operating agreements, the structure of the oil and gas industry, and trends in gas pricing in regards to antitrust claims in the market for oil and gas leases.
- **ISO New England**
  Assistance in the development of winter fuel assurance programs for 2013/2014, 2014/2015 and 2015/2016, including oil inventory, dual fuel, liquefied natural gas and demand response programs
- **Ameren Transmission**
  Analysis of the impact of Multi Value Project No. 16, a new transmission project, on energy market competition in Illinois (using PROMOD).
- **Vancouver Energy**
  Assessment of economic impacts of a new energy distribution terminal, including change in economic activity, property value impacts, and changes in rail congestion.
- **ISO New England**
  Assessment of the economic costs associated with winter 2013/2014 reliability programs, including oil inventory, dual fuel, liquefied natural gas, and demand response programs.
- **ISO New England**
  Assessment of and testimony regarding the economic and reliability impacts of proposed capacity market rules introducing new performance incentives.
- **ITC Midwest**
  Analysis of and testimony regarding the LMP and production cost impacts of new transmission infrastructure (using PROMOD).
- **Entergy**
  Evaluation of economic damages associated with an alleged contract breach.
- **Ameren Transmission**
  Analysis of the impact of the Illinois River Project, a new transmission project, on energy market competition in Illinois (using PROMOD).
- **Dayton Power and Light**
  Evaluation of the aggregate benefits created by a proposed rate plan.
- **Corporation with Distribution Companies Across Multiple Jurisdictions**
  Regulatory assessment considering current ratemaking models, regulatory environment, and alternative ratemaking structures.

- **ISO New England**
  Assessment of the costs, feasibility, and effectiveness of technical options to securing fuel supply for gas-fired generators.
- **ISO New England**
  Assessment of reliability risks and potential market and regulatory solutions to electric-gas interdependencies.
- **Pacific Gas and Electric**
  Assessment of ratemaking issues, including cost of capital adjustments, associated with a gas pipeline safety plan
- **Confidential Technology Company**
  Analysis of the regional economic impacts of a prototype biofuels production facility at two potential development sites (using the IMPLAN model).
- **ISO New England**
  Statistical analysis of the performance of resources responding to system contingencies.
- **Direct Energy**
  Assistance developing regulatory options for promoting retail competition in Pennsylvania, including development of customer service auctions.
- **ISO New England**
  Assistance developing design enhancements for the region's Forward Reserve Markets.
- **Confidential Client**
  Analysis of energy and capacity market implications of a potential asset agreement (using GE's Multi-Area Production Simulation Software).
- **Confidential Client**
  Analysis of fleet turnover decisions and outcomes (using GE's Multi-Area Production Simulation Software).
- **Confidential Regulated Utility**
  Development of a white paper on transmission planning and policy needed to support legislative and regulatory goals for renewable development.
- **Commonwealth Edison**
  Analysis of appropriate ratemaking tools (cost of equity adjustment) in light of energy efficiency program requirements.
- **New England Power Generators Association**
  Analysis of impacts of proposed electric power company merger.
- **Confidential Technology Company**
  Development of a quantitative model of energy savings associated with end-use technological modifications.
- **National Grid**
  Development of an internal white paper assessing the potential for alternative ratemaking tools to mitigate multiple utility capital, load, and service challenges.
- **EDF Group**
  Analysis of financial and credit implications of the sale of a portion of power generation assets.
- **New England States Committee on Electricity**
  Technical support and analysis related to design of regulations and wholesale electricity markets to achieve resource adequacy.
- **National Grid Utilities**
  Assistance developing ratemaking plans including revenue decoupling and associated revenue adjustments

