KATHLEEN SPEES

Principal

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Dr. Kathleen Spees is a Principal at The Brattle Group with expertise in wholesale electricity and environmental policy design and analysis. Her work for market operators, regulators, regulated utilities, and market participants focuses on:

- Wholesale Power Market Reform
- Capacity Market Design
- Wholesale Energy and Ancillary Service Market Design
- Carbon and Environmental Policy
- Generation and Transmission Asset Valuation
- Analysis of Emerging Technologies and Specialized Products

Dr. Spees has worked in more than a dozen international jurisdictions supporting the design and enhancement of environmental policies and wholesale power markets. Her clients include electricity system operators in PJM, Midcontinent ISO, New England, Ontario, New York, Alberta, Texas, Italy, and Australia. Electricity market design assignments involve ensuring adequacy of capacity and energy market investment incentives to achieve reliability objectives at least cost; designing carbon and clean energy policies that effectively interact with wholesale electricity markets; enhancing operational reliability and efficiency through energy market, scarcity pricing, and ancillary service market improvements; effectively integrating intermittent renewables, storage, demand response, and other emerging technologies; evaluating benefits and costs of industry reform initiatives; and enhancing efficiency at market interties.

For system operators and regulators, Dr. Spees provides expert support through stakeholder forums, independent public reports, and testimony in regulatory proceedings. For utilities and market participants, her assignments support business strategy, investment decisions, asset transactions, contract negotiation, regulatory proceedings, and litigation. Dr. Spees has developed and applied a wide range of analytical and modeling tools to inform these policy, market design, and business decisions.

Dr. Spees earned her PhD in Engineering and Public Policy within the Carnegie Mellon Electricity Industry Center in 2008 and her MS in Electrical and Computer Engineering from Carnegie Mellon University in 2007. She earned her BS in Physics and Mechanical Engineering from Iowa State University in 2005.

Publications posted at: http://www.brattle.com/experts/kathleen-spees

REPRESENTATIVE EXPERIENCE

WHOLESALE POWER MARKET REFORM

- **Ontario Market Renewal Benefits Case.** For the Ontario Independent Electricity System Operator (IESO), developed an analysis evaluating the benefits and implementation costs associated with fundamental reforms to wholesale power markets, including implementing nodal pricing, a day-ahead energy market, enhanced intra-day unit commitment, operability

reforms, an enhanced intertie design, and a capacity market. Analysis included: (a) market visioning sessions with IESO staff and stakeholders to identify future market design requirements; (b) identify primary drivers and quantify system efficiency benefits; (c) review lessons learned from other markets' reforms to identify opportunities and reform risks; (d) conduct a bottom-up analysis of implementation costs for replacing market systems; and (e) evaluate interactions with existing supply contracts.

- **MISO Market Development Vision.** For the Midcontinent Independent System Operator (MISO), worked with staff and stakeholders to codify a Market Vision as the basis for motivating and prioritizing market development initiatives over the next 2-5 years. Authored a foundational report for that Vision, including: describing the core services MISO must continue to provide to support a well-functioning market; establishing a set of principles for enhancing those services; identifying seven Focus Areas offering the greatest opportunities for improving MISO's electricity market; and proposing criteria for prioritizing initiatives within and across Focus Areas.
- **Australia NEM Electricity Market Vision for Enabling Innovation and Clean Energy.** On behalf of the Australian Energy Market Operator reviewed electricity market design options for the future of the NEM. Evaluated opportunities for relying on markets, innovation, and new technologies to address a range of challenges in the context of significant increases in customer costs, high gas prices, large clean energy penetration, coal retirements, uncertain carbon policies, and emerging reliability and security concerns.
- **Thailand Power Market Reform.** Supported market design options and recommendations for potential power market reforms in Thailand, including the introduction of forward, day-ahead, and real-time energy markets, as well as the potential introduction of a bilateral or centralized capacity market. Examined interactions with retail rates, existing contracts, and self-supply arrangements.
- **Power Market Reform to Accommodate Decarbonization and Clean Energy Policies.** For the system operator in a jurisdiction pursuing significant clean energy and decarbonization policies, assisted in evaluating market design alternatives. Estimated energy price, customer cost, and reliability implications under alternative energy, ancillary service, and capacity market design scenarios. Quantified implications of key uncertainties such as intermittent resource penetration levels and impacts of interties with external regions. Provided research and comparative analysis of design alternatives and lessons learned from other jurisdictions.
- **Western Australia Power Market Reform Options.** For EnerNOC, developed a whitepaper describing high-level market reform options in the face of escalating customer costs in Western Australia. Described the drivers of capacity payment costs in comparison to other major cost driver. Identified high-level options for pursuing capacity and energy-only market design reforms, comparing advantages and disadvantages.
- **Russian Capacity and Natural Gas Market Liberalization.** On behalf of a market participant, conducted an assessment of market design, regulatory uncertainty, and liberalization success. Focus was on the efficiency of market design rules in the newly introduced system of capacity

