Before the Maryland Public Service Commission

Case No. 9406

Rebuttal Testimony of

Ahmad Faruqui

On Behalf of

Baltimore Gas and Electric Company

March 4, 2016

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I. INTRODUCTION

Q. Please state your name, job title, business address and party for whom you are filing testimony.

A. My name is Ahmad Faruqui. I am a Principal with The Brattle Group. My business address is 201 Mission Street, Suite 2800, San Francisco, California 94105. I am filing testimony in this proceeding on behalf of Baltimore Gas and Electric Company ("BGE").

Q. Please describe your professional background and experience.

A. I am an energy economist with 37 years of consulting and research experience. During my career, I have advised some one hundred and twenty five electric and gas utilities, regulatory commissions, government agencies, transmission system operators, private energy companies, equipment manufacturers, and IT companies in five continents and have given presentations on energy matters in all six continents. Besides the United States, my clients have been located in Australia, Canada, Chile, Egypt, Hong Kong, Jamaica, Philippines, Saudi Arabia, South Africa, and Vietnam. I have advised them on a wide range of issues including rate design, load forecasting, demand response, energy efficiency, distributed energy resources, cost-benefit analysis of emerging technologies, integration of retail and wholesale markets, and integrated resource planning. I have testified or appeared before a dozen state and provincial regulatory commissions and legislative bodies. I have authored or co-authored more than one hundred papers on energy economics and co-edited three books on electricity pricing and customer choice.

More details regarding my professional background and experience are set forth in my Statement of Qualifications, which is attached to my rebuttal testimony as Company Exhibit AF-1.

Q. What are your responsibilities as a Principal with The Brattle Group?

A. I lead the firm's practice in understanding and managing the changing needs of energy consumers.

Q. Have you previously testified before Maryland Public Service Commission?

A. Yes. I testified before the Maryland Public Service Commission (the "Commission") in Case No. 9208, where the Commission considered and approved BGE's request to deploy its Smart Grid Initiative.

II. OVERVIEW AND PURPOSE OF THE REBUTTAL TESTIMONY

Q. In the process of preparing for this rebuttal testimony, did you have an opportunity to review any of the testimony submitted by the parties in this proceeding?

A. Yes. I have reviewed the direct and supplemental direct testimonies of Company Witnesses Michael B. Butts and William B. Pino. I also reviewed the direct testimonies of Commission Staff Witness Daniel J. Hurley and Maryland Office of People's Counsel ("OPC") Witnesses Maximillian Chang, Paul Chernick, and Nancy Brockway.

Q. What is the purpose of your rebuttal testimony?

A. My rebuttal testimony is offered in support of BGE's request to recover costs associated with its Smart Grid Initiative and metering devices that pre-date the

deployment of a Smart Grid system. In this respect, my rebuttal testimony has several specific purposes:

First, I will provide my opinion on the reasonableness of the cost-effectiveness analysis performed by BGE on its Smart Grid Initiative and the Company's determination that the Smart Grid Initiative is cost-effective.

Second, I will respond to the position of OPC Witnesses Chang and Chernick that BGE's calculated benefits for its BGE Smart Energy Rewards® ("SER") program should be reduced to account for "free ridership."

Third, I will respond to the position of OPC Witnesses Brockway and Chang that the undepreciated book value of BGE's investment in metering devices that pre-date the deployment of a Smart Grid system (commonly referred to as "legacy meters") should be included in a cost-effectiveness analysis.

Fourth, I will respond to the position of OPC Witness Chang that the value of the bill credits paid to participants of the SER program should be included as a "cost" in the cost-effectiveness analysis.

Finally, I will respond to the position of OPC Witness Brockway that BGE should not be entitled to full recovery of its investment in legacy meters.

III. COST-EFFECTIVENESS OF BGE'S SMART GRID INITIATIVE

Q. Are you generally familiar with BGE's Smart Grid Initiative?

A. Yes, I am. In fact, as I mentioned previously, I testified as a witness on behalf of BGE in Case No. 9208 on the topic of BGE's Smart Energy Pricing program (now referred to as the SER program). Since the Commission's decision in Case No. 9208 to authorize BGE to deploy a Smart Grid system, I have continued to monitor BGE's

deployment effort and customers' realization of benefits from the Smart Grid Initiative.

Q. Have you had the opportunity to review BGE's cost-effectiveness analysis of its Smart Grid Initiative?

A. Yes. In connection with my preparation of this rebuttal testimony, I reviewed the cost-effectiveness analysis prepared by BGE and detailed in the direct and supplemental direct testimonies of Company Witnesses Butts and Pino.

Q. Based upon your expertise in economics and the energy industry, do you have an opinion on the reasonableness of the cost-effectiveness analysis performed by BGE?

A. Yes, I do. It is my opinion that the cost-effectiveness analysis performed by BGE is very reasonable and consistent with the commonly accepted methods for performing such an analysis in the energy industry. BGE's cost-effectiveness analysis properly included the actual and projected costs and benefits of the Smart Grid Initiative and produced a strong positive benefit-cost ratio.

IV. OPC'S IMPROPER REDUCTION TO THE BENEFITS OF THE SER PROGRAM TO ACCOUNT FOR "FREE RIDERSHIP"

Q. What is "free ridership"?

A. As OPC Witness Chang describes in his direct testimony, free-riders are "those customers who randomly decrease load, instead of decreasing load due to the SER program." This is a fair definition of the term "free ridership."

Q. What is the position of OPC on "free ridership" in connection with the benefits realized from BGE's SER program?

A. OPC argues that BGE's SER program benefits are overstated and need to be adjusted to account for free ridership. More specifically, OPC Witness Chang recommends a reduction in SER program benefits of 28% to account for free ridership within the SER participant group. In so doing, OPC Witness Chang also assumes that random increases in load are symmetric with the random decreases in load in terms of both the number of customers as well as the resulting load impact.

Q. Do you agree with OPC Witness Chang's arguments on free ridership?

A. No, I do not. OPC Witness Chang argues that all of the benefits associated with the SER program should be reduced by 28 percent due to free ridership within the participant group without any evidence to support such a claim. Mr. Chang points out that some customers in the participant group that reduced load did so randomly, and therefore should not be counted as contributing to the SER program. But he neglects to point out that some customers in the participant group increased their load on the Energy Savings Days ("ESDs"). Therefore, it is more likely the case that free ridership within the participant group is offset by those customers in the participant group that actually increased load during the ESDs.

Q. Please explain why the participant group could include customers that increased load during the ESDs.

A. BGE follows a two-stage approach in determining the SER load impacts. The first stage involves identifying the group of customers that are thought to have contributed to the load reduction efforts during the ESDs using the Customer Baseline ("CBL")

method. The second stage involves running a regression model on a panel dataset comprised of this participating customer group to estimate the load impacts. While the CBL methods are widely used in the industry to reward customers based on their performance on the ESDs, they do have their limitations. It is entirely possible that some customers who are identified as being a participating customer in the first stage actually raise their usage on ESDs.

