BEFORE THE
PUBLIC SERVICE COMMISSION OF
SOUTH CAROLINA

DOCKET NO. 2020-264-E
DOCKET NO. 2020-265-E

In the Matter of:	)	
	)	
Duke Energy Carolinas, LLC's Establishment of Solar Choice Metering Tariffs Pursuant to S.C. Code Ann. Section 58-40-20	)	**REBUTTAL TESTIMONY OF AHMAD FARUQUI FOR DUKE ENERGY CAROLINAS, LLC AND DUKE ENERGY PROGRESS, LLC**
	)	
Duke Energy Progress, LLC's Establishment of Solar Choice Metering Tariffs Pursuant to S.C. Code Ann. Section 58-40-20	)	

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I. INTRODUCTION AND SUMMARY

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Ahmad Faruqui and my business address is 201 Mission Street, Suite 2800
San Francisco, CA 94105.

Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT CAPACITY?

A. I am a Principal with The Brattle Group, an economics consulting firm. In that role, I lead the firm's practice on all energy-related matters that involve the customers of electric and gas utilities. These matters include assessing and evaluating the economics of distributed energy resources, demand response, electrification, energy efficiency and rate design.

Q. ON WHOSE BEHALF ARE YOU SUBMITTING TESTIMONY?

A. I am testifying on behalf of Duke Energy Carolinas, LLC ("DEC") and Duke Energy Progress, LLC ("DEP) (DEC and DEP are herein referred to collectively as the "Companies").

Q. DID YOU PREVIOUSLY FILE DIRECT TESTIMONY IN THIS PROCEEDING?

A. No, I did not.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE THE PUBLIC SERVICE COMMISSION OF SOUTH CAROLINA (THE "COMMISSION")?

A. No.

Q. ARE YOU INCLUDING ANY EXHIBITS IN SUPPORT OF YOUR REBUTTAL TESTIMONY?

A. Yes. I am including my resume as **Faruqui Rebuttal Exhibit 1** and a utility industry publication as **Faruqui Rebuttal Exhibit 2.**

Q. WAS FARUQUI REBUTTAL EXHIBIT 1 PREPARED BY YOU OR AT YOUR DIRECTION AND UNDER YOUR SUPERVISION?

A. Yes.

Q. WHAT IS THE PURPOSE OF YOUR REBUTTAL TESTIMONY IN THIS PROCEEDING?

A. The purpose of my rebuttal testimony is to comment on three issues that pertain to the testimony submitted by the Office of Regulatory Staff's Witness Brian Horii. First, I rebut Witness Horii's testimony as it ignores the full context of the Stipulation filed in this docket on November 2, 2020 (the "Stipulation"). Second, I rebut Witness Horii's testimony as it ignores the full context of the rate design aspects of the Stipulation. And, third, I rebut Witness Horii's testimony as it ignores the full context of the cost of service methodology that is used to compute the cost shifts from solar to non-solar customers. These omissions all become clearer when considered with a national landscape in the background, as I lay out in my testimony. These omissions, I believe, show that Witness Horii did not fully consider what South Carolina's General Assembly indicated was important in assessing the solar choice tariffs submitted by the Companies in this proceeding (the "Solar Choice Tariffs").

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Q. WHAT ARE YOUR QUALIFICATIONS AS THEY PERTAIN TO THIS TESTIMONY?

A. I am an internationally recognized rate design expert and have advised clients on how to introduce innovative rate designs in North America, the Middle East, East Asia, Australia and New Zealand.[1] I have helped design experiments to test the impact of innovative rates such as time-of-use ("TOU") rates, critical peak pricing ("CPP") rates and peak time rebates ("PTR") on customer usage. I have also analyzed the data from these experiments to evaluate the impacts. I have spoken on the topic of innovative rate design at conferences, seminars and workshops in all of these locations and also in Europe. While working as a project manager at Electric Power Research Institute ("EPRI") in the Electric Utility Rate Design Study in the early 1980's, I interacted extensively with utilities and commissioners throughout North America on TOU rates. Soon after the California Energy Crisis of 2000-01, I worked with stakeholders in California to design and evaluate a Statewide Pricing Pilot that featured a variety of TOU and CPP rates. The pilot ran from 2003-04 and its results were cited widely outside the state. Since 2009, I have often presented on the innovative rate design and load flexibility at numerous National Association of Regulatory Utility Commissioners' conferences and published widely on the topic.[2] [3]Since 2014, I have been testifying on matters related to net energy metering

[1] On Google Scholar, there are more than 5,000 citations to my publications and most of them relate to articles and papers I have written on innovative rate design. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=ahmad+faruqui&oq=ah.