contracts combined with capacity payments, as well as on the impacts of gas price liberalization delays.

- **PJM Review of International Energy-Only, Capacity Market, and Capacity Payment Mechanisms.** For PJM Interconnection, conducted a review of energy-only markets, capacity payment systems, and capacity markets on behalf of PJM market operator. Reviewed reliability, volatility, and overall investment outcomes related to details of market designs in bilateral, centralized, and forward commitment markets.
- **Options for Reconciling Regulated Planning and Wholesale Power Markets in in MISO.** For NRG, developed a whitepaper assessing reliability and economic implications of current capacity market and integrated planning approaches, and the challenges in accommodating retail access and integrated planning within the same market region. Recommended options for enhancing the MISO capacity market and regulated entities' approaches to planning.
- **Review of California Planning and Market Mechanisms for Resource Adequacy.** For Calpine, evaluated interactions and implications of California's policy, planning, and market mechanisms affecting resource adequacy. Recommended improvements to reconcile inconsistencies and enhance efficiencies in regulated long-term procurements, short term local resource adequacy construct, and CAISO backstop mechanisms.

Capacity Market Design

- **PJM Review of Capacity Market Design and Demand Curve Parameters: 2011, 2014, and 2018.** For PJM Interconnection, conducted independent periodic reviews of PJM's Reliability Pricing Model. Analyzed market functioning for resource adequacy including uncertainty and volatility of prices, net cost of new entry parameters, impacts of administrative parameters and regulatory uncertainties, locational mechanisms, demand curve shape, incremental auction procedures, and other market mechanisms. Developed a probabilistic simulation model evaluating the price volatility and reliability implications of alternative demand curve shapes and recommended a revised demand curve shape. Provided expert support to stakeholder proceedings, testimony submitted before the Federal Energy Regulatory Commission, and before the Maryland Public Service Commission.
- **MISO Resource Adequacy Construct.** For MISO, conducted a review of MISO's resource adequacy construct. Subsequent assistance to MISO in enhancing the market design for resource adequacy related to market redesign, capacity market seams, and accommodation of both regulated and restructured states. Provided background presentations to stakeholders on the capacity market design provisions of NYISO, PJM, CAISO, and ISO-NE.
- **Alberta Energy-Only Market Review for Long-Term Sustainability: 2011 and 2013 Update.** For AESO, conducted a review of the ability of the energy-only market to attract and retain sufficient levels of capacity for long-term resource adequacy. Evaluation of the outlook for revenue sufficiency under forecasted carbon, gas, and electric prices, potential impact of environmentally-driven retirements, potential federal coal retirement mandate, and provincial energy policies.