Q. Has BGE quantified the offsetting effect on free ridership due to customers increasing their usage during ESDs?

A. No. It is just as difficult to quantify the extent of free ridership on SER benefits as it is to quantify the extent of load increases by certain customers on SER benefits. Since there is no way to quantify these impacts, the approach that BGE has taken to quantifying the average load impact of the SER program is the only practical alternative.

Q. Can you please summarize the argument set forth by OPC Witness Chernick regarding his proposed free ridership adjustment of the SER program impacts?

A. Dr. Chernick argues that BGE's estimate of the SER savings includes customers reacting to the rebate incentive as well as those who happened to have lower consumption on that day (*i.e.*, free riders), but does not net out the customers who had higher consumption for other reasons. He claims that his best estimate for the actual load effect of the SER program would be to calculate the change in total load from all eligible SER-only customers.

Q. Do you agree with OPC Witness Chernick's arguments?

A. No, I do not. In a simple example, OPC Witness Chernick compares a group of customers' usage in two days in July and finds as follows:

> [A]mong the 20 customers whose usage decreased from July 11 to July 20, the average reduction was over one kWh, more than 11%. If this utility had implemented some program to encourage conservation on July 20, BGE's approach would identify the 20 customers whose load reduction as "participants" . . . and conclude that the program resulted in a reduction of a kWh apiece for 56% of eligible customers.[1]

But the process discussed in this example only represents the first stage in BGE's approach to estimating SER program impacts. After identifying the group of participants, in Dr. Chernick's example of 20 customers, BGE estimates a panel data regression using the participants to account for the impact of weather between ESD and non-ESD days, as well as individual characteristics of customers affecting their usage. It is unlikely that the impact resulting from the panel data regression will yield "a reduction of a kWh apiece." This is simply because some of the customers identified as participants in stage one are not actually found to reduce their usage after normalizing for weather and other factors in stage two. They increase their usage and this serves to dampen the average load impact that is derived from the panel regression model.

Q. Why did BGE only analyze the loads of the participant group to establish the impact of the SER program?

A. BGE chose to select a "participant" group to gauge the effectiveness of the load-reducing capability of the program. Viewing the program from a participant perspective will most effectively capture the real impact of the program. The

[1] Direct Testimony of Paul Chernick at p. 13.

program's success should be characterized as how effective it is in incenting customers to achieve change in their electric consumption behavior. Therefore, it would be misleading to characterize the load-reducing capability of the program with the inclusion of non-participating customers, as is suggested by Dr. Chernick. The non-participating customers are not engaged in the program, and therefore should not affect how the load-reducing success of the program is characterized.

Q. In your opinion, do you believe any adjustment of the Company's SER benefits is required to account for free ridership?

A. No, I do not believe that any adjustment is warranted.

V. OPC'S POSITION ON THE INCLUSION OF THE UNDEPRECIATED BOOK VALUE OF LEGACY METERS AS A "COST" IN THE COST-EFFECTIVENESS ANALYSIS

Q. Did BGE include the undepreciated book value of legacy meters as a "cost" in the Company's cost-effectiveness analysis?

A. No.

Q. Do you agree with BGE's approach of not incorporating undepreciated book values of retired legacy meters in the Smart Grid Initiative cost-effectiveness analysis?

A. Yes, I do. In this context, undepreciated book value of legacy meters represent a sunk cost (i.e., costs incurred in the past) and sunk costs should not be considered in making business decisions.[2] The reasoning behind this is fairly simple. Sunk costs do not have any bearing on any future business decisions. This approach to the treatment of sunk costs derives from a basic precept in microeconomics that decisions

[2] For a detailed discussion, see Richard B. McKenzie and Dwight R. Lee, "Microeconomic for MBAs: The Economic Way of Thinking for Managers," Cambridge University Press 2006.

about the future should be determined on the basis of marginal revenue (or benefits) versus marginal costs. Since marginal costs are those directly associated with an action, costs in the past, i.e., sunk costs, are not relevant to a current decision about the future.[3]

Q. Does OPC Witness Chang include legacy meter costs in his cost-effectiveness analysis of the Smart Grid Initiative?

A. Yes, he does. OPC Witness Chang regards the sunk cost of legacy meters as relevant for the Smart Grid Initiative cost-effectiveness analysis, when it should be disregarded. The literature has revealed that including sunk costs in decision making is a cause of error that can result in excessive costs to business and society overall.[4] Examples of the "sunk cost effect" have been documented in decisions regarding information technology projects (Keil, 1995; Drummond, 1998) and real estate development projects (Cornell, Longstaff and Schwartz, 1996). By including sunk costs of legacy meters in his analysis, OPC Witness Chang is producing an analysis that could lead to an inefficient economic decision.

[3] William Young Davis, "Return the 'Sunk Costs are Sunk' Concept to Principles of Economics Textbooks," Journal of Business and Economic Research, Volume 3, Number 6, June 2005.

[4] For more discussion, see Gregory Kenneth Laing, "Decision Making Under Sunk Costs," Doctor of Philosophy Thesis, School of Accounting and Finance, University of Wollongong, 2002. http://ro.uow.edu.au/cgi/viewcontent.cgi?article=2909&context=theses.

VI. OPC'S INCLUSION OF SER BILL CREDITS AS A "COST" IN THE COST-EFFECTIVENESS ANALYSIS

Q. What is OPC's position on how SER bill credit should be treated in the Smart Grid Initiative cost-effectiveness analysis?

A. OPC Witness Chang argues that the Commission should include the value of the bill credits paid to participants of the SER program as a "cost" in the Smart Grid Initiative cost-effectiveness analysis.

Q. Should the bill credits received by SER program participants who lower their energy usage on ESDs be considered as a "cost" in the cost-effectiveness analysis of the Smart Grid Initiative?

A. No. The bill credits that participants in the SER program receive in return for reducing load on ESDs do not result in an incremental cost or benefit to the Smart Grid Initiative. Rather, bill credits are simply transfer payments from all customers to participants. Therefore, the inclusion of the bill credits as a "cost" in the cost-effectiveness analysis by OPC makes no economic sense.

Q. Are you aware of any Maryland precedent on treatment of bill credits in a cost-effectiveness analysis?

A. Yes. In regards to BGE's energy efficiency and demand response programs in Case No. 9154, my understanding is that rebates and bill credits have never been included in the cost-effectiveness analyses used to assess whether the Commission should approve those programs as cost effective.

VII. OPC'S POSITION ON BGE'S ABILITY TO FULLY RECOVER ITS INVESTMENT IN LEGACY METERS

Q. Do you agree with the recommendation of OPC Witness Brockway that BGE should not be entitled to full recovery of its investment in legacy meters?

A. No, I do not.

Q. Is granting BGE full recovery of its investment in legacy meters consistent with the manner in which such investments have been treated by other state commissions?