[2] "Time of Use Rates: An International Perspective," with Cecile Bourbonnais, Energy Regulation Quarterly, Volume 8, Issue 2, June 2020.

[3] "The Tariffs of Tomorrow: Innovations in Rate Designs," with Cecile Bourbonnais, IEEE Power and Energy Magazine, Volume 18, Issue 3, May–June 2020.

("NEM") in Arizona, Idaho, Kansas, Montana and Nevada. I have also presented on NEM to a workshop organized by the Staff of the New York Public Service Commission and to the Board of Directors of the Sacramento Municipal Utility District. I have written articles on cost shifts caused by NEM in the Public Utilities Fortnightly and The Electricity Journal.[4] I have participated in seminars and webinars on the subject and interacted extensively on the subject with experts in the field in 20 countries on 6 continents.

In my career, I have advised some 150 clients in 12 countries on 5 continents and appeared before regulatory bodies, governments, and legislative councils in Alberta (Canada), Arizona, Arkansas, California, Colorado, Connecticut, Delaware, District of Columbia, Egypt, FERC, Georgia, Illinois, Indiana, Iowa, Jamaica, Kansas, Kentucky, Michigan, Maryland, Minnesota, Missouri, Nevada, New Brunswick (Canada), Nova Scotia (Canada), Ohio, Oklahoma, Ontario (Canada), Pennsylvania, the Philippines, Saudi Arabia (ECRA), Texas, and Washington.

I serve on the editorial board of The Electricity Journal and have authored or coauthored more than 150 papers in peer-reviewed and trade journals dealing with various aspects of rate design, demand side management, energy efficiency, demand response, load forecasting, decarbonization and electrification. I have also co-edited 5 books on industrial structural change, customer choice, and electricity

[4] "Quantifying Net Energy Metering Subsidies," with Sanem Sergici, Yingxia Yang, and Maria Castañer, The Electricity Journal, Volume 32, Issue 8, October 2019; "Net Metering FAQ – Rate design and subsidies," with Steve Mitnick, Public Utilities Fortnightly, October 2018. https://www.fortnightly.com/fortnightly/2018/10/net-metering-faq

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pricing. My work has been cited in Bloomberg, Businessweek, The Economist, Forbes, and National Geographic, in addition to news outlets including the Los Angeles Times, The New York Times, San Francisco Chronicle, San Jose Mercury News, and the Washington Post. I have also appeared on Fox Business News and NPR.

I have also taught economics at San Jose State University, the University of California, Davis, and the University of Karachi and delivered guest lectures at universities such as Carnegie Mellon, Harvard, Idaho, MIT, New York University, Northwestern, Rutgers, Stanford, UC Berkeley, and UC Davis.

II. CONTEXT OF STIPULATION

Q. CAN YOU PROVIDE YOUR UNDERSTANDING OF THE CONTEXT IN WHICH THE STIPULATION TOOK PLACE?

A. Yes. The Stipulation should be viewed against the backdrop of state legislation, Act 62, which calls for the elimination of cost shifts between solar and non-solar customers but also encourages the deployment of rooftop solar panels. Below are relevant excerpts from Act 62.

> Section 58-40-20. (A) It is the intent of the General Assembly to:
>
> (1) build upon the successful deployment of solar generating capacity through Act 236 of 2014 to continue enabling market-driven, private investment in distributed energy resources across the State by reducing regulatory and administrative burdens to customer installation and utilization of onsite distributed energy resources;
>
> (2) avoid disruption to the growing market for customer-scale distributed energy resources; and
>
> (3) require the commission to establish solar choice metering requirements that fairly allocate costs and benefits to eliminate any cost shift or subsidization associated with net metering to the greatest extent practicable.

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> Section 58-40-20. (G) In establishing a successor solar choice metering tariff, the commission is directed to:
>
> (1) eliminate any cost shift to the greatest extent practicable on customers who do not have customer-sited generation while also ensuring access to customer-generator options for customers who choose to enroll in customer-generator programs; and
>
> (2) permit solar choice customer-generators to use customer-generated energy behind the meter without penalty.