- **Economic Implications of Resource Adequacy Requirements.** For the U.S. Federal Energy Regulatory Commission, reviewed economic and reliability implications of resource adequacy requirements based on traditional reliability criteria as well as alternative standards based on economic criteria. Evaluated total system costs, customer costs, supplier net revenues, and demand response implications under a range of reserve margins as well as under different energy-only and capacity market designs.
- **Winter Resource Adequacy and Reliability.** For an RTO, analyzed the risk of winter reliability and resource adequacy shortages. Examined the drivers of winter reliability concerns including unavailability of specific resource types, winter fuel supply shortages, and weather-driven outages. Developed a range of potential reforms for addressing identified concerns.
- **Alberta Capacity Market Design.** Supported the development of a capacity market design in Alberta. Provided expert support to public working groups and AESO staff to review analytical questions, develop and evaluate design alternatives, and draft design documents. Supported on all aspects of market design including establishing reliability requirements, developing demand curve parameters, evaluating seasonal capacity resources, setting capacity ratings, product definition and obligations, and penalty mechanisms.
- **European Market Flexibility and Capacity Auction Design.** For European client, developed a market-based design for meeting flexible and traditional capacity needs in the context of high levels of intermittent resource penetration, degraded energy and ancillary pricing signals, and ongoing electricity market reforms. Engaged in meetings with industry and European Commission staff to develop and refine design options. Developed a model simulating market clearing results in a two-product auction and projecting prices over time.
- **Italian Capacity Market Design.** For Italy's transmission system operator Terna, supported development of a locational capacity market design and locational capacity demand curves based on simulation modeling on the value of capacity to customers.
- **Capacity Auction Design for Western Australia**. For Western Australia's Public Utility Office, drafted a whitepaper and advised on the design of its new capacity auction mechanism.
- **IESO Capacity Auction Design.** Provided expert support to IESO staff in support of a new capacity auction design. Provided detailed memos describing options, tradeoffs, and lessons learned on every aspect of capacity auction design. Supported stakeholder engagement, conducted analysis of design alternatives, and developed design proposals.
- **PJM Seasonal Capacity Market Design.** For the Natural Resources Defense Council, provided testimony and economic analysis in support of improving the capacity market design to better accommodate seasonal capacity resources.
- **ISO New England Capacity Demand Curve**. For ISO New England, worked with RTO staff and stakeholders to develop a selection of capacity demand curves and evaluate them for their efficiency and reliability performance. Began with a review of lessons learned from other market and an assessment of different potential design objectives. Developed and implemented a statistical simulation model to evaluate probabilistic reliability, price, and reserve margin outcomes in a locational capacity market context under different candidate demand curve

shapes. Submitted Testimony before the Federal Energy Regulatory Commission supporting a proposed system-wide demand curve, with ongoing support to develop locational demand curves for individual capacity zones.

- **MISO-PJM Capacity Market Seams Analysis.** For MISO, evaluated barriers to capacity trade with neighboring capacity markets, including mechanisms for assigning and transferring firm transmission rights and cross-border must-offer requirements. Evaluated economic impacts of addressing the barriers and identified design alternatives for enabling capacity trade.
- **MISO Competitive Retail Choice Solution.** For MISO, evaluated design alternatives for accommodating the differing needs of states relying on competitive retail choice and integrated resource planning. Conducted probabilistic simulations of likely market results under alternative market designs and demand curves. Provided expert support in stakeholder forums and submitted expert testimony before the Federal Energy Regulatory Commission.
- **Capacity Market Manipulation.** For a market participant, supported economic and policy analysis of an alleged instance of capacity market withholding.
- **Demand Curve and Net Cost of New Entry Review.** For an RTO, provided a high-level conceptual review of its approach to establishing demand curve and net cost of new entry parameters. Identified potential reliability and economic efficiency concerns, and recommended enhancements.
- **Western Australia Reserve Capacity Mechanism and Transition Mechanism**. For EnerNOC, authored two public reports related to the energy market reforms in Western Australia. The first report evaluated the characteristics of the Western Australia Reserve Capacity Mechanism in comparison with international best practices and made recommendations for improvements, whether pursuing a capacity market or energy-only market design. The second report evaluated and recommended changes to the regulator's proposed mechanism for transitioning to its long-term capacity market design.
- **Cost of New Entry Study to Determine PJM Auction Parameters: 2011 and 2014.** For PJM Interconnection, partnered with engineering, procurement, and construction firm to develop bottom-up cost estimates for building new gas combined cycles and combustion turbines. Affidavit before the Federal Energy Regulatory Commission and participation in settlement discussions on the same.

WHOLESALE ENERGY AND ANCILLARY SERVICE MARKET DESIGN

- **Greece Energy and Ancillary Service Market Reform.** For the Hellenic Association of Independent Power Producers, provided expert advice and a report on how to reform wholesale power markets to conform with policy mandates and meet system flexibility needs. Analyzed energy and ancillary market pricing and rules to identify opportunities to enhance efficiency, improve participation of emerging resources, achieve market coupling, and better integrate intermittent resources. Proposed high-level design recommendations for implementing forward, day-ahead, intraday, and balancing markets consistent with European Target Model requirements. Developed detailed design recommendations for near-term and long term

enhancements to market operations, pricing, dispatch, and settlements. Provided expert support in meetings with European Commission staff.