- **NARUC and FERC**
  Analysis of "best practices" in state policies for competitive procurement of retail electricity supply.
- **New York ISO**
  Analysis of single-clearing-price versus pay-as-bid market designs.
- **Confidential System Operator**
  Analysis of metrics for characterizing the economic value provided by regional transmission organizations.
- **TransCanada**
  Assessment of regulatory and finance issues involved in fuel adjustment clauses within long-term standard offer service contracts.
- **New York ISO**
  Analysis of market implications of fuel diversity issues.
- ***Vitol S.A. Inc. vs. BP Products North America, Inc.***
  Analysis of damages from breach of commodity swap contract (petroleum).
- **Confidential**
  Analysis of alleged exercise and extension of market power in a wholesale electricity market, including statistical analysis of spot and real-time electricity markets and statistical modeling of outages using hazard model methods to examine potential physical withholding.
- **Confidential**
  Financial and strategic analysis of gas supply contracting alternatives.
- **Confidential**
  Analysis of value of generating assets using real options analysis.
- **Confidential**
  Statistical analysis of prices in the spot and forward markets using time-series methods for an energy trading firm in a federal proceeding related to the reasonableness of the terms of certain forward market contracts.
- **Confidential**
  Financial and strategic analysis of renewable generation technologies.

**Environment**

- **Western States Petroleum Association**
  Analysis of approaches to transitioning to long-run efficient climate policies.
- **Western States Petroleum Association**
  Analysis of the implications of a GHG cap-and-trade market rule for other climate policies for the state of Oregon.
- **Greater Boston Real Estate Board**
  Development of a white paper evaluating mandatory residential energy labeling/benchmarking policies.
- **Western States Petroleum Association**
  Analysis of key changes to California's GHG cap-and-trade market rule for the 2021–2030 compliance period.
- ***Florida v. Georgia***
  Analysis of economic issues related to current and proposed alternative apportionment of water between the states of Florida and Georgia before the US Supreme Court.
- **Western States Petroleum Association and Chevron**
  Analysis of key regulatory issues in the design of California's GHG cap-and-trade system for the 2021–2030 period

- *New Jersey DEP v. Occidental Chemical Corp., et al.*
  One behalf of Maxus, assessment of reliability of analyses and conclusions reached regarding settlement of claims related to environmental contamination.
- **Chevron**
  Development of a white paper on post-2020 climate policy for California.
- *C&A Carbone v. County of Rockland*
  Support of expert testimony regarding a violation of the dormant commerce clause.
- *New Jersey DEP v. ExxonMobil*
  Assessment of methods for valuation of environmental contamination.
- **American Petroleum Institute**
  Assessment of issues related to the impact of changes to National Ambient Air Quality Standard Requirements on oil and gas exploration and production.
- **Greater Boston Real Estate Board**
  Development of a white paper on mandatory building energy labeling/benchmarking policies.
- **Little Hoover Commission**
  Analysis of the economic and environmental consequences of a local climate policy plan implemented in the context of a state-wide cap-and-trade system.
- **Exelon**
  Analysis of the economic and market consequences of EPA's Clean Air Transport Rule.
- **Chevron**
  Assessment of lessons learned from federal requirements for regulatory review for the potential development of state requirements.
- **Western States Petroleum Association and Chevron**
  Regulatory support and analysis related to climate policy in California, including submission of various comments and reports to the Air Resources Board.
- **Honeywell**
  Analysis of proposed limits on HFC consumption under domestic climate policy.
- **Electric Power Research Institute**
  Analysis of three 2006 studies on the economic impact of meeting the California carbon emissions reduction targets (in the California Global Warming Solutions Act of 2006).
- **Confidential**
  Assessment of various policy issues in the design of national climate change policies, including market-based policies, approaches to cost containment, offset projects, and non-$CO_2$ GHGs.
- **Confidential**
  Quantitative analysis of the impacts for technology, consumers, and asset owners of a market-based domestic climate policy.
- **Toyota**
  Analysis of the economic value of emissions for a major auto manufacturer associated with alleged non-compliance with emissions control requirements.
- **Barajas Airport**
  Evaluation of the regional economic impacts of runway expansions at the Barajas airport in Spain.

**Finance and Commercial Damages**

- *Anderson, et al. v. American Family Insurance*
  Analysis of reliability of methodologies to estimate diminution in property value associated with remediated property damage.