Eliminating cost shifts from customer generators to non-customer generators while also encouraging the installation of solar panels by future customers requires a balancing act. That's why Act 62 uses the phrase, "to the greatest extent practicable" when addressing the elimination of cost shift and notes its intent to build upon the successful deployment of solar generating capacity and its desire to avoid disruption to the growing marketplace. Witness Horii does not appear to consider the multiple facets of Act 62.

Q. DOES WITNESS HORII ADEQUATELY VALUE THE FACT THAT THERE IS A STIPULATION PROPOSED IN THIS MATTER?

A. No.

Q. PLEASE EXPLAIN THE NATURE OF THE DEBATE BETWEEN UTILITIES AND THE SOLAR INDUSTRY THROUGHOUT THE REST OF THE COUNTRY AND WHETHER SUCH STIPULATIONS ARE COMMON.

A. Such Stipulations are rare, and Witness Horii does not address this. The national debate around NEM has been, at times, intensely adversarial and, at times, inconclusive. Overall it has been mostly unproductive. The parties have been at cross purposes more often than not, with utilities seeking to minimize cost shifting by either modifying NEM rules or rate design and the solar industry not wanting to

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change either the rules of NEM or rate design, since either would make rooftop solar panels less attractive for potential customers.

Q. DOES THIS STIPULATION REPRESENT A BREAKTHROUGH IN RESOLVING THE DEBATES AROUND NEM?

A. Yes, it represents a breakthrough and this is ignored by Witness Horii. This Stipulation has successfully broken a log jam that has stymied the NEM conversations between utilities and the solar industry around the country. I believe the Stipulation contains a new paradigm that is worthy of consideration by all other jurisdictions. Of course, each jurisdiction is unique with its own set of players, cost of service studies, rate designs and average rate levels. I am not suggesting that the terms of this Stipulation be applied in a literal sense by all other jurisdictions.

Q. WITNESS HORII EXPRESSES CONCERN OVER THE AGREEMENT AMONG THE SETTLING PARTIES. PLEASE EXPLAIN WHAT TYPICALLY OCCURS IN AN ADVERSARIAL NEM PROCEEDING.

A. Witness Horii states that he is concerned that the settling parties aligned their business interests to the potential detriment of non-solar customers and South Carolina taxpayers. However, Witness Horii ignored that the Settling Parties acknowledged their desire to avoid a contentious adversarial proceeding before the Commission or the North Carolina Utilities Commission and thereby collaborated to implement the Solar Choice Tariffs within the spirit of Act 62 and North Carolina law. The Settling Parties understood the downfall of an adversarial proceeding.

In an adversarial proceeding both sides present their case, with the utility focusing on minimizing the cost shift from non-solar to solar customers and the

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solar industry focusing on preserving the status quo to maintain the incentive for customers to invest in rooftop solar panels and arguing that the utility wants to eliminate the solar industry. The solar industry argues that if a change is made, either to the rules that govern NEM or to the rate design, it will not only eliminate jobs but also lead to the elimination of a clean source of energy. Usually before the hearings, commissions will hold one or more public meetings to discuss the proposals that have been offered by the various parties in the case. Invariably, the only people who show up at these public meetings will be either solar customers or solar contractors. Thus, both the content and the tenor of the conversation that takes place at these public meetings is entirely one sided. After the hearings have concluded, the commissioners weigh in all the evidence and also the discussions that took place at the public meetings. They often find it difficult to approve any significant changes in the status quo.

Q. PLEASE EXPLAIN YOUR EXPERIENCE WITH ADVERSARIAL NEM PROCEEDINGS THROUGHOUT THE COUNTRY.

A. Witness Horii does not seem to recognize the value of a Stipulation in this NEM proceeding. I would argue that a Stipulation is ideal, especially considering the potential downfalls of an adversarial proceeding. I've participated in many adversarial NEM proceedings throughout the country and they are typically contentious, drawn out, and result in less-than-ideal outcomes. Below are summaries of some of these proceedings.