- **Alberta Energy and Ancillary Service Market Enhancements.** Supported the development of market design enhancements to better support flexibility needs and align with capacity market implementation. Developed design proposals and evaluated alternatives for immediate and long-term reforms including monitoring and mitigation, enhanced administrative scarcity pricing, ancillary service co-optimization, day-ahead markets,
- **SPP Ramp Product Proposal.** For Golden Spread Electric Cooperative, developed recommendations for the design and implementation of a ramping product to most efficiently and cost-effectively manage intermittency needs. Reviewed opportunities to determine the most appropriate quantity of resources, forward product timeframe, price formation, and interactions with existing pricing and commitment procedures.
- **ERCOT Energy Market Design and Investment Incentives Review.** For the Electric Reliability Council of Texas (ERCOT), conducted a study to: (a) characterize the factors influencing generation investment decisions; (b) evaluate the energy market's ability to support investment and resource adequacy at the target level; (c) examine efficiency of pricing and incentives for energy and ancillary services, focusing on scarcity events; and (d) evaluate options to enhance long-term resource adequacy while maintaining market efficiency. Performed forward-looking simulation analyses of prices, investment costs, and reliability. Interviewed a broad spectrum of stakeholders; worked with ERCOT staff to understand the relevant aspects of their planning process, operations, and market data. Supported ongoing proceedings with stakeholders and before the Public Utility Commission of Texas.
- **Scarcity and Surplus Event Pricing.** For an RTO, examined the efficiency and reliability implications of its pricing mechanisms during scarcity and surplus events, and evaluated potential market reforms. Options reviewed included adjusting the price cap consistent with the value of lost load, adjusting supplier offer caps, imposing administrative scarcity prices at varying levels of emergency events, ancillary service market pricing interactions, and reducing the price floor below zero.
- **MISO Wind Curtailment Interactions with Energy Market Pricing and Transmission Interconnection Processes.** For MISO, evaluated the efficiency and equity implications of wind curtailment prioritization mechanisms and options for addressing stakeholder concerns, including interconnection agreement types, energy and capacity injection rights, ARR/FTR allocation mechanisms, energy market offers, and market participant hedging needs.
- **Survey of Energy Market Seams.** For the Alberta Electric System Operator (AESO), assessed the implications of energy market seams inefficiencies between power markets in Canada, the U.S., and Europe for the Alberta Electric System Operator. Evaluation of options for improving seams based on other markets' experiences with inter-regional transmission upgrades, energy market scheduling and dispatch, transmission rights models, and resource adequacy.
- **New England Fuel Security Market Design.** For NextEra, developed design proposals for using market-based mechanisms to meet regional fuel security needs including through a fuel security

reserve product that would enhance pricing and operations for fuel security in the energy and ancillary service markets, and options for a long-term solution through forward auctions for fuel security.

- **Reliability Auctions for the NEM.** For the Australian Electricity Market Operator conducted an international review of the range of approaches to supporting reliability and system security through competitive auctions. Focused on product definition including, various aspects of reliability and system security, auctions focused on enabling non-traditional resource types, options ranging from strategic reserve models to partial needs procurements to capacity markets, and potential for impacts on energy-only market pricing and performance.
- **ERCOT Operating Reserves Demand Curve and Economically Optimal Reserve Margin 2014 and 2018.** For the Public Utility Commission of Texas and ERCOT, co-authored a report estimating the economically-optimal reserve margin. Compared to various reliability-based reserve margins, and evaluated the cost and uncertainty of energy-only and a potential capacity market in ERCOT. Conducted the study in collaboration with Astrape Consulting to construct a series of economic and reliability modeling simulations that account for uncertain weather patterns, generation and transmission outages, and multi-year load forecasting errors. The simulations also incorporate detailed representation of the Texas power market, including intermittent wind and solar generation, operating reserves, different types of demand response, the full range of emergency procedures (such as operating reserve deletion), scarcity pricing provisions, and load-shed events.
- **Southern Company Independent Auction Monitor.** For Southern Company, developed auction monitoring capability and protocol development for monitoring hourly and daily auctions. Supported functions included daily and annual audits of internal company processes and data inputs related to load forecasting, purchases and sales, and outage declarations. Analyzed company data to develop monitoring protocols and automated tools. Coordinated implementation of data collection and aggregation system required for market oversight and for detailed internal company data audits.

