BEFORE THE CORPORATION COMMISSION OF OKLAHOMA

IN THE MATTER OF THE APPLICATION OF BRANDY L. WREATH, DIRECTOR OF THE PUBLIC UTILITY DIVISION, FOR DETERMINATION OF THE CALCULATION OF LOST NET REVENUES AND SHARED SAVINGS PURSUANT TO THE DEMAND PROGRAM RIDER OF OKLAHOMA GAS AND ELECTRIC COMPANY	)	CAUSE NO. PUD 201500153

Responsive Testimony

of

Ahmad Faruqui

on behalf of

Oklahoma Gas and Electric Company

May 13, 2015

I. Introduction

Q. What is your name and address?

A. My name is Ahmad Faruqui. I am a Principal with the Brattle Group, a consulting firm that specializes in the analysis of complex issues pertaining to economics and finance. My address is 201 Mission Street, Suite 2800, San Francisco, California 94105.

Q. On whose behalf are you submitting testimony?

A. I am testifying on behalf of Oklahoma Gas and Electric Company (OG&E).

Q. What are your qualifications?

A. I lead Brattle's consulting practice focused on strategies for understanding and managing the ways in which consumers use energy. I am an economist with 35 years of research and consulting experience. During my career, I have advised more than a hundred electric and gas utilities, private energy companies, technology providers, transmission system operators, regulatory commissions and government agencies in the United States and in Australia, Canada, Egypt, Hong Kong, Jamaica, Philippines, Saudi Arabia, South Africa and Vietnam on a wide range of customer-side issues including sales and peak demand forecasting, demand response, energy efficiency, rate design, integrated resource planning, and the use of demand-side resources to facilitate the integration of retail and wholesale markets. On these issues, I have testified or appeared before a dozen state and provincial regulatory commissions and legislative bodies.

My work on demand response has been cited widely throughout the globe. I served as the lead consultant to the US Federal Energy Regulatory Commission Staff in carrying out a national assessment of demand response potential. This analysis was carried out for all 50 states and the District of Columbia. This was followed by the development of a national action plan for demand response. Both the assessment and the action plan were filed with the US Congress. I have carried out a wide range of demand response assessments for a wide variety of utilities and independent system operators in the US and Canada. These have included program design and evaluation activities and

encompassed both pricing-based demand response programs and curtailment-based demand response programs for all classes of customers. In the area of dynamic pricing, I have designed and evaluated a number of pilot programs in the US, including those in California, Connecticut, Florida, Illinois, Michigan and Maryland. Two of these projects, one in California and one in Maryland, were granted awards from industry trade associations. I have also advised the US Department of Energy on the design and evaluation of two major smart grid customer behavior program studies in Michigan and Ohio. Currently, I am carrying out an impact evaluation of dynamic pricing programs for two Mid-Atlantic utilities and for the Ontario Power Authority in Canada.

I hold bachelor's and master's degrees in economics from the University of Karachi, Pakistan, a master's degree in agricultural economics and a master's degree in economics, both from the University of California at Davis, and a doctoral degree in economics, also from the University of California at Davis. My resume is included as Exhibit AF-1 to this testimony.

Q. **What role have you played in the development of demand-side management in the industry?**

A. I was part of a small team of researchers at the Electric Power Research Institute (EPRI) and the Edison Electric Institute (EEI) that helped coin the term, demand-side management (DSM) at a meeting that was held in the early 1980s at the O'Hare Hilton at Chicago airport. I published a three-volume set of reports on DSM, which were the very first reports written on the topic. Later, I managed a large EPRI project which further developed the concept and involved a series of utility case studies. It established a multi-step framework for establishing objectives, doing a cost-benefit analysis, designing programs, monitoring and evaluating the programs and revising the objectives. These ideas were aired at a series of regional and national conferences. Later, as a consultant, I carried out several DSM planning studies for clients around the US and Canada and eventually around the globe. I published several EPRI reports on the subject and also wrote primers on the topic for organizations such as the World Bank.

Q. **What is the main reason for doing demand-side management?**

A. The main reason is to defer the need for conventional supply-side capacity and thereby lower customer bills. That reduction in bills comes about when savings in capacity and fuel costs are passed on through to customers. A side benefit is the reduction of environmental emissions.