- **Confidential Client**
  Support during settlement, including analysis of factors contributing to assessment of fines associated with an operational incident in the context of a shareholder derivative suite.
- ***In the Matter of Current and Future Conditions of Baltimore Gas and Electric Company***
  Analysis of financial and credit implications of the sale of a portion of power generation assets.
- ***Becarra, et al. v. The Argentine Republic***
  Analysis of bond pricing, transactions, and holdings related to default of sovereign bonds.
- ***Capital One Financial v. Commissioner of Internal Revenue***
  Analysis of transfers between financial institutions within credit card networks.
- **Confidential Client**
  Analysis of the impact of product taxes on firm market shares related to determination of payments under a settlement agreement.
- ***Kourosh A. Dastgheib v. Genentech***
  Analysis of damages related to breached contract and appropriation of trade secrets in the development of a pharmaceutical product.
- **Confidential Client**
  Analysis of allegations regarding mutual fund day trading, including analysis of trading patterns and calculation of dilution.

**Antitrust**

- **BlackRock**
  Analysis of potential impact of common ownership on competition, including econometric analysis of such impacts in the commercial airline industry.
- **Confidential Client**
  Analysis of alleged monopolization of energy price indices.
- ***Central Garden & Pet v. Monsanto***
  Estimation of damages associated with an alleged monopolization and foreclosure resulting from a distribution agreement.
- ***In re: Vitamins Antitrust Litigation***
  In a price-fixing case across multiple markets in the pharmaceutical industry, estimated overcharges and cartel periods based on a time-series analysis of price data.
- **Confidential Retail Consumer Product Company**
  Analysis of multiple antitrust claims (including foreclosure, monopolization, and vertical restraints) related to an alleged collusive distribution arrangement.
- ***Michlin Diazo Products v. Oce-USA and Oce Printing Systems***
  Analysis of alleged tying of aftermarket products and the provision of service, including evaluation of the alleged tie, competitive effects, and damages.
- **Confidential Petrochemical Company**
  Analysis of liability, timing, geographic scope, and damages issues for a petrochemical company facing potential price-fixing charges by the Department of Justice (DOJ) and private parties.
- **Confidential Scientific Equipment Company**
  Analysis of tying, monopolization, and patent abuse claims involving a patent licensing scheme for process and instrument patents.
- ***Endobionics, Inc. v. Medtronic, Inc.***
  Analysis of foreclosure, attempted monopolization of innovation markets, and damages claims arising from the termination of an investment/licensing agreement.

- **Confidential Scientific Equipment Company**
  Estimation of damages related to alleged invalid patents and tying of products to patent rights associated with a process patent.

TESTIMONY AND OTHER FILINGS

- **Additional Evidence Regarding the Design for Alberta's Capacity Market**
  *Alberta Utilities Commission, Proceeding No. 23757*
  April 4, 2019
- **Testimony on Behalf of ISO New England**
  *Federal Energy Regulatory Commission, Docket No. ER19-1428-000*
  March 25, 2019
- **Evidence Regarding the Design for Alberta's Capacity Market**
  *Alberta Utilities Commission, Proceeding No. 23757*
  February 28, 2019
- **Direct Testimony on Behalf of Ameren Transmission Company of Illinois**
  *Missouri Public Service Commission, Case No. EA-2017-0345*
  September 14, 2017
- **Supplemental Affidavit on Behalf of New York Independent System Operator**
  *Federal Energy Regulatory Commission, Docket No. ER17-386-000*
  December 21, 2016
- **Affidavit on Behalf of New York Independent System Operator**
  *Federal Energy Regulatory Commission, Docket No. ER17-386-000*
  November 18, 2016
- **Pre-Filed Testimony on Behalf of Vancouver Energy**
  *Washington Energy Facilities Site Evaluation Council, Case No. 15-001*
  May 2016
- **Surrebuttal Testimony on Behalf of Ameren Transmission Company of Illinois**
  *Missouri Public Service Commission, Case No. EA-2015-0146*
  November 16, 2015
- **Affidavit on Behalf of Joint Filing Group, Southwest Power Pool**
  *Federal Energy Regulatory Commission, Docket No. ER15-2268-000*
  August 31, 2015
- **Direct Testimony on Behalf of Ameren Transmission Company of Illinois**
  *Missouri Public Service Commission, Case No. EA-2015-0146*
  May 29, 2015
- **Rebuttal Testimony on Behalf of Ameren Transmission Company of Illinois**
  *Illinois Commerce Commission, Docket No. 14-0514*
  March 5, 2015
- **Rebuttal Testimony on Behalf of MidAmerican Transmission Company**
  *Illinois Commerce Commission, Docket No. 14-0494*
  March 5, 2015
- **Direct Testimony on Behalf of Ameren Transmission Company of Illinois**
  *Illinois Commerce Commission, Docket No. 14-0514*
  August 21, 2014
- **Direct Testimony on Behalf of MidAmerican Transmission Company**
  *Illinois Commerce Commission, Docket No. 14-0494*
  August 4, 2014