CARBON AND ENVIRONMENTAL POLICY

- **Integrating Markets and Public Policy in New England.** For a coalition of stakeholders, engaged in a collaborative effort to develop market-based approaches for accommodating and achieving state decarbonization objectives. Developed and refined design proposals including carbon pricing and market-based clean energy procurements, while identifying options for reducing regulatory uncertainties, avoiding cross subsidies across states, and mitigating customer cost impacts. Evaluated options for improving interactions with existing energy, capacity, renewable energy credit, and carbon markets. Conducted modeling of price, cost, and emissions outcomes under a range of designs. Engaged in an iterative process to develop, present, and refine design proposals based on input from a broad array of stakeholders. Provided expert support in outreach to state policymakers and industry groups.

- **Ontario Market Evolution to Support a 90% Clean Energy System and Increasing Distributed Resources.** For the IESO, supported the activities of the non-emitting stakeholder committee to model market reforms necessary to fully enable the 90% clean energy fleet. Supported stakeholder workshops to identify potential futures with many more distributed resources, a range of technology costs, and a variety of market designs. Conducted modeling analysis to analyze market outcomes including cost, reliability, resource curtailment, and resource revenues.
- **National Carbon Policy Design and Interactions with Power Markets.** For an international regulator, analyzed a range of options for the design of a carbon policy for the electricity sector, considering impacts on the wholesale electricity market and interactions with other sectors. Analyzed a range of alternatives for intensity-based and cap-and-trade based approaches, alternative allocations methods, and interactions with renewables standards. Developed two detailed design alternatives within the specified policy constraints.
- **Review of International Carbon Mechanisms.** For an RTO, conducted a survey of international carbon pricing, cap-and-trade, and rate-based mechanisms, and detailed review of design elements of the mechanisms implemented in Europe, California, Alberta, and the Regional Greenhouse Gas Initiative. Evaluated a range of alternatives for implementing the Clean Power Plan across states while effectively integrating with wholesale markets.
- **New York ISO Carbon Pricing.** For the New York ISO, examined economic implications of a possible carbon pricing proposal within the wholesale electricity market. Developed a whitepaper evaluating interactions with state environmental policies, wholesale power markets, intertie pricing, capacity market, and transmission planning. Estimated energy price and customer cost impacts.
- **Carbon Allowance Allocations Alternatives.** For the National Resources Defense Council, developed a whitepaper examining the advantages and disadvantages of auction-based, customer-based, and generator-based approaches to allocating carbon allowances. Developed recommendations for avoiding the introduction of inefficient investment, retirement, and operational incentives under each type of design, and for mitigating customer cost impacts.
- **Power Market Impacts of Clean Power Plan Alternatives.** Conducted a modeling assessment of price, cost, and emissions implications of different rate-based, subcategory rate-based, and mass-based implementation of the Clean Power Plan in Texas. Estimated energy, emission reduction credit, and carbon prices under each scenario, and net revenue and operating implications for several types of generating plants.
- **Review of Hydropower Industry Implications under Clean Air Act 111(d).** For the National Hydropower Association, provided members review of the implications for new and existing hydropower resources of proposed EPA Clean Power Plan under Clean Air Act Section 111(d). Analyzed impacts under a variety of potential revisions to the proposed rule, different potential state compliance options, differing plan regulatory statuses, mass-based vs. rate-based compliance, regulated planning vs. market-based compliance, and cooperative vs. stand-alone compliance.