<u>Nevada:</u>

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In 2015, I was a witness in the case and testified on behalf of NV Energy[5] and the hearings were very adversarial. NV Energy asked the Public Utilities Commission to reverse a decision that restored favorable NEM rates for solar customers in northern Nevada, which was served by NV Energy's Sierra Pacific operating company. The Commission approved the change but subsequently the solar industry advocates in Nevada took their concerns to the legislature. On March 8, 2017, an Assemblyman introduced AB 270 to reverse the Public Utilities Commission's decision.[6] Eventually no change was made either in NEM or in the rate design for NEM customers.[7]

Salt River Project ("SRP"):

In 2014, I submitted testimony on behalf of the management of the SRP to the SRP Board[8] and I appeared before the SRP Board three times in 2015. A non-unanimous Board decision was reached to move all new solar customers to three-part rates. Based on this change a lawsuit ensued, which was later settled. At some point, the Board members changed, and the new Board approved the introduction of an energy-only TOU rate for solar customers, in addition to the three-part rate. Currently, SRP offers four rates to customers with rooftop solar panels.

[5] 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.

[6] https://en.wikipedia.org/wiki/Net_metering_in_Nevada.

[7] https://www.utilitydive.com/news/nevada-lawmakers-consider-bill-to-restore-retail-net-metering/439228/ and https://lasvegassun.com/news/2016/sep/20/sandoval-shakes-up-puc-by-appointing-2-new-commiss/.

[8] Testimony before the Board of Directors on behalf of Salt River Project, in the matter of "An Evaluation of SRP's Electric Rate Proposal for Residential Customers with Distributed Generation," December 31, 2014.

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Idaho Power:

In 2018, I testified on behalf of Idaho Power.[9] After a contested hearing, the Commission approved the creation of a separate rate class for solar customers but new rates were not created for solar customers. That was left to a future hearing which, to the best of my knowledge, has not occurred.

Northwestern Energy:

In 2018-19, I testified on behalf of Northwestern Energy.[10] It was a contested hearing that had been preceded by a public meeting. The Commission decided not to change the status quo for NEM.

Westar Energy (later Evergy):

[9] Rebuttal Testimony before the Idaho Public Utilities Commission on behalf of Idaho Power Company (Idaho Power), in the matter of the Application of Idaho Power Company for Authority to Establish New Schedules for Residential and Small General Service Customers with On-Site Generation, Case No. IPC-E-17-13, January 26, 2018.

[10] Rebuttal testimony before the Public Service Commission of the State of Montana on behalf of NorthWestern Energy, in the matter of NorthWestern Energy's Application for Authority to Increase Retail Electric Utility Service Rates and for Approval of Electric Service Schedules and Rules and Allocated Cost of Service and Rate Design, Docket No. D2018.2.12, April 2019; Prefiled direct testimony before the Public Service Commission of the State of Montana on behalf of NorthWestern Energy, in the matter of NorthWestern Energy's Application for Authority to Increase its Retail Electric Utility Service Rates and for Approval of its Electric Service Schedules and Rules, Docket No. D2018.2.12, September 28, 2018.

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Between 2015 and 2020, I have testified on behalf of Westar Energy (now Evergy) in several cases.[11] Initially, the Kansas Commission approved the creation of a separate rate class for NEM customers. In a following case, the Kansas Commission approved the institution of a three-part rate for NEM customers. That decision was taken to the Court of Appeals by the solar industry and the decision was upheld. The solar industry then took it to the Kansas Supreme Court which remanded the case back to the Kansas Commission, stating that state law prohibited price discrimination. The case has been reheard by the Commission and a decision is expected later in February.

Q. YOU SAY THAT WITNESS HORII FAILED TO CONSIDER THE OVERALL STIPULATION IN THIS DOCKET. DO YOU THINK THAT THE STIPULATION THE COMPANIES REACHED WITH THE SOLAR

[11] Rebuttal testimony before the State Corporation Commission of the State of Kansas on behalf of Evergy Kansas Central, Inc. and Evergy Kansas South, Inc. in the matter of the Joint Application of Westar Energy, Inc. and Kansas Gas and Electric Company to Make Certain Changes in Their Charges for Electric Services, Docket No. 18-WSEE-328-RTS, December 04, 2020; Direct testimony before the State Corporation Commission of the State of Kansas on behalf of Evergy Kansas Central, Inc. and Evergy Kansas South, Inc. in the matter of the Joint Application of Westar Energy, Inc. and Kansas Gas and Electric Company to Make Certain Changes in Their Charges for Electric Services, Docket No. 18-WSEE-328-RTS, October 13, 2020; Rebuttal testimony before the State Corporation Commission of the State of Kansas, on behalf of Westar Energy, in the matter of the Joint Application of Westar Energy, Inc. and Kansas Gas and Electric Company for Approval to Make Certain Changes in their Charges for Electric Services, Docket No. 18-WSEE-328-RTS, July 3, 2018; Direct testimony before the State Corporation Commission of the State of Kansas, on behalf of Westar Energy, in the matter of the Joint Application of Westar Energy, Inc. and Kansas Gas and Electric Company for Approval to Make Certain Changes in their Charges for Electric Services, Docket No. 18-WSEE-328-RTS, February 1, 2018; Reply affidavit before the State Corporation Commission of the State of Kansas, on behalf of Westar Energy, in the matter of the General Investigation to Examine Issues Surrounding Rate Design for Distributed Generation Customers, Docket No. 16-GIME-403-GIE, May 5, 2017; 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.