Q. **What are the ways in which utilities can be encouraged to pursue demand-side management?**

A. While DSM benefits the customer through lowering bills and improves the environment by lowering emissions, it lowers utility revenues and hurts profitability. There are three ways in which utilities can be encouraged to pursue DSM, thereby making it a win-win-win strategy. Two of them involve the removal of disincentives and one involves the provision of incentives. The first one is to provide timely cost recovery to the utilities, the second one is to make them whole by recovering lost net revenues (LNR) and the third one is to give them a share of the savings in total resource costs.

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

A. I address the issue of how LNR associated with demand-side management programs should be measured. First, I present my opinion of the correct methodology to adopt in calculating the LNR associated with demand response programs in general, and OG&E's SmartHours program in particular. In my opinion, OG&E uses the correct methodology to calculate LNR. To illustrate the methodology, I calculate the LNR associated with the SmartHours program. Second, I state the adverse consequences on the economics of the SmartHours program if the LNR were calculated according to the PUD's methodology.

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

A. My testimony is organized into several sections. In Section II, I present the key points from the Settlement Agreement (Cause No. PUD 201200134) related to the recovery of program costs, LNR and incentives offered to OG&E's Demand Portfolio. Section III presents my opinion on how LNR should be calculated for the SmartHours program, and I compare how my LNR numbers differ from the OG&E's and PUD's calculations.

Finally, in Section IV, I present what would be the consequences if the LNR was calculated according to PUD's methodology, and how it might affect the very successful SmartHours program.

II. Settlement Agreement Pertaining to the Computation of LNR Recovery for OG&E's SmartHours Program

Q. **What costs and benefits was OG&E allowed to recover for its Demand Portfolio as per the Joint Stipulation and Settlement Agreement (Cause No. PUD 201200134)?**

A. The Agreement[1] states that for energy efficiency programs, OG&E shall recover program costs, LNR, and the incentives resulting from the success of the energy efficiency programs.

For the demand response programs, OG&E shall recover LNR through the Demand Program Rider with the exception of the integrated volt var control program (IVVC) for which OG&E shall not recover the LNR. OG&E shall also recover the demand response program costs. Unlike the energy efficiency programs, OG&E shall not recover the incentives associated with the demand response programs: SmartHours and IVVC.

Q. **Are there different types of demand response programs?**

A. Yes, at a high level, two types of demand response programs can be distinguished. One uses the price signal to provide customers with an incentive for either curtailing peak loads or moving them to off-peak periods. If they don't lower their peak usage, they may see higher bills. These programs are generally called price response programs. The other programs pay customers money for curtailing their load during peak periods. If they don't lower their peak usage, they don't see higher bills. They are variously called curtailment or load reduction programs.

[1] Joint Stipulation and Settlement Agreement, in the matter of the application of Oklahoma Gas and Electric Company for an order of the Commission approving its 2013 Demand Portfolio and authorizing recovery of the costs of the demand programs through the Demand Program Rider, Cause No. PUD 201200134, December 2012.

Q. **What specific Demand Program from OG&E's Demand Portfolio is the focus of your testimony**?

A. I focus on the SmartHours program, which is a price response program.

III. LNR for SmartHours Program Should Account for Both Change in Load Shape and Change in Rates

Q. **How is the LNR defined?**

A. LNR has been defined by the Commission as[2]:

> **"Lost Net Revenue"** means income from the retail sale of electricity forgone by a utility directly resulting from the success of its demand portfolio, less expenses the utility was not required to pay by forgoing the sales.

Q. **What is the purpose of the LNR mechanism?**

A. The recovery of LNR removes a *major* disincentive for the utility to engage in demand-side management programs. It makes the utility indifferent to offering or not offering the program. Without the mechanism, it faces a significant disincentive to offering the program and may not offer it.