- **Enabling Canadian Imports for U.S. Clean Energy Policies.** For a coalition of Canadian electricity producers and policymakers, reviewed a range of options for U.S. states to pursue clean energy policies and the Clean Power Plan while enabling contributions from clean energy imports.
- **Clean Power Plan Regulatory and Stakeholder Support.** For a cooperative entity, provided support in developing internal and external positioning associated with the Clean Power Plan. Analyzed state-wide emissions targets and compliance alternatives. Supported messaging and stakeholder engagement at the state and federal levels. Submitted testimony before the Environmental Protection Agency.
- **State Compliance Strategy under the Clean Power Plan.** For a regulated utility, evaluated options and feasibility of meeting state standards under 111(d) rate standards under a number of compliance scenarios. Developed an hourly dispatch model covering backcast and forecast years through the interim and final compliance timelines, accounting for impacts of load growth, renewables growth, coal-to-gas redispatch, coal minimum dispatch constraints, planned retirements, new generation development, and export commitments. Estimated the ability to meet the standard under various compliance strategies.
- **New Gas Combined Cycle Plants Under the Clean Power Plan.** For the National Resources Defense Council, developed a whitepaper evaluating the economic implications of Clean Power Plan implementation plans that do or do not cover gas combined cycle plants on a level basis with other fossil-emitting plants. Conducted simulation analyses comparing the economic and emissions implications of alternative approaches.
- **MISO Coal Retrofit Supply Chain Analysis.** For the MISO, analyzed the fleet-wide requirements for retrofitting plants to upgrade for the Mercury and Air Toxics Standard. Reviewed the upstream engineering services, procurement, and construction supply chain to evaluate the ability to upgrade the fleet within the available time window. Analyzed the potential for operational and reliability concerns from simultaneous planned outages needed to support fleet-wide retrofit requirements in the MISO footprint.
- **Impact of Environmental Policies on Coal Plant Retirement.** For a PJM market participant, conducted a zone-level analysis of PJM market prices and used unit-level data to conduct a virtual dispatch of coal units under a series of long-term capacity, fuel, and carbon price scenarios. Modeled retirement decisions of plants by PJM zone and the effect of the carbon price on the location and aggregate size of these retirement decisions.

Generation and Transmission Asset Valuation

- **Generation and Transmission Asset Valuations (Multiple Clients).** For multiple clients, top-line operating cost and revenues estimation for generation and transmission assets in PJM, ISO-NE, MISO, SPP, and ERCOT; experience with a range of asset types including gas CCs, gas CTs, coal, wind, waste-to-energy, cogeneration, and HVDC lines. Evaluation exercises include forecasting market prices and net revenues from energy, capacity, ancillary service, and (if applicable) renewable energy credit markets. Valuations account for the operational impacts and economic value of existing power purchase agreements and other hedges. Clients typically require

qualitative and quantitative analysis of regulatory risks under a range of operational and market scenarios. Valuation efforts often conducted in the context of due diligence for transactions, business decisions, and contract negotiations.

- **Executive Education and Investment Opportunities Surveys (Multiple Clients).** For multiple clients, provided executive education and detailed survey material to support investments in new markets and strategic decision-making. Educational efforts provided over a range of levels including high-level executive sessions, all-day workshop sessions, and detailed support for analytical teams. Examples of subject matter include: (a) cross-market surveys comparing investment attractiveness in many dimensions based on market fundamentals, regulatory structure, and contracting opportunities; and (b) single-market deep-dive educational sessions on capacity, energy, ancillary service, and financial/hedging product functioning and market performance.
- **In-House Fundamentals Capability Development (Multiple Clients).** For multiple clients, supported the development of in-house capability for market fundamentals analysis. Typically needed in the context of new entrants to a market or system operators expanding the scope of their internal analytical capabilities. Scope of support has included: (a) initial education, backup support, and advisory support for fundamentals teams entering a new market; (b) development and transfer of new purpose-built modeling tools such as capacity market models; and (c) external peer review or independent assessment functions.
- **Asset or Fleet Valuation in Support of Litigation and Arbitration Proceedings (Multiple Clients).** In litigation and arbitration contexts, provided estimates of economic damages or asset/fleet value estimates that would have applied at the time of a particular business decision. Supported expert testimony, litigation workpapers, and assessment of opposing experts' analysis.
- **Economic Analysis of Plant Retrofit and Fuel Contracting Decisions (Multiple Clients).** Supported plant operational and investment decisions for enhancing the value of particular assets, including contexts such as: (a) retrofitting plants from oil to gas generation; (b) retrofitting single-cycle to combined cycle with different capacities for duct firing; (c) enhancing ancillary service capability; and (d) and contracting for firm gas capability. Evaluated operational, cost, and revenue impacts of alternatives and compared to present investment costs.
- **Financial Implications of Regulatory, Policy, and Market Design Changes (Multiple Clients).** Conducted analyses of risks and opportunities associated with regulatory, policy, and market design changes. Examples include an analysis of potential Trump administration policies, implications of potential clean energy and carbon policies, and assessing private risks from changes to ancillary service market rules.