- **Rebuttal Testimony on Behalf of ITC Midwest LLC**
  *Minnesota Public Utilities Commission, Docket No. CN-12-1053*
  April 25, 2014
- **Direct Testimony on Behalf of ITC Midwest LLC**
  *Minnesota Public Utilities Commission, Docket No. CN-12-1053*
  February 24, 2014
- **Testimony on Behalf of ISO New England**
  *Federal Energy Regulatory Commission, Docket No. ER14-1050-001*
  February 12, 2014
- **Affidavit on Behalf of ISO New England, Performance Incentives Market Rule Changes**
  *Federal Energy Regulatory Commission, Docket No. ER14-1050-001*
  January 14, 2014
- **Comments Regarding on the Proposed Regulation to Implement the AB 32 Cap-and-Trade Program (with Robert N. Stavins)**
  *California Air Resources Board*
  August 2011
- **Comments Submitted to the Little Hoover Commission's Study of Regulatory Reform in California (with Robert N. Stavins)**
  January 2011
- **Comments Regarding on the Proposed Regulation to Implement the AB 32 Cap-and-Trade Program**
  *California Air Resources Board*
  December 2010
- **Comments Regarding Cost Containment Provisions of Preliminary Draft Cap-and-Trade Regulation**
  *California Air Resources Board*
  July 2010
- **Comments Regarding the Draft Report "Allocating Emissions Allowances Under California's Cap-and-Trade System" (with Robert N. Stavins)**
  *Economics and Allocation Advisory Committee, California Air Resources Board*
  December 1, 2009

## ARTICLES AND PAPERS

"GHG Cap-and-Trade: Implications for Effective and Efficiency Climate Policy in Oregon," with Robert N. Stavins, The Harvard Project on Climate Agreements, Discussion Paper 18-92, November 2018.

"Key Issues Facing California's GHG Cap-and-Trade System for 2021-2030," with Robert N. Stavins, M-RCBG Faculty Working Paper 2018-02, Mossavar-Rahmani Center for Business and Government, Harvard Kennedy School, July 2018.

"Beyond AB 32: Post-2020 Climate Policy for California," with Robert N. Stavins, Regulatory Policy Program, Mossavar-Rahmani Center for Business and Government, Harvard Kennedy School, January 2014.

"Three Lingering Design Issues Affecting Market Performance in California's GHG Cap-and-Trade Program," with Robert N. Stavins, Regulatory Policy Program, Mossavar-Rahmani Center for Business and Government, Harvard Kennedy School, January 2013.

"Using the Value of Allowances from California's GHG Cap-and-Trade System," with Robert N. Stavins, Regulatory Policy Program, Mossavar-Rahmani Center for Business and Government, Harvard Kennedy School, August 27, 2012.

"Implications of Policy Interactions for California's Climate Policy," with Robert N. Stavins, Regulatory Policy Program, Mossavar-Rahmani Center for Business and Government, Harvard Kennedy School, August 27, 2012.