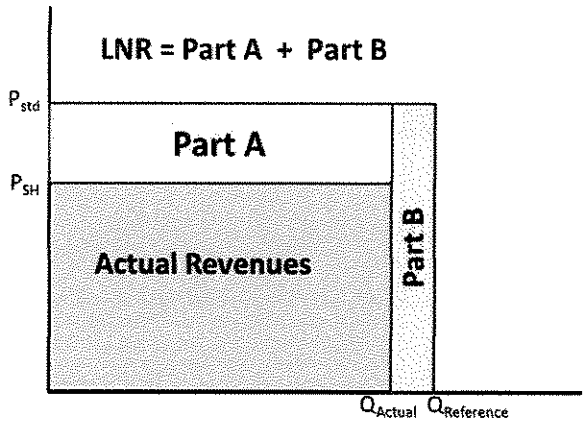
Q. **In your expert opinion, how should LNR associated with the SmartHours program be computed?**

A. The definition of LNR involves two elements. For ease of exposition, I am going to call them Parts A and B as shown in Figure 1. Part A consists of net revenue losses that arise when customers switch from the standard rate to the SmartHours rate prior to making any changes in their load shapes. Part B consists of net revenue losses that arise when customers change their load shape in response to the incentives provided by the SmartHours rate by either curtailing their usage during their peak period, say B1, or by shifting it to the off-peak period, say B2.

[2] Title 165:35-41-3 Definitions.

Figure 1

Illustration of the Computation of LNR



Q. **What are industry best practices for calculating LNR for demand response programs?**

A. Industry best practices are summarized in the California Public Utilities commission (CPUC) demand response (DR) Protocols[3] and the Synapse-RAP report[4]. Both specify that LNR should account for both Part A and Part B.

The CPUC DR protocols makes it clear that the net revenue loss from change in sales should be based on the difference in actual revenue and the revenue under the participant's previous rate. This change in revenue accounts for both change in rates (Part A) and change in load shape (Part B).

> "Revenue loss (or gain) should be calculated in a similar manner as bill increases (or reductions), as discussed above, so that incentives are eliminated and any change in the participant's rate structure is accounted for."[5]

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[3] California Public Utilities Commission (2010). "Decision Adopting a Method for Estimating the Cost-Effectiveness of Demand Response Activities," Attachment 1: 2010 Demand Response Cost-Effectiveness Protocols, December 16. Link: http://www.cpuc.ca.gov/NR/rdonlyres/7D2FEDB9-4FD6-4CCB-B88F-DC190DFE9AFA/0/Protocolsfinal.DOC (accessed on March 27, 2015)

[4] Woolf, Tim, Erin Malone, Lisa Schwartz, and John Shenot (2013). "A Framework for Evaluating the Cost-Effectiveness of Demand Response," prepared for the National Forum on the National Action Plan on Demand Response: Cost-effectiveness Working Group, February. Link: http://emp.lbl.gov/sites/all/files/napdr-cost-effectiveness.pdf (accessed on March 27, 2015)

[5] California Public Utilities Commission (2010). "Decision Adopting a Method for Estimating the Cost-Effectiveness of Demand Response Activities," Attachment 1: 2010 Demand Response Cost-Effectiveness Protocols, December 16, see p. 34.

"For example, in a program which changes the participant's rates but does not provide any incentives, such as CPP, the bill reduction (or increase) would be the difference between the actual bill and the bill the participant would have received had the participant stayed on the previous rate."[6]

The Synapse-RAP report also echoes that LNR from demand response programs should account for both Part A and Part B:

"Ideally, this [lost revenue] calculation should account for the fact that demand response participants may move from one rate class to another when joining a demand response program."..."Lost revenues should be calculated based on the net reduction in sales, accounting for both reductions and increases. Also, the lost revenue calculations should account for the different retail prices in effect during different times, to the extent that there are any such retail price differences."[7]

Q. **What is the position of the PUD?**

A. The PUD's position, as stated in Cause No. PUD 201500153, is that LNR should be computed just using Part B (change in load shape) and not account for Part A (change in rates): "lost net revenues are to be calculated by multiplying the Demand Program savings by an embedded fixed cost factor."[8]

Q. **What is your opinion of the PUD's position?**

A. I believe their position applies to energy efficiency (EE) programs since no rate change is involved when these programs are rolled out. PUD's position can also apply to demand response programs where an incentive is provided without involving a rate change (e.g.