EMERGING TECHNOLOGIES AND SPECIALIZED PRODUCTS

- **RTO Business Models Analysis for Enabling Customer-Side Disruption and the Clean Energy Future.** For a system operator, engaged in an executive strategy analysis to evaluate a range of electricity sector business models under a future with high penetrations of distributed resources and decarbonization. Developed detailed scenario descriptions of the business models

envisioned considering different roles and scope of services provided by the RTO, distribution companies, load serving entities, and third-party aggregators. Created an interactive tool for mapping financial flows and energy flows at all points in the electricity value chain under each business model considered, and drew implications for value proposition of each segment of the market.

- **Enabling Market Participation from Non-Emitting and Emerging Technologies.** For an Ontario stakeholder group, provided expert support to identify market design enhancements to enable and integrate non-emitting and emerging technologies. Examined participation barriers and design enhancements to unlock full value of resources for supporting energy, flexibility, capacity, and other value streams to the province.
- **International Review of Demand Response Integration into Wholesale Electricity Markets.** For the Australian Energy Market Commission, authored a report describing the range of approaches and market experience integrated demand response into wholesale energy, ancillary service, and capacity markets. Provided detailed discussion of approaches in Singapore, Alberta, ERCOT, PJM, ISO New England, and Ontario. Summarized lessons learned regarding demand response business models, efficient wholesale pricing signals, and interactions with retail markets.
- **Oncor Value of Distributed Storage**. For Oncor Electric Delivery Company, conducted a benefit-cost analysis of adding varying levels of distributed storage into the ERCOT market. Value streams considered including market values such as energy and ancillary services, as well as regulated system values including deferred transmission and distribution costs, and avoiding distribution outages. Evaluated value from the perspectives of customers, a merchant storage developer, and society as a whole, as well as evaluating impacts on incumbent suppliers.
- **Oncor Distributed Storage Business Models to Supply Customer, Distribution System, and Wholesale Value Streams**. For Oncor Electric Delivery Company, conducted a benefit-cost analysis of adding varying levels of distributed storage into the Texas market. Recommended policy changes to enable storage under a range of business models (merchant, utility-owned, customer-owned, and third-party owned), and to allow for the development of resources that could provide multiple value streams. Value streams considered including market values such as energy and ancillary services, distribution-system values including deferred transmission and distribution costs, and customer value streams including avoiding distribution outages. Evaluated value from the perspectives of customers, a merchant storage developer, and society as a whole, as well as evaluating impacts on incumbent suppliers.
- **Risk and Financial Analysis of PJM Capacity Performance Product.** For a market participant, conducted a probabilistic assessment of the expected value, upside, and downside risks (both market-wide and private) associated with PJM's capacity performance product. Evaluated the likely frequency of scarcity events on average and as concentrated in particular years to estimate the expected value of bonus payments if operating as an energy-only asset, and the net potential bonus/penalty if operating as a capacity performance resource. Estimated risk-neutral and risk-averse capacity price offer levels; characterized the magnitude of risk exposure of poor asset performance coincided with system scarcity events.

- **Demand Response Auction Design**. For a system operator, assisted in the high-level and detailed designs of a demand response auction. Supported market rule development, auction clearing optimization specification, and quality control testing of auction clearing engine.
- **Hedging Products for Wind**. For a hedge fund, provided analytical support for the development of a hedging product for wind developers. Evaluated the risk exposure based on day-ahead and real-time participation, locational price differentials, profile and curtailment risks, and discrepancies with exchange-traded hedging products.
- **Tariff Design for Merchant Transmission Upgrades.** For a transmission developer, evaluated tariff design options for capturing market value of wind and transmission for a market participant proposing a large HVDC upgrade to enable wind developments.
- **Magnitude and Potential Impact of "Missing Efficiency" in PJM.** For the Natural Resources Defense Council, analyzed the potential magnitude of energy efficiency programs in PJM that are not accounted for on either demand side (through load forecast adjustments) or on the supply side (in the capacity market). Estimated potential energy and capacity market customer cost impacts in both the short-run and long-run if adjusting the load forecast to account for the missing efficiency.
- **Financial Transmission Right and Virtual Bidding Market Manipulation Litigation for PJM.** For PJM Interconnection, analyzed financial transmission rights, energy market, and virtual trading data for expert testimony regarding market manipulation behavior.
- **Wind and Storage.** For a developer of potential storage assets, simulation analysis modeling combined effects of gas dispatch, wind variability, load variability, and minimum generation conditions to determine the value of electric storage under various levels of wind penetration. Conducted portfolio analysis to determine the optimal level of storage on a systems level to minimize cost as a function of wind penetration levels.
- **Market Reforms to Meet Emerging Flexibility Needs.** For the Natural Resources Defense Council, authored a report on the electricity market reforms needed in the context of declining needs for baseload resources, increasing levels of intermittent supply, and increasing needs for flexible resources.