A. Yes. Based upon my experience and understanding of the energy industry, it is the norm to grant a utility full recovery of an investment such as the legacy meters that BGE has upgraded with smart metering devices as part of the Smart Grid Initiative. OPC Witness Brockway's suggestion that such is not the case is simply not true. Further, in both of the cases cited by OPC Witness Brockway in her direct testimony, the state public utility commissions granted a return *of* the utility's investment in legacy meters. The decision of the Kansas Commission not to grant a return *on* the utility's investment in legacy meters is inconsistent with the decisions of other jurisdictions, including the California Commission case cited by OPC Witness Brockway. I have reviewed decisions made by commissions in certain states where some of the largest deployments of AMI have occurred and found that both recovery *of* the investment in legacy meters and a return *on* the utility's investment have been granted. Besides California, the commissions in Georgia, Illinois, Michigan, Pennsylvania, and Texas have made such decisions.

Q. Even though inclusion of sunk costs does not make economic sense in a cost-effectiveness analysis, should utilities be allowed to recover sunk costs (in this case undepreciated cost of legacy meters)?

A. Yes, the two decisions are quite different. While sunk costs should not play any role in a cost-effectiveness analysis, not allowing the recovery of sunk costs would create a disincentive for utilities that wish to replace old assets with technologically superior assets. They would simply wait until the old assets had been fully depreciated. This would not be a good decision since it would retard technological innovation. Virtually no utility would be willing to write off assets since such action would immediately lower their earnings.

Q. Does this conclude your testimony?

A. Yes.

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Principal

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Dr. Ahmad Faruqui leads a consulting practice focused on understanding and managing the way customers use energy. His clients include utilities, commissions, equipment manufacturers, technology developers, and energy service companies. The practice encompasses a wide range of activities:

- **Rate design.** The recent decline in electricity sales has generated an entire crop of new issues that utilities must address in order to remain profitable. A key issue is the under-recovery of fixed costs and the creation of unsustainable cross-subsidies. To address these issues, we are creating alternative rate designs, testing their impact on customer bills, and sponsoring testimony to have them implemented. We are currently undertaking a large-scale project for a large investor-owned utility to estimate marginal costs, design rates, and produce a related software tool, working in close coordination with their internal executives. We have created a Pricing Roundtable which serves as virtual think tank on addressing the risks of under-recovery in the face of declining growth. About 18 utilities are a part of the think tank.

- **Demand forecasting.** We help utilities to identify the reasons for the slowdown in sales growth, which include utility energy efficiency programs, governmental codes and standards, distributed general, and fuel switching brought on by falling natural gas prices and the weak economic recovery. We present widely on the issue and are researching new methods for forecasting peak demand, such as the use of quantile regression.

- **Demand response.** For several clients in the United States and Canada, we are studying the impact of dynamic pricing. We have completed similar studies for a utility in the Asia-Pacific region and a regulatory body in the Middle East. We also conduct program design studies, impact evaluation studies, and cost-benefit analysis, and design marketing programs to maximize customer enrollment. Clients include utilities, regulators, demand response providers, and technology firms.

- **Energy efficiency.** We are studying the potential role of combined heat and power in enhancing energy efficiency in large commercial and industrial facilities. We are also carrying out analyses of behavioral programs that use social norming to induce change in the usage patterns of households.

- **New product design and cost-benefit analysis of emerging customer-side technologies**. We analyze market opportunities, costs, and benefits for advanced digital meters and associated infrastructure, smart thermostats, in-home displays, and other devices. This includes product design, such as proof-of-concept assessment, and a comparison of the costs and benefits of these new technologies from several vantage points: owners of that technology, other electricity customers, the utility or retail energy provider, and society as a whole.

In each of these areas, the engagements encompass both quantitative and qualitative analysis. Dr. Faruqui's reports, and derivative papers and presentations, are often widely cited in the media. The Brattle Group often sponsors testimony in regulatory proceedings and Dr. Faruqui has testified or appeared before a dozen state and provincial commissions and legislative bodies in the United States and Canada.

Dr. Faruqui's survey of the early experiments with time-of-use pricing in the United States is referenced in Professor Bonbright's treatise on public utilities. He managed the integration of results across the top five of these experiments in what was the first meta-analysis involving innovative pricing. Two of his dynamic experiments have won professional awards, and he was named one of the world's Top 100 experts on the smart grid by Greentech Media.

He has consulted with more than 50 utilities and transmission system operators around the globe and testified or appeared before a dozen state and provincial commissions and legislative bodies in the United States and Canada. He has also advised the Alberta Utilities Commission, the Edison Electric Institute, the Electric Power Research Institute, FERC, the Institute for Electric Efficiency, the Ontario Energy Board, the Saudi Electricity and Co-Generation Regulatory Authority, and the World Bank. His work has been cited in publications such as *The Economist, The New York Times*, and *USA Today* and he has appeared on Fox News and National Public Radio.

Dr. Faruqui is the author, co-author or editor of four books and more than 150 articles, papers, and reports on efficient energy use, some of which are featured on the websites of the Harvard Electricity Policy Group and the Social Science Research Network. He has taught economics at San Jose State University, the University of California at Davis and the University of Karachi. He holds a an M.A. in agricultural economics and a Ph. D. in economics from The University of California at Davis, where he was a Regents Fellow, and B.A. and M.A. degrees in economics from The University of Karachi, where he was awarded the Gold Medal in economics.

AREAS OF EXPERTISE

- *Innovative pricing*. He has identified, designed and analyzed the efficiency and equity benefits of introducing innovative pricing designs such as dynamic pricing, time-of-use pricing and inclining block rates.
- *Regulatory strategy.* He has helped design forward-looking programs and services that exploit recent advances in rate design and digital technologies in order to lower customer bills and improve utility earnings while lowering the carbon footprint and preserving system reliability.
- *Cost-benefit analysis of advanced metering infrastructure*. He has assessed the feasibility of introducing smart meters and other devices, such as programmable communicating

thermostats that promote demand response, into the energy marketplace, in addition to new appliances, buildings, and industrial processes that improve energy efficiency.