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[6] *Id.*, see p. 28.

[7] Woolf, Tim, Erin Malone, Lisa Schwartz, and John Shenot (2013). "A Framework for Evaluating the Cost-Effectiveness of Demand Response," prepared for the National Forum on the National Action Plan on Demand Response: Cost-effectiveness Working Group, February,, see p.31.

[8] In the matter of the application of Brandy L. Wreath, Director of the Public Utility Division, for determination of the calculation of lost nest revenues and shared savings pursuant to the demand program rider of Oklahoma Gas and Electric Company, Cause No. PUD 201500153, April 14, 2015, at 8.

load reduction programs defined above). PUD's position is incomplete for programs such as SmartHours which intrinsically involve a change in rates.

Q. **Have you computed the LNR associated with SmartHours?**

A. Yes, I have.

Q. **What are the details of the computation?**

A. I calculate the LNR for the year 2013 for each of the four tariffs under the SmartHours program: Residential-VPP and VPP Plus, Residential-TOU, General Service-VPP and VPP Plus, and General Service-TOU. It is important that the calculation be done for the year as a whole and not just for the summer months. I note that VPP Plus represents customers subscribed to the VPP tariff who also received a programmable communicating thermostat (PCT).

The LNR is calculated as the difference in total revenue for all customers under the SmartHours program and the reference revenue had the customers continued on the standard tariff. The inputs into the LNR calculations are the average reference daily load (kWh/day), average daily actual load (kWh/day), and the on-peak and off-peak average daily load during the peak summer months (June to September)[9]. The different tariff structures under the SmartHours program and the standard tariff, the total number of customers under each of the SmartHours tariff, and the number of price-days called are also inputs into the LNR calculations.[10]

To demonstrate how the LNR is calculated, I show next how the LNR is calculated for residential customers under the SmartHours VPP tariff for a winter month - January (with no VPP pricing) and a summer month- June (with VPP pricing).

[9] The on-peak and off-peak consumption is reported separately for days with LPP, SPP, HPP, MPP, CPE pricing. The weekends are priced based on off-peak rates so only average daily consumption is reported. Data provided by OG&E.

[10] Data provided by OG&E.

LNR for January under the Residential – VPP program:

In January there is no VPP pricing under the SmartHours program, and the residential VPP program offers a 2-block rate similar to the standard residential tariff. The block threshold (600 kWh) and the rates (5.73 ¢/kWh up to 600 kWh, and 1.73 ¢/kWh for additional load) are the same under the SmartHours program and standard tariff.

$$Actual\ Revenue\ in\ January =$$
$$\{600\ \text{kWh} * 0.0573\ \$/\text{kWh} + [(\text{average } \mathbf{actual} \text{ daily load for January} * 31\ \text{days} - 600\ \text{kWh}) * 0.0173\ \$/\text{kWh}] + \$13[11]\} * \text{number of customers}$$

$$Reference\ Revenue\ in\ January =$$
$$= \{600\ \text{kWh} * 0.0573\ \$/\text{kWh} + [(\text{average } \mathbf{reference} \text{ daily load for January} * 31\ \text{days} - 600\ \text{kWh}) * 0.0173\ \$/\text{kWh}] + \$13[12]\} * \text{number of customers}$$

LNR is calculated as the difference between the actual revenue and the reference revenue. I note that in January the difference in actual and reference revenue comes solely from the differences in actual load and reference load as the rates are the same under the two cases.

Now, I show how the computation of actual and reference revenue would change when there is a difference in rates as in the month of June.

LNR for June under the Residential – VPP program:

In 2013, June had 3 days with LPP pricing (2.7 ¢/kWh), 6 days with SPP pricing (6.8 ¢/kWh), 9 days with HPP pricing (14.0 ¢/kWh), 0 days with MPP pricing (38.0 ¢/kWh), 2 CPE days (38.0 ¢/kWh), and 10 off-peak days (2.7 ¢/kWh) including weekends and

[11] There is a $13 per customer charge that is included both in standard residential tariff and SmartHours residential program. Data provided by OG&E.