"The Interdependence of Electricity and Natural Gas: Current Factors and Future Prospects," with Paul Hibbard, *The Electricity Journal*, May 2012.

"California's Cap-and-Trade Decisions," *Forbes.com*, August 19, 2010.

"Competitive Procurement of Retail Electricity Supply: Recent Trends in State Policies and Utility Practices," with Susan F. Tierney, *The Electricity Journal*, March 2009.

"Pay-as-Bid vs. Uniform Pricing: Discriminatory Auctions Promote Strategic Bidding and Market Manipulation," with Susan F. Tierney and Rana Mukerji, *Public Utilities Fortnightly*, March 2008.

"Free Greenhouse Gas Cuts: Too Good to Be True?" with Judson Jaffe and Robert Stavins, VoxEU.org, January 3, 2008.

"Too Good to Be True? An Examination of Three Economic Assessments of California Climate Change Policy," with Robert N. Stavins and Judson Jaffe, AEI-Brookings Joint Center for Regulatory Studies, Related Publication 07-01. Jan 2007.

"Options, Uncertainty and Sunk Costs: An Empirical Analysis of Land Use," Journal of Environmental Economics and Management, Vol. 46, p. 86-105, 2003.

"The database on the economics and management of endangered species (DEMES)," with David Cash, Andrew Metrick, and Martin Weitzman, in *Protecting Endangered Species in the United States: Biological Needs, Political Realities, Economic Choices*. Cambridge University Press, 2001.

"The Issue of Climate," *Fundamentals of the Global Power Industry, Petroleum Economist*, 2000.

"Review of "Sustainable Cities: Urbanization and the Environment in International Perspective," *Environmental Impact Assessment Review*, (Vol. 12, No, 4), 1993.

"Bottle Bills and Municipal Recycling," *Resource Recycling*, June 1991.

**WORKING PAPERS**

*Reassessing Common Ownership: Corrections to Azar, Schmalz, and Tecu*, with Mark Egland, Owen Hearey, and Channing Verbeck, October 2, 2019.

*Quality* and *Quantity: Alternatives for Addressing Reliability Concerns from Shifting Resource Mixes*, June 23, 2014.

*Reliability and Resource Performance*, May 16, 2012.

*Can Cost Containment Raise Costs? Allowance Reserves in Practice*, March 2012.

*Generation Fleet Turnover in New England: Modeling Energy Market Impacts*, with Paul Hibbard, Pavel Darling, and Bentley Clinton, June 2011.

*A Hazard Rate Analysis of Mirant's Generating Plant Outages in California*, with William Hogan and Scott Harvey, presented at the IDEI Conference on Competition and Coordination in the Electricity Sector, Toulouse, France, January 16–17, 2004.

*The Pollution Control and Management Response of Thai Firms to Formal and Informal Regulation*, with Theodore Panayotou, 1999.

*Differential Industry Response to Formal and Informal Environmental Regulations in Newly Industrializing Economies: The Case of Thailand*, with Theodore Panayotou and Qwanruedee Limvorapitak, presented at Harvard Institute for International Development 1997 Asia Environmental Economics Policy Seminar, Bangkok, Thailand, February 1997.

*The Effects of Uncertainty on Landowner Conversion Decisions*, John F. Kennedy School of Government, Center for Science and International Affairs, Environment and Natural Resources Program, Discussion Paper 95-14, December 1995.

**REVIEW OF ACADEMIC ARTICLES**

*Economics of Energy & Environmental Policy*

*Ecological Economics*

*Journal of Environmental Economics and Management*

*Transportation Research*

**SELECTED PRESENTATIONS**

"Regional Generation Trends – State Policy Drivers and Responses," EBA Energizer, Energy Bar Association, Power Generation and Marketing Subcommittee, December 3, 2019.