- *Demand forecasting and weather normalization.* He has pioneered the use of a wide variety of models for forecasting product demand in the near-, medium-, and long-term, using econometric, time series, and engineering methods. These models have been used to bid into energy procurement auctions, plan capacity additions, design customer-side programs, and weather normalize sales.
- *Customer choice*. He has developed methods for surveying customers in order to elicit their preferences for alternative energy products and alternative energy suppliers. These methods have been used to predict the market size of these products and to estimate the market share of specific suppliers.
- *Hedging, risk management, and market design*. He has helped design a wide range of financial products that help customers and utilities cope with the unique opportunities and challenges posed by a competitive market for electricity. He conducted a widely-cited market simulation to show that real-time pricing of electricity could have saved Californians millions of dollars during the Energy Crisis by lowering peak demands and prices in the wholesale market.
- *Competitive strategy*. He has helped clients develop and implement competitive marketing strategies by drawing on his knowledge of the energy needs of end-use customers, their values and decision-making practices, and their competitive options. He has helped companies reshape and transform their marketing organization and reposition themselves for a competitive marketplace. He has also helped government-owned entities in the developing world prepare for privatization by benchmarking their planning, retailing, and distribution processes against industry best practices, and suggesting improvements by specifying quantitative metrics and follow-up procedures.
- *Design and evaluation of marketing programs.* He has helped generate ideas for new products and services, identified successful design characteristics through customer surveys and focus groups, and test marketed new concepts through pilots and experiments.
- *Expert witness.* He has testified or appeared before state commissions in Arkansas, California, Colorado, Connecticut, Delaware, the District of Columbia, Illinois, Indiana, Iowa, Kansas, Michigan, Maryland, Ontario (Canada) and Pennsylvania. He has assisted

clients in submitting testimony in Georgia and Minnesota. He has made presentations to the California Energy Commission, the California Senate, the Congressional Office of Technology Assessment, the Kentucky Commission, the Minnesota Department of Commerce, the Minnesota Senate, the Missouri Public Service Commission, and the Electricity Pricing Collaborative in the state of Washington. In addition, he has led a variety of professional seminars and workshops on public utility economics around the world and taught economics at the university level.

EXPERIENCE

Innovative Pricing

- **Report examining the costs and benefits of dynamic pricing in the Australian energy market.** For the Australian Energy Market Commission (AEMC), developed a report that reviews the various forms of dynamic pricing, such as time-of-use pricing, critical peak pricing, peak time rebates, and real time pricing, for a variety of performance metrics including economic efficiency, equity, bill risk, revenue risk, and risk to vulnerable customers. It also discusses ways in which dynamic pricing can be rolled out in Australia to raise load factors and lower average energy costs for all consumers without harming vulnerable consumers, such as those with low incomes or medical conditions requiring the use of electricity.

- **Whitepaper on emerging issues in innovative pricing.** For the Regulatory Assistance Project (RAP), developed a whitepaper on emerging issues and best practices in innovative rate design and deployment. The paper includes an overview of AMI-enabled electricity pricing options, recommendations for designing the rates and conducting experimental pilots, an overview of recent pilots, full-deployment case studies, and a blueprint for rolling out innovative rate designs. The paper's audience is international regulators in regions that are exploring the potential benefits of smart metering and innovative pricing.

- **Assessing the full benefits of real-time pricing.** For two large Midwestern utilities, assessed and, where possible, quantified the potential benefits of the existing residential real-time pricing (RTP) rate offering. The analysis included not only "conventional" benefits such as avoided resource costs, but under the direction of the state regulator was

expanded to include harder-to-quantify benefits such as improvements to national security and customer service.

- **Pricing and Technology Pilot Design and Impact Evaluation for Connecticut Light & Power (CL&P).** Designed the Plan-It Wise Energy pilot for all classes of customers and subsequently evaluated the Plan-It Wise Energy program (PWEP) in the summer of 2009. PWEP tested the impacts of CPP, PTR, and time of use (TOU) rates on the consumption behaviors of residential and small commercial and industrial customers.
- **Dynamic Pricing Pilot Design and Impact Evaluation: Baltimore Gas & Electric.** Designed and evaluated the Smart Energy Pricing (SEP) pilot, which ran for four years from 2008 to 2011. The pilot tested a variety of rate designs including critical peak pricing and peak time rebates on residential customer consumption patterns. In addition, the pilot tested the impacts of smart thermostats and the Energy Orb.
- **Impact Evaluation of a Residential Dynamic Pricing Experiment: Consumers Energy (Michigan).** Designed the pilot and carried out an impact evaluation with the purpose of measuring the impact of critical peak pricing (CPP) and peak time rebates (PTR) on residential customer consumption patterns. The pilot also tested the influence of switches that remotely adjust the duty cycle of central air conditioners.
- **Impact Simulation of Ameren Illinois Utilities' Power Smart Pricing Program.** Simulated the potential demand response of residential customers enrolled to real- time prices. Results of this simulation were presented to the Midwest ISO's Supply Adequacy Working Group (SAWG) to explore alternative ways of introducing price responsive demand in the region.
- **The Case for Dynamic Pricing: Demand Response Research Center.** Led a project involving the California Public Utilities Commission, the California Energy Commission, the state's three investor-owned utilities, and other stakeholders in the rate design process. Identified key issues and barriers associated with the development of time-based rates. Revisited the fundamental objectives of rate design, including efficiency and equity, with a special emphasis on meeting the state's strongly-articulated needs for demand response and energy efficiency. Developed a score-card for evaluating competing rate designs and applied it to a set of illustrative rates that were created for four customer classes using actual utility data. The work was reviewed by a national peer-review panel.

- **Developed a Customer Price Response Model: Consolidated Edison.** Specified, estimated, tested, and validated a large-scale model that analyzes the response of some 2,000 large commercial customers to rising steam prices. The model includes a module for analyzing conservation behavior, another module for forecasting fuel switching behavior, and a module for forecasting sales and peak demand
- **Design and Impact Evaluation of the Statewide Pricing Pilot: Three California Utilities.** Working with a consortium of California's three investor-owned utilities to design a statewide pricing pilot to test the efficacy of dynamic pricing options for mass-market customers. The pilot was designed using scientific principles of experimental design and measured changes in usage induced by dynamic pricing for over 2,500 residential and small commercial and industrial customers. The impact evaluation was carried out using state-of-the-art econometric models. Information from the pilot was used by all three utilities in their business cases for advanced metering infrastructure (AMI). The project was conducted through a public process involving the state's two regulatory commissions, the power agency, and several other parties.
- **Economics of Dynamic Pricing: Two California Utilities.** Reviewed a wide range of dynamic pricing options for mass-market customers. Conducted an initial cost-effectiveness analysis and updated the analysis with new estimates of avoided costs and results from a survey of customers that yielded estimates of likely participation rates.
- **Economics of Time-of-Use Pricing: A Pacific Northwest Utility.** This utility ran the nation's largest time-of-use pricing pilot program. Assessed the cost-effectiveness of alternative pricing options from a variety of different perspectives. Options included a standard three-part time-of-use rate and a quasi-real time variant where the prices vary by day. Worked with the client in developing a regulatory strategy. Worked later with a collaborative to analyze the program's economics under a variety of scenarios of the market environment.
- **Economics of Dynamic Pricing Options for Mass Market Customers - Client: A Multi-State Utility.** Identified a variety of pricing options suited to meet the needs of mass-market customers, and assessed their cost-effectiveness. Options included standard three-part time-of-use rates, critical peak pricing, and extreme-day pricing. Developed plans for implementing a pilot program to obtain primary data on customer acceptance and load shifting potential. Worked with the client in developing a regulatory strategy.