[12] *Id.*

holidays. I was provided the average on-peak load (consumption during 2pm to 7pm peak period[13]) and the average off-peak load for each of the different pricing level days.

$$\textit{Actual Revenue in June during a HPP day} =$$
$$= \{\text{number of HPP days}$$
$$* [(\text{average on} - \text{peak load on HPP day} * 0.14\ \$/\text{kWh})$$
$$+ (\text{average off} - \text{peak load on HPP day} * 0.027\ \$/\text{kWh})]\}$$
$$* \text{number of customers}$$

Similarly, I calculate the actual revenue during LPP, SPP, MPP and CPE days. For the weekends, the actual revenue is just based on the off-peak load and the off-peak rate. The actual total revenue for June is obtained by summing up the actual revenues for each of these different types of pricing days, and adding in the customer charge revenues. The reference revenue during June is calculated in a similar manner as shown for January, except that the consumption and rates are now based on June.

Q. **How do your calculations of the LNR compare with the OG&E's computations?**

A. I estimate the LNR to be $11.647 million for the SmartHours program. In comparison, the OG&E LNR estimates are $11.209 million. My LNR estimate is greater than OG&E's calculations by $437,957 which is a 3.9% difference. The month-by-month LNR numbers are presented in Table 1.

The difference between my LNR calculations and those of OG&E arises from a few minor changes I made to the OG&E analysis. The changes I made are as follows:[14]

1. I corrected the number of SPP and HPP pricing days in June to six and nine, respectively, in the Residential VPP and Residential TOU calculations (as informed by OG&E).

[13] For the CPE event days which were called only during a 3 hour window within the 5 hour peak window, the revenues were calculated assuming that the total consumption during the 2-7pm window was based on the CPE pricing. This is a conservative assumption as it overestimates the actual revenues and underestimates the LNR.

[14] I quantified the effect of each individual change done one at a time on OG&E's LNR estimate: Correction #1 lowered the LNR by about $31,000; Correction #2 lowered the LNR by $230; Correction #3 increased the LNR by about $37,000; Correction #4 increased the LNR by about $432,000. These corrections overall lead to my LNR estimates exceeding OG&E's estimates by $437,957.

2. I removed an erroneous additional customer charge for November and December that was present in OG&E's Standard Margin calculations.
3. I calculate the consumption (kWh) in the two-tiered rate structure differently than OG&E. I do not use the 'Weights by % of kWh billed per Block' as used by OG&E and instead calculate the consumption in each block directly from the kWh threshold values.[15]
4. OG&E calculations mistakenly do not account for the majority of the reference revenues from the general service customers in the months of May and October. I account for these revenues in my calculations.

Table 1. Comparison of LNR ($)
Across OG&E's, PUD's and My Calculations

Month	Ahmad Faruqui	OG&E	PUD	Difference from OG&E	Difference from PUD
[1]	[2]	[3]	[4]	[5] = [2] - [3]	[6] = [2] - [4]
January	(7,904)	(7,937)	(7,904)	33	(0)
February	(3,473)	(3,485)	(3,473)	12	0
March	3,181	3,148	3,181	33	(0)
April	(46,945)	(47,020)	(46,945)	75	(0)
May	(1,153,619)	(1,039,661)	(392,662)	(113,958)	(760,958)
June	(1,687,311)	(1,717,962)	(975,839)	30,651	(711,472)
July	(2,493,742)	(2,493,752)	(1,505,592)	10	(988,150)
August	(1,881,991)	(1,882,046)	(1,033,114)	54	(848,878)
September	(2,199,159)	(2,161,991)	(834,875)	(37,167)	(1,364,284)
October	(2,177,646)	(1,859,771)	(117,502)	(317,875)	(2,060,143)
November	(4,199)	(4,232)	(4,199)	32	(0)
December	6,220	6,078	6,220	142	(0)
Total	(11,646,588)	(11,208,631)	(4,912,703)	(437,957)	(6,733,885)

Sources and Notes: OG&E figures from file: 2013 Energy Savings (use for LNR)-FINAL.xlsx, Summary tab. PUD figures from file: 2013 Energy Savings (use for LNR)-FINAL_PUD original.xlsx, PUD_LR_summary tab.