"Cost Containment – Which Cap-and-Trade Features Matter Most?" Climate Forum on California's Cap-And-Trade Program, International Emissions Trading Association, Carbon Market Compliance Association, Latham and Watkins, LLC, September 19, 2018.

"Northeast Power Markets Outlook: Addressing the Capacity and Reliability Crunch" and "Natural Gas: Cross-Border Trade, Market Dynamics, and Infrastructure Woes," EUCI 4TH Annual US Canada Cross-Border Energy Summit, March 12–13, 2018.

"Implications of the Expansion of "Non-Traditional" Resources for the Northeast Power Markets," Northeast Energy and Commerce Association's Power Markets Conference, November 14, 2017.

"The FERC's Anti-Market Manipulation Rule: Trends and Developments," webinar, The Knowledge Group, April 12, 2017.

"State Policy and Wholesale Power Markets: Emerging Issues Across the Markets," Northeast Energy and Commerce Association, Power Markets Conference, November 1, 2016.

"Net Metering," workshop, EUCI, Residential Demand Charges, October 20, 2016.

"Evaluating Carbon Risk Measures Under Policy Uncertainty," workshop, EUCI U.S./Canada Cross-Border Power Summit, March 14–15, 2016.

"Implications of Policy Initiatives for Wholesale Markets," Northeast Energy and Commerce Association, Power Markets Conference, November 17, 2015.

"The Western United States' Impact On Global Climate Change Policy," 2015 WSPA Issues Conference, September 30, 2015.

"Capacity Performance (and Incentive) Reform" and "Out of Market Actions," EUCI Conference: Capacity Markets: Gauging Their Real Impact on Resource Development & Reliability, August 31–September 1, 2015.

"California Climate Goals for 2030 to 2050," California Council on Environmental and Economic Balance, Summer Issues Seminar, July 14, 2015.

"Local and Regional Climate Protection Efforts," California Council on Environmental and Economic Balance, Summer Issues Seminar, July 14, 2015.

"Current Regional Transmission Planning and Issues in New England," Law Seminar International Transmission in the Northeast, March 19, 2015.

"Stakeholder Assessment and Outlook for the Markets," Power Markets Conference, Northeast Energy and Commerce Association, October 20, 2014.

"Market Changes to Promote Fuel Adequacy – Capacity Markets to Promote Fuel Adequacy," moderator of panel discussion, Northeast Energy Summit 2014, September 17–19, 2014.

"Quality *and* Quantity: Alternatives for Addressing Reliability Concerns from Shifting Resource Mixes," Center for Research In Regulated Industries 27th Annual Western Conference June 26, 2014.

"Climate Policy Choices – RPS, Cap-and-Trade & the Implications for Actions (and Exits) that Affect Emissions," Electric Utilities Environmental Conference, February 4, 2014.

"Multiple Dimensions of Gas-Electric Coordination Concerns," Electric Utilities Environmental Conference, February 3, 2014.

"The Economics of Cap-and-Trade in the California Power Markets," EUCI Conference, California Carbon Policy Impacts on Western Power Markets, January 27, 2014.

"An Economic Perspective on Building Labeling Policies," Greater Boston Real Estate Board, April 26, 2013.

"Market-Based Policies to Address Climate Change," Sustainable Middlesex, May 4, 2013.

"Market Forces and Prospects/Economic Ripple Effects, 5-10 Years Ahead," Air & Waste Management Association, New England Section, October 12, 2012.

"Gas and Electric Coordination: Is It Needed? If So, To What End?" Harvard Electric Policy Group, Cambridge, MA, October 11, 2012.

"Reliability and Resource Performance," Center for Research In Regulated Industries 31st Annual Eastern Conference May 16, 2012.

"Can Cost Containment Raise Costs? Allowance Reserves in Practice," International Industrial Organization Conference, Boston, MA, April 9, 2011.

"Ratemaking Mechanisms/Tools as Carrots for Achieving Desirable Regulatory Outcomes," Conference on Electric Utility Rate Cases, Law Seminars International, Boston, Massachusetts, November 9, 2010.

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