- **Real-Time Pricing in California - Client: California Energy Commission.** Surveyed the national experience with real-time pricing of electricity, directed at large power customers. Identified lessons learned and reviewed the reasons why California was unable to implement real-time pricing. Catalogued the barriers to implementing real-time pricing in California, and developed a program of research for mitigating the impacts of these barriers.
- **Market-Based Pricing of Electricity - Client: A Large Southern Utility.** Reviewed pricing methodologies in a variety of competitive industries including airlines, beverages, and automobiles. Recommended a path that could be used to transition from a regulated utility environment to an open market environment featuring customer choice in both wholesale and retail markets. Held a series of seminars for senior management and their staffs on the new methodologies.
- **Tools for Electricity Pricing - Client: Consortium of Several U.S. and Foreign Utilities.** Developed Product Mix, a software package that uses modern finance theory and econometrics to establish a profit-maximizing menu of pricing products. The products range from the traditional fixed-price product to time-of-use prices to hourly real-time prices, and also include products that can hedge customers' risks based on financial derivatives. Outputs include market share, gross revenues, and profits by product and provider. The calculations are performed using probabilistic simulation, and results are provided as means and standard deviations. Additional results include delta and gamma parameters that can be used for corporate risk management. The software relies on a database of customer load response to various pricing options called StatsBank. This database was created by metering the hourly loads of about one thousand commercial and industrial customers in the United States and the United Kingdom.
- **Risk-Based Pricing - Client: Midwestern Utility.** Developed and tested new pricing products for this utility that allowed it to offer risk management services to its customers. One of the products dealt with weather risk; another one dealt with risk that real-time prices might peak on a day when the customer does not find it economically viable to cut back operations.

Demand Response

- **National Action Plan for Demand Response: Federal Energy Regulatory Commission.** Led a consulting team developing a national action plan for demand response (DR). The national action plan outlined the steps that need to be taken in order to maximize the amount of cost-effective DR that can be implemented. The final document was filed with U.S. Congress in June 2010.
- **National Assessment of Demand Response Potential: Federal Energy Regulatory Commission.** Led a team of consultants to assess the economic and achievable potential for demand response programs on a state-by-state basis. The assessment was filed with the U.S. Congress in 2009, as required by the Energy Independence and Security Act of 2007.
- **Evaluation of the Demand Response Benefits of Advanced Metering Infrastructure: Mid-Atlantic Utility.** Conducted a comprehensive assessment of the benefits of advanced metering infrastructure (AMI) by developing dynamic pricing rates that are enabled by AMI. The analysis focused on customers in the residential class and commercial and industrial customers under 600 kW load.
- **Estimation of Demand Response Impacts: Major California Utility.** Worked with the staff of this electric utility in designing dynamic pricing options for residential and small commercial and industrial customers. These options were designed to promote demand response during critical peak days. The analysis supported the utility's advanced metering infrastructure (AMI) filing with the California Public Utilities Commission. Subsequently, the commission unanimously approved a $1.7 billion plan for rolling out nine million electric and gas meters based in part on this project work.

Smart Grid Strategy

- **Development of a smart grid investment roadmap for Vietnamese utilities.** For the five Vietnamese power corporations, developed a roadmap to guide future smart grid investment decisions. The report identified and described the various smart grid investment options, established objectives for smart grid deployment, presented a multi-phase approach to deploying the smart grid, and provided preliminary recommendations regarding the best investment opportunities. Also presented relevant case studies and an assessment of the current state of the Vietnamese power

grid. The project involved in-country meetings as well as a stakeholder workshop that was conducted by *Brattle* staff.

- **Cost-Benefit Analysis of the Smart Grid: Rocky Mountain Utility.** Reviewed the leading studies on the economics of the smart grid and used the findings to assess the likely cost-effectiveness of deploying the smart grid in one geographical location.
- **Modeling benefits of smart grid deployment strategies.** Developed a model for assessing benefits of smart grid deployment strategies over a long-term (e.g., 20-year) forecast horizon. The model, called iGrid, is used to evaluate seven distinct smart grid programs and technologies (e.g., dynamic pricing, energy storage, PHEVs) against seven key metrics of value (e.g., avoided resource costs, improved reliability).
- **Smart grid strategy in Canada.** The Alberta Utilities Commission (AUC) was charged with responding to a Smart Grid Inquiry issued by the provincial government. Advised the AUC on the smart grid, and what impacts it might have in Alberta.
- **Smart grid deployment analysis for collaborative of utilities.** Adapted the iGrid modeling tool to meet the needs of a collaborative of utilities in the southern U.S. In addition to quantifying the benefits of smart grid programs and technologies (e.g., advanced metering infrastructure deployment and direct load control), the model was used to estimate the costs of installing and implementing each of the smart grid programs and technologies.
- **Development of a smart grid cost-benefit analysis framework.** For the Electric Power Research Institute (EPRI) and the U.S. DOE, contributed to the development of an approach for assessing the costs and benefits of the DOE's smart grid demonstration programs.
- **Analysis of the benefits of increased access to energy consumption information.** For a large technology firm, assessed market opportunities for providing customers with increased access to real time information regarding their energy consumption patterns. The analysis includes an assessment of deployments of information display technologies and analysis of the potential benefits that are created by deploying these technologies.

- **Developing a plan for integrated smart grid systems.** For a large California utility, helped to develop applications for funding for a project to demonstrate how an integrated smart grid system (including customer-facing technologies) would operate and provide benefits.

Demand Forecasting

- **Comprehensive Review of Load Forecasting Methodology: PJM Interconnection.** Conducted a comprehensive review of models for forecasting peak demand and re-estimated new models to validate recommendations. Individual models were developed for 18 transmission zones as well as a model for the RTO system.
- **Analyzed Downward Trend: Western Utility.** We conducted a strategic review of why sales had been lower than forecast in a year when economic activity had been brisk. We developed a forecasting model for identifying what had caused the drop in sales and its results were used in an executive presentation to the utility's board of directors. We also developed a time series model for more accurately forecasting sales in the near term and this model is now being used for revenue forecasting and budgetary planning.
- **Analyzed Why Models are Under-Forecasting: Southwestern Utility.** Reviewed the entire suite of load forecasting models, including models for forecasting aggregate system peak demand, electricity consumption per customer by sector and the number of customers by sector. We ran a variety of forecasting experiments to assess both the ex-ante and ex-post accuracy of the models and made several recommendations to senior management.
- **U.S. Demand Forecast: Edison Electric Institute.** For the U.S. as a whole, we developed a base case forecast and several alternative case forecasts of electric energy consumption by end use and sector. We subsequently developed forecasts that were based on EPRI's system of end-use forecasting models. The project was done in close coordination with several utilities and some of the results were published in book form.
- **Developed Models for Forecasting Hourly Loads: Merchant Generation and Trading Company.** Using primary data on customer loads, weather conditions, and economic activity, developed models for forecasting hourly loads for residential, commercial,

and industrial customers for three utilities in a Midwestern state. The information was used to develop bids into an auction for supplying basic generation services.