[15] This difference in methodology makes my calculations different from OG&E in two ways: a) no rounding of the block weights is required by me, b) OG&E's 1st block weights erroneously exceeds one in the Standard Residential VPP program, and I avoid this mistake.

Q. **The PUD witness Ms. Champion questions whether the $11.2 million LNR estimate claimed by the Company is a real loss to the Company.[16] Do you agree with Ms. Champion?**

A. No. It is a straightforward measure of the loss of revenue that the Company incurs when customers migrate to the dynamic pricing tariff and, additionally, in many cases, change their load shapes. Recovery of this lost revenue eliminates what would otherwise be a major disincentive to the Company for pursuing demand response programs such as SmartHours.

Q. **If OG&E was allowed to recover LNR as estimated by the PUD accounting for just Part B, how much would that affect OG&E's earnings?**

A. The loss would be significant. I have estimated that to be $6.7 million, as shown in Table 1.

Q. **Is that a significant amount?**

A. Yes, it is a significant amount. It represents 58% of the correct LNR amount.

IV. Consequences of Using PUD's LNR Methodology

Q. **Should dynamic pricing rates be revenue neutral with flat rates?**

A. Yes, but they should be revenue neutral on a risk-adjusted basis. Flat rates embody a hedging premium to account for load volatility, price volatility and correlations between load and price. While this premium is not transparent or explicitly communicated in the tariff design, it is always present. Without this premium, the utility would lose money on a rate that allows customers to purchase an unlimited amount of energy at a fixed rate. Dynamic pricing rates transfer some of the price risk to customers, with time-of-use rates transferring the least amount of risk (since they involve known pricing periods and known prices) and real time pricing transferring the most amount of risk. The expected value of dynamic pricing rates should be lower than the expected value of the flat rate,

[16] Kathy Champion Direct Testimony, Cause No. PUD 201500153, April 2014, p. 11, lines 14-17.

since the former are unhedged in varying degrees while the latter is fully hedged. If this is not done, then relatively few customers are likely to take the dynamic pricing rate. Most customers are risk averse and even those with better than average load factors, who would gain instantly from the dynamic pricing rate, will not adopt it. That is confirmed by reviewing the enrollment rate in strictly revenue neutral dynamic pricing programs. Most of the enrollment numbers are less than five percent.

Q. **If LNR is calculated using PUD's method might that cause OG&E to redesign the rate to alleviate the adverse impact on earnings?**

A. Yes, if LNR is calculated using PUD's method i.e. only based on change in load shape (Part B) and OG&E is not allowed to recover loss in net revenue due to rate change (Part A) then it may lead to rate redesign by OG&E to minimize the LNR. The rate redesign might be such that the resulting LNR is considerably smaller than the current values and are close to the PUD numbers. Such a rate redesign may involve a reduction in the differential between peak and off-peak prices in the SmartHours program.

Q. **What would be the consequences of this rate redesign?**

A. The program would not be as attractive to customers and a large number of customers might be expected to drop out of the program. Additionally, few additional customers might join the program.

Q. **What would be the consequences of customers dropping out?**

A. The amount of demand response arising from the program would go down. Supply side resources would have to be brought on line sooner. This would reduce economic efficiency and put an upward pressure on customer bills. It would also raise environmental emissions associated with the production of electricity.

Q. **Has switching to the SmartHours benefitted customers?**

A. Yes, it has. On an average, in 2014, the residential customers on the SmartHours program

saved about $150 on their total bill during the SmartHours Season[17] compared to if they had been on standard tariff, which represents average savings of 18%.[18] In addition, OG&E has made it risk-free for customers to enroll in the SmartHours program in their first year by crediting the difference in bill if the customers pay more by switching to SmartHours. OG&E reports that 99% of the customers saved by switching to SmartHours program relative to the standard tariff.[19]

Q. **Has the SmartHours program led to reduction in peak load and reduced need for supply side resources?**

A. Yes, in 2014, the SmartHours program, reduced peak demand by 151 MW.[20] After the two-year demand response study, OG&E stated in 2012 that "These study results clearly demonstrate that smart technology coupled with dynamic pricing enables customers to reduce their maximum peak energy use, which will help delay the need for building incremental generation until at least 2020."[21] Table 2 presents the energy and peak demand reductions from the SmartHours program forecasted in OG&E's 2014 Integrated Resource Plan. [22] By 2020, the SmartHours program is projected to reduce peak demand by 194 MW. The Resource Plan states that the contribution of the SmartHours program towards reduction in energy and demand forecast is significant and is a result of the successful performance and customer enrollments.