REPRESENTATIVE PUBLICATIONS

PAPERS AND REPORTS

Brown, Toby, Neil Lessem, Roger Lueken, Kathleen Spees, and Cathy Wang. *High-Impact, Low-Probability Events and the Framework for Reliability in the National Electricity Market.* Prepared for the Australian Energy Market Commission, February 2019.

Newell, Samuel A., Ariel Kaluzhny, Kathleen Spees, Kevin Carden, Nick Wintermantel, Alex Krasny, and Rebecca Carroll. *Estimation of the Market Equilibrium and Economically Optimal Reserve Margins for the ERCOT Region.* Prepared for the Electric Reliability Council of Texas, Inc. December 20, 2018.

Spees, Kathleen. *An Economic Perspective on Reliability: Rethinking System Needs and in a Future Dominated by Renewables, New Tech, and Engaged Consumers.* Presented at the Electricity Consumers Resource Council. November 28, 2018.

Spees, Kathleen. *The Cutting Edge in Resource Planning.* Presented to the Solar Energy Industries Association. November 12, 2018.

Spees, Kathleen. *Clean Energy Markets: The "Missing Link" to Market Design 3.0.* Presented to the Harvard Electricity Policy Group. October 4, 2018.

Pfeifenberger, Johannes P., Kathleen Spees, Michael Hagerty, Mike Tolleth, Martha Caulkins, Emily Shorin, Sang H. Gang, Patrick S. Daou, and John Wroble. *AESO Cost of New Entry Analysis: Combustion Turbines and Combined-Cycle Plants with November 1, 2021 Online Date.* Prepared for Alberta Electric System Operator. September 4, 2018.

Pfeifenberger, Johannes P., John Tsoukalis, Judy Chang, and Kathleen Spees. *Initial Comments on SPP's Draft Ramp Product Report.* August 30, 2018.

Spees, Kathleen, Johannes P. Pfeifenberger, Samuel A. Newell, and Judy Chang. *Harmonizing Environmental Policies with Competitive Markets: Using Wholesale Power Markets to Meet State and Customer Demand for a Cleaner Electricity Grid More Cost Effectively.* July 30, 2018.

Newell, Samuel A., David Luke Oates, Johannes P. Pfeifenberger, Kathleen Spees, Michael Hagerty, John Imon Pedtke, Matthew Witkin, and Emily Shorin. *Fourth Review of PJM's Variable Resource Requirement Curve.* April 19, 2018.

Newell, Samuel A., Kathleen Spees, Yingxia Yang, Elliott Metzler, and John Imon-Pedtke. *Opportunities to More Efficiently Meet Seasonal Capacity Needs in PJM.* April 12, 2018.

Spees, Kathleen, Samuel A Newell, David Luke Oates, Toby Brown, Neil Lessem, Daniel Jang, and John Imon Pedtke. *Near Term Reliability Auctions in the NEM: Lessons from International Jurisdictions.* Prepared for the Australian Energy Market Operator, August 23, 2017.

Newell, Samuel A., Roger Lueken, Jürgen Weiss, Kathleen Spees, Pearl Donohoo-Vallett, and Tony Lee. *Pricing Carbon into NYISO's Wholesale Energy Market to Support New York's Decarbonization Goals.*

Prepared for the New York Independent System Operator. August 10, 2017.

Newell, Samuel A., Johannes P. Pfeifenberger, Judy Chang, and Kathleen Spees. "How Wholesale Power Markets and State Environmental Policies Can Work Together," *Utility Dive,* July 10, 2017.

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