- **Gas Demand Forecasting System - Client: A Leading Gas Marketing and Trading Company, Texas.** Developed a system for gas nominations for a leading gas marketing company that operated in 23 local distribution company service areas. The system made week-ahead and month-ahead forecasts using advanced forecasting methods. Its objective was to improve the marketing company's profitability by minimizing penalties associated with forecasting errors.

Demand Side Management

- **The Economics of Biofuels.** For a western utility that is facing stringent renewable portfolio standards and that is heavily dependent on imported fossil fuels, carried out a systematic assessment of the technical and economic ability of biofuels to replace fossil fuels.
- **Assessment of Demand-Side Management and Rate Design Options: Large Middle Eastern Electric Utility.** Prepared an assessment of demand-side management and rate design options for the four operating areas and six market segments. Quantified the potential gains in economic efficiency that would result from such options and identified high priority programs for pilot testing and implementation. Held workshops and seminars for senior management, managers, and staff to explain the methodology, data, results, and policy implications.
- **Likely Future Impact of Demand-Side Programs on Carbon Emissions - Client: The Keystone Center.** As part of the Keystone Dialogue on Climate Change, developed scenarios of future demand-side program impacts, and assessed the impact of these programs on carbon emissions. The analysis was carried out at the national level for the U.S. economy, and involved a bottom-up approach involving many different types of programs including dynamic pricing, energy efficiency, and traditional load management.
- **Sustaining Energy Efficiency Services in a Restructured Market - Client: Southern California Edison.** Helped in the development of a regulatory strategy for implementing energy efficiency strategies in a restructured marketplace. Identified the various players that are likely to operate in a competitive market, such as third-party energy service companies (ESCOS) and utility affiliates. Assessed their

objectives, strengths, and weaknesses and recommended a strategy for the client's adoption. This strategy allowed the client to participate in the new market place, contribute to public policy objectives, and not lose market share to new entrants. This strategy has been embraced by a coalition of several organizations involved in the California PUC's working group on public purpose programs.

- **Organizational Assessments of Capability for Energy Efficiency - Client: U.S. Agency for International Development, Cairo, Egypt.** Conducted in-depth interviews with senior executives of several energy organizations, including utilities, government agencies, and ministries to determine their goals and capabilities for implementing programs to improve energy end-use efficiency in Egypt. The interviews probed the likely future role of these organizations in a privatized energy market, and were designed to help develop U.S. AID's future funding agenda.
- **Enhancing Profitability Through Energy Efficiency Services - Client: Jamaica Public Service Company.** Developed a plan for enhancing utility profitability by providing financial incentives to the client utility, and presented it for review and discussion to the utility's senior management and Jamaica's new Office of Utility Regulation. Developed regulatory procedures and legislative language to support the implementation of the plan. Conducted training sessions for the staff of the utility and the regulatory body.

Advanced Technology Assessment

- **Competitive Energy and Environmental Technologies - Clients: Consortium of clients, led by Southern California Edison, Included the Los Angeles Department of Water and Power and the California Energy Commission.** Developed a new approach to segmenting the market for electrotechnologies, relying on factors such as type of industry, type of process and end use application, and size of product. Developed a user-friendly system for assessing the competitiveness of a wide range of electric and gas-fired technologies in more than 100 four-digit SIC code manufacturing industries and 20 commercial businesses. The system includes a database on more than 200 end-use technologies, and a model of customer decision making.
- **Market Infrastructure of Energy Efficient Technologies - Client: EPRI.** Reviewed the market infrastructure of five key end-use technologies, and identified ways in which the infrastructure could be improved to increase the penetration of these

technologies. Data was obtained through telephone interviews with equipment manufacturers, engineering firms, contractors, and end-use customers

TESTIMONY

Arizona

Direct Testimony before the Arizona Corporation Commission on behalf of Arizona Public Service Company, in the matter of the Application for UNS Electric, Inc. for the Establishment of Just and Reasonable Rates and Charges Designed to Realize a Reasonable Rate of Return on the Fair Value of the Properties of UNS Electric, Inc. Devoted to the its Operations Throughout the State of Arizona, and for Related Approvals, Docket No. E-04204A-15-0142, December 9, 2015.

California

Rebuttal Testimony before the Public Utilities Commission of the State of California, Pacific Gas and Electric Company Joint Utility on Demand Elasticity and Conservation Impacts of Investor-Owned Utility Proposals, in the Matter of Rulemaking 12-06-013, October 17, 2014.

Prepared testimony before the Public Utilities Commission of the State of California on behalf of Pacific Gas and Electric Company on rate relief, Docket No. A.10-03-014, summer 2010.

Qualifications and prepared testimony before the Public Utilities Commission of the State of California, on behalf of Southern California Edison, Edison SmartConnect™ Deployment Funding and Cost Recovery, exhibit SCE-4, July 31, 2007.

Testimony on behalf of the Pacific Gas & Electric Company, in its application for Automated Metering Infrastructure with the California Public Utilities Commission. Docket No. 05-06-028, 2006.

Colorado

Rebuttal testimony before the Public Utilities Commission of the State of Colorado in the Matter of Advice Letter No. 1535 by Public Service Company of Colorado to Revise its Colorado PUC No.7 Electric Tariff to Reflect Revised Rates and Rate Schedules to be Effective on June 5, 2009. Docket No. 09al-299e, November 25, 2009.

Direct testimony before the Public Utilities Commission of the State of Colorado, on behalf of Public Service Company of Colorado, on the tariff sheets filed by Public Service Company of Colorado with advice letter No. 1535 – Electric. Docket No. 09S-__E, May 1, 2009.

Connecticut

Testimony before the Department of Public Utility Control, on behalf of the Connecticut Light and Power Company, in its application to implement Time-of-Use , Interruptible Load Response, and Seasonal Rates- Submittal of Metering and Rate Pilot Results- Compliance Order No. 4, Docket no. 05-10-03RE01, 2007.

District of Columbia

Direct testimony before the Public Service Commission of the District of Columbia on behalf of Potomac Electric Power Company in the matter of the Application of Potomac Electric Power Company for Authorization to Establish a Demand Side Management Surcharge and an Advance Metering Infrastructure Surcharge and to Establish a DSM Collaborative and an AMI Advisory Group, case no. 1056, May 2009.

Illinois

Direct testimony on rehearing before the Illinois Commerce Commission on behalf of Ameren Illinois Company, on the Smart Grid Advanced Metering Infrastructure Deployment Plan, Docket No. 12-0244, June 28, 2012.

Testimony before the State of Illinois – Illinois Commerce Commission on behalf of Commonwealth Edison Company regarding the evaluation of experimental residential real-time pricing program, 11-0546, April 2012.

Prepared rebuttal testimony before the Illinois Commerce Commission on behalf of Commonwealth Edison, on the Advanced Metering Infrastructure Pilot Program, ICC Docket No. 06-0617, October 30, 2006.

Indiana

Direct testimony before the State of Indiana, Indiana Utility Regulatory Commission, on behalf of Vectren South, on the smart grid. Cause no. 43810, 2009.