[17] SmartHours Season is from June to September. The bill savings may include usage during part of May and part of October depending on the billing cycle dates. For example, a customer may be billed on June 10th which would roughly cover the period of May 9th to June 9th, so the customer usage from May 9th to May 31st would be counted in the total savings.

[18] Data provided by OG&E.

[19] Data provided by OG&E.

[20] See OG&E (2014). "2014 Annual Report," p. 3.

[21] Press release, "Second Year Preliminary Results Confirm Smart Technology Helps Reduce Peak Energy Use," assessed on April 10, 2015 at http://phx.corporate-ir.net/phoenix.zhtml?c=106374&p=irol-newsArticle&ID=1652157&highlight=

[22] See OG&E (2014). "2014 Integrated Resource Plan," Tables 7 and 8 at p. 25.

Table 2. Energy and Peak Demand Projections from the SmartHours Program

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
DR Energy Reduction (GWh)	66	67	67	66	67	68	68	68	67	67
DR Peak Demand Reduction (MW)	189	194	194	194	194	194	194	194	194	194

Source: 2014 OG&E Integrated Resource Plan, Tables 7 and 8 at p. 25

Q. **Have you reviewed other dynamic pricing programs such as SmartHours?**

A. Yes.

Q. **How does SmartHours compare with other programs?**

A. SmartHours program has the highest customer enrollment rates compared to other full-scale opt-in dynamic pricing-based demand response programs across the US.[23] SmartHours program had more than 100,000 customers in 2014 which is about 12% of OG&E's total customers.[24] I believe these high enrollment rates flow from the customer-centric manner in which the program is marketed to eligible customers. Awareness about the program is very high among the general population of customers. And among the population of enrolled customers, satisfaction is very high. Moreover, the customer has total control over the thermostat settings, unlike other utility programs in which the utility controls the thermostat.

Q. **How would you summarize your testimony?**

A. I conclude that the calculations of the LNR for the SmartHours program should account for both the change in load shape and change in rates as the customers switch from standard tariff to the SmartHours program. Not accounting for the change in rates, as is proposed by the PUD, will lead to significant losses for OG&E. If OG&E is not compensated for loss in revenues due to change in rates, then due to the high losses, it might be forced to redesign the rates for the SmartHours program. The rate redesign can lead to reduced incentives for customers to participate in the program, and the customer

[23] See Faruqui, Ahmad, Ryan Hledik and Neil Lessem (2014). "Smart by Default," *Public Utilities Fortnightly*, August, p. 28, Figure 2.

[24] Data provided by OG&E.

dropout will erode the SmartHours program benefits such as reduced peak demand and energy savings that are being realized and are projected to increase in the future.

Q. **What recommendations do you have for the Commission?**

A. I would recommend that the Commission commend OG&E for running SmartHours, a very fine dynamic pricing program. During the past few months, I have spoken on dynamic pricing and demand response at events around North America and most recently in Australia. I am also in regular email contact with pricing experts throughout the globe. The SmartHours program compares very favorably with best industry practices and has garnered the highest praise in all of those interactions. It is a very customer friendly and the high enrollment rate it has elicited is proof of that. Even non-participating customers benefit from the fact that the program avoids the need for building expensive new capacity. The Commission should let OG&E continue with the program by ensuring that the Company recovers the lost net revenues associated with the program. I have reviewed the literature on recovering lost net revenues and the Company's approach to recovering them. I have found that the Company's methodology is consistent with the literature. I recommend that the Commission approve the Company's estimate of lost net revenues.

Q. **Does that conclude your testimony?**

A. Yes.

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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

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.

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.

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