Kansas

Direct testimony before the State Corporation Commission of the State of Kansas, on behalf of Westar Energy, in the matter of the Application of Westar Energy, Inc. and Kansas Gas and Electric Company to Make Certain Changes in Their Charges for Electric Service, Docket No. 15-WSEE-115-RTS, March 2, 2015.

Maryland

Direct testimony before the Public Service Commission of Maryland, on behalf of Potomac Electric Power Company and Delmarva Power and Light Company, on the deployment of Advanced Meter Infrastructure. Case no. 9207, September 2009.

Prepared direct testimony before the Maryland Public Service Commission, on behalf of Baltimore Gas and Electric Company, on the findings of BGE's Smart Energy Pricing ("SEP") Pilot program. Case No. 9208, July 10, 2009.

Minnesota

Rebuttal testimony before the Minnesota Public Utilities Commission State of Minnesota on behalf of Northern States Power Company, doing business as Xcel Energy, in the matter of the Application of Northern States Power Company for Authority to Increase Rates for Electric Service in Minnesota, Docket No. E002/GR-12-961, March 25, 2013.

Direct testimony before the Minnesota Public Utilities Commission State of Minnesota on behalf of Northern States Power Company, doing business as Xcel Energy, in the matter of the Application of Northern States Power Company for Authority to Increase Rates for Electric Service in Minnesota, Docket No. E002/GR-12-961, November 2, 2012.

Nevada

Prepared rebuttal testimony before the Public Utilities Commission of Nevada on behalf of Nevada Power Company and Sierra Pacific Power Company d/b/a NV Energy, in the matter of net metering and distributed generation cost of service and tariff design, Docket Nos. 15-07041 and 15-07042, November 3, 2015.

Prepared direct testimony before the Public Utilities Commission of Nevada on behalf of Nevada Power Company d/b/a NV Energy, in the matter of the application for approval of a cost of service study and net metering tariffs, Docket No. 15-07, July 31, 2015.

New Mexico

Direct testimony before the New Mexico Regulation Commission on behalf of Public Service Company of New Mexico in the matter of the Application of Public Service Company of New Mexico for Revision of its Retail Electric Rates Pursuant to Advice Notice No. 507, Case No. 14-00332-UT, December 11, 2014.

Pennsylvania

Direct testimony before the Pennsylvania Public Utility Commission, on behalf of PECO on the Methodology Used to Derive Dynamic Pricing Rate Designs, Case no. M-2009-2123944, October 28, 2010.

REGULATORY APPEARANCES

Arkansas

Presented before the Arkansas Public Service Commission, "The Emergence of Dynamic Pricing" at the workshop on the Smart Grid, Demand Response, and Automated Metering Infrastructure, Little Rock, Arkansas, September 30, 2009.

Delaware

Presented before the Delaware Public Service Commission, "The Demand Response Impacts of PHI's Dynamic Pricing Program" Delaware, September 5, 2007.

Kansas

Presented before the State Corporation Commission of the State of Kansas, "The Impact of Dynamic Pricing on Westar Energy" at the Smart Grid and Energy Storage Roundtable, Topeka, Kansas, September 18, 2009.

Ohio

Presented before the Ohio Public Utilities Commission, "Dynamic Pricing for Residential and Small C&I Customers" at the Technical Workshop, Columbus, Ohio, March 28, 2012.

Texas

Presented before the Public Utility Commission of Texas, "Direct Load Control of Residential Air Conditioners in Texas," at the PUCT Open Meeting, Austin, Texas, October 25, 2012.

PUBLICATIONS

Books

"Making the Most of the No Load Growth Business Environment," with Dian Grueneich. *Distributed Generation and Its Implications for the Utility Industry*. Ed. Fereidoon P. Sioshansi. Academic Press, 2014. 303-320.

"*Arcturus*: An International Repository of Evidence on Dynamic Pricing," with Sanem Sergici. *Smart Grid Applications and Developments, Green Energy and Technology*. Ed. Daphne Mah, Ed. Peter Hills, Ed. Victor O. K. Li, Ed. Richard Balme. Springer, 2014. 59-74.

"Will Energy Efficiency make a Difference," with Fereidoon P. Sioshansi and Gregory Wikler. *Energy Efficiency: Towards the end of demand growth*. Ed. Fereidoon P. Sioshansi. Academic Press, 2013. 3-50.

"The Ethics of Dynamic Pricing." *Smart Grid: Integrating Renewable, Distributed & Efficient Energy*. Ed. Fereidoon P. Sioshansi. Academic Press, 2012. 61-83.

Electricity Pricing in Transition. Co-editor with Kelly Eakin. Kluwer Academic Publishing, 2002.

Pricing in Competitive Electricity Markets. Co-editor with Kelly Eakin. Kluwer Academic Publishing, 2000.

Customer Choice: Finding Value in Retail Electricity Markets. Co-editor with J. Robert Malko. Public Utilities Inc. Vienna. Virginia: 1999.

The Changing Structure of American Industry and Energy Use Patterns. Co-editor with John Broehl. Battelle Press, 1987.

Customer Response to Time of Use Rates: Topic Paper I, with Dennis Aigner and Robert T. Howard, Electric Utility Rate Design Study, EPRI, 1981.

Technical Reports

Quantifying the Amount and Economic Impacts of Missing Energy Efficiency in PJM's Load Forecast, with Sanem Sergici and Kathleen Spees, prepared for The Sustainable FERC Project, September 2014.

Structure of Electricity Distribution Network Tariffs: Recovery of Residual Costs, with Toby Brown, prepared for the Australian Energy Market Commission, August 2014.

Impact Evaluation of Ontario's Time-of-Use Rates: First Year Analysis, with Sanem Sergici, Neil Lessem, Dean Mountain, Frank Denton, Byron Spencer, and Chris King, prepared for Ontario Power Authority, November 2013.

Time-Varying and Dynamic Rate Design, with Ryan Hledik and Jennifer Palmer, prepared for RAP, July 2012. http://www.raponline.org/document/download/id/5131

The Costs and Benefits of Smart Meters for Residential Customers, with Adam Cooper, Doug Mitarotonda, Judith Schwartz, and Lisa Wood, prepared for Institute for Electric Efficiency, July 2011. http://www.smartgridnews.com/artman/uploads/1/IEE_Benefits_of_Smart_Meters_Final.pdf

Measurement and Verification Principles for Behavior-Based Efficiency Programs, with Sanem Sergici, prepared for Opower, May 2011. http://opower.com/uploads/library/file/10/brattle_mv_principles.pdf

Methodological Approach for Estimating the Benefits and Costs of Smart Grid Demonstration Projects. With R. Lee, S. Bossart, R. Hledik, C. Lamontagne, B. Renz, F. Small, D. Violette, and D. Walls. Pre-publication draft, prepared for the U. S. Department of Energy, Office of Electricity Delivery and Energy Reliability, the National Energy Technology Laboratory, and the Electric Power Research Institute. Oak Ridge, TN: Oak Ridge National Laboratory, November 28, 2009.

Moving Toward Utility-Scale Deployment of Dynamic Pricing in Mass Markets. With Sanem Sergici and Lisa Wood. Institute for Electric Efficiency, June 2009.

Demand-Side Bidding in Wholesale Electricity Markets. With Robert Earle. Australian Energy Market Commission, 2008. http://www.aemc.gov.au/electricity.php?r=20071025.174223

Assessment of Achievable Potential for Energy Efficiency and Demand Response in the U.S. (2010-2030). With Ingrid Rohmund, Greg Wikler, Omar Siddiqui, and Rick Tempchin. American Council for an Energy-Efficient Economy, 2008.

Quantifying the Benefits of Dynamic Pricing in the Mass Market. With Lisa Wood. Edison Electric Institute, January 2008.

California Energy Commission. *2007 Integrated Energy Policy Report,* CEC-100-2007-008-CMF.

Applications of Dynamic Pricing in Developing and Emerging Economies. Prepared for The World Bank, Washington, DC. May 2005.

Preventing Electrical Shocks: What Ontario—And Other Provinces—Should Learn About Smart Metering. With Stephen S. George. C. D. Howe Institute Commentary, No. 210, April 2005.

Primer on Demand-Side Management. Prepared for The World Bank, Washington, DC. March 21, 2005.

Electricity Pricing: Lessons from the Front. With Dan Violette. White Paper based on the May 2003 AESP/EPRI Pricing Conference, Chicago, Illinois, EPRI Technical Update 1002223, December 2003.

Electric Technologies for Gas Compression. Electric Power Research Institute, 1997.

Electrotechnologies for Multifamily Housing. With Omar Siddiqui. EPRI TR-106442, Volumes 1 and 2. Electric Power Research Institute, September 1996.

Opportunities for Energy Efficiency in the Texas Industrial Sector. Texas Sustainable Energy Development Council. With J. W. Zarnikau et al. June 1995.

Principles and Practice of Demand-Side Management. With John H. Chamberlin. EPRI TR-102556. Palo Alto: Electric Power Research Institute, August 1993.

EPRI Urban Initiative: *1992 Workshop Proceedings (Part I)*. The EPRI Community Initiative. With G.A. Wikler and R.H. Manson. TR-102394. Palo Alto: Electric Power Research Institute, May 1993.

Practical Applications of Forecasting Under Uncertainty. With K.P. Seiden and C.A. Sabo.TR-102394. Palo Alto: Electric Power Research Institute, December 1992.

Improving the Marketing Infrastructure of Efficient Technologies: A Case Study Approach. With S.S. Shaffer. EPRI TR- I 0 1 454. Palo Alto: Electric Power Research Institute, December 1992.

Customer Response to Rate Options. With J. H. Chamberlin, S.S. Shaffer, K.P. Seiden, and S.A. Blanc. CU-7131. Palo Alto: Electric Power Research Institute (EPRI), January 1991.

Articles and Chapters

"Impact Measurement of Tariff Changes when Experimentation is not an Option – A case study of Ontario, Canada," with Sanem Sergici, Neil Lessem, and Dean Mountain, *Energy Economics*, 52, December 2015, pp. 39-48.

"Efficient Tariff Structures for Distribution Network Services," with Toby Brown and Lea Grausz, *Economic Analysis and Policy*, 48, December 2015, pp. 139-149.

"The Emergence of Organic Conservation," with Ryan Hledik and Wade Davis, *The Electricity Journal*, Volume 28, Issue 5, June 2015, pp. 48-58.
http://www.sciencedirect.com/science/article/pii/S1040619015001074

"The Paradox of Inclining Block Rates," with Ryan Hledik and Wade Davis, *Public Utilities Fortnightly*, April 2015.
http://www.fortnightly.com/fortnightly/2015/04/paradox-inclining-block-rates

"Smart By Default," with Ryan Hledik and Neil Lessem, *Public Utilities Fortnightly*, August 2014.
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"Quantile Regression for Peak Demand Forecasting," with Charlie Gibbons, SSRN, July 31, 2014.
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"Study Ontario for TOU Lessons," *Intelligent Utility*, April 1, 2014.
http://www.intelligentutility.com/article/14/04/study-ontario-tou-lessons?quicktabs_11=1&quicktabs_6=2

"Impact Measurement of Tariff Changes When Experimentation is Not an Option – a Case Study of Ontario, Canada," with Sanem Sergici, Neil Lessem, and Dean Mountain, SSRN, March 2014.
http://ssrn.com/abstract=2411832

"Dynamic Pricing in a Moderate Climate: The Evidence from Connecticut," with Sanem Sergici and Lamine Akaba, *Energy Journal*, 35:1, pp. 137-160, January 2014.

"Charting the DSM Sales Slump," with Eric Schultz, *Spark*, September 2013.
http://spark.fortnightly.com/fortnightly/charting-dsm-sales-slump

"Arcturus: International Evidence on Dynamic Pricing," with Sanem Sergici, *The Electricity Journal*, 26:7, August/September 2013, pp. 55-65.
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"Dynamic Pricing of Electricity for Residential Customers: The Evidence from Michigan," with Sanem Sergici and Lamine Akaba, *Energy Efficiency*, 6:3, August 2013, pp. 571–584.

"Benchmarking your Rate Case," with Ryan Hledik, *Public Utility Fortnightly*, July 2013.
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"Surviving Sub-One-Percent Growth," *Electricity Policy*, June 2013.

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"Demand Growth and the New Normal," with Eric Shultz, *Public Utility Fortnightly*, December 2012.
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"Smart Pricing, Smart Charging," with Ryan Hledik, Armando Levy, and Alan Madian, *Public Utility Fortnightly*, Volume 149, Number 10, October 2011.
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"The Energy Efficiency Imperative" with Ryan Hledik, *Middle East Economic Survey*, Vol LIV: No. 38, September 19, 2011.

"Are LDCs and customers ready for dynamic prices?" with Jürgen Weiss, *Fortnightly's Spark*, August 25, 2011.
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gas and electric company experiment," with Sanem Sergici, *Journal of Regulatory Economics*, 40:1, August 2011, pp. 82-109.

"Better Data, New Conclusions," with Lisa Wood, *Public Utilities Fortnightly*, March 2011, pp. 47-48. http://www.fortnightly.com/archive/puf_archive_0311.cfm

"Residential Dynamic Pricing and 'Energy Stamps,'" *Regulation*, Volume 33, No. 4, Winter 2010-2011, pp. 4-5. http://www.cato.org/pubs/regulation/regv33n4/v33n4.html

"Dynamic Pricing and Low-Income Customers: Correcting misconceptions about load-management programs," with Lisa Wood, *Public Utilities Fortnightly*, November 2010, pp. 60-64. http://www.fortnightly.com/archive/puf_archive_1110.cfm

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"California: Mandating Demand Response," with Jackalyne Pfannenstiel, *Public Utilities Fortnightly*, January 2008, pp. 48-53.
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