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INDUSTRY AND OTHER PARTIES STRIKES A REASONABLE BALANCE BETWEEN THE DIFFERENT PERSPECTIVES?

A. Yes. I believe this Stipulation goes a long way toward addressing the cost shift issue by moving solar customers to a TOU rates, applying TOU netting to compute the bill, imposing a minimum bill, and applying a grid access fee for systems above a certain size. It simultaneously encourages solar adoption by providing an upfront incentive based on the energy efficiency benefit, provided the customer-generators install a smart thermostat and pair it with a CPP program.

Q. ARE THE SOLAR CHOICE TARIFFS AND RIDERS PROPOSED IN THIS STIPULATION NEW AND INNOVATIVE?

A. Yes, I believe the Solar Choice tariffs and riders proposed in this Stipulation are new and innovative because they combine TOU rates with CPP and allow and energy efficiency incentives for installing rooftop solar panels for customers enrolled in demand response. TOU rates and CPP rates are among the most innovative rates in the utility industry and the Stipulation embodies both of them.[12] The Stipulation resolves not only a long-standing dispute between the utility industry and the solar industry, parties that have traditionally been at logger heads throughout the country. This Stipulation also integrates distributed energy resources (smart thermostats) with energy efficiency (rooftop solar panels) and

[12] "The Tariffs of Tomorrow: Innovations in Rate Designs," with Cecile Bourbonnais, *IEEE Power and Energy Magazine*, Volume 18, Issue 3, May–June 2020; "Time of Use Rates: An International Perspective," with Cecile Bourbonnais, *Energy Regulation Quarterly*, Volume 8, Issue 2, June 2020; https://www.energyregulationquarterly.ca/articles/time-of-use-rates-an-international-perspectives#sthash.tNurCwB7.IH1irft2.dpbs; "Transitioning to Modern Residential Rate Designs," with Lea Grausz and Cecile Bourbonnais, *Public Utility Fortnightly*, January 2019; "The Transformative Power of Time-Varying Rates," with Cecile Bourbonnais, https://energycentral.com/c/em/transformative-power-time-varying-rates.

innovative rate design (TOU rates and CPP rates). The Stipulation has been covered extensively in the trade press and generated much positive interest in the utility industry. UtilityDive, a well-respected industry publication, lauded the proposal as a "landmark settlement" and is one example of the industry's positive reception of the proposed Stipulation.[13] The complete article from Utility Dive is included as **Faruqui Rebuttal Exhibit 2.**

Q. WITNESS HORII STATES THAT HE IS CONCERNED THAT THE COMPANIES AND THE SOLAR PARTIES ALIGNED INTERESTS TO THE POTENTIAL DETRIMENT OF NON-SOLAR CUSTOMERS IN SOUTH CAROLINA. PLEASE EXPLAIN THE VALUE THAT THIS STIPULATION AGREEMENT BRINGS TO THE COMPANIES' CUSTOMERS.

A. The Stipulation provides the Companies' customers in South Carolina with a viable pathway to invest in rooftop solar panels and reduce their energy bills while promoting clean energy in the state. The Stipulation also reduces the cost shift that would otherwise occur from solar to non-solar customers. The Stipulation fulfills the full intent of Act 62, which Witness Horii ignores.

Q. ON PAGE 32 OF HIS TESTIMONY, WITNESS HORII ASKS THE COMMISSION TO PRIORITIZE THE GOAL OF ELIMINATING THE COST SHIFT TO THE GREATEST EXTENT PRACTICABLE OVER

[13] https://www.utilitydive.com/news/duke-solar-industry-breakthrough-settlement-aims-to-end-rooftop-solar-cost/585124/#:~:text=A%20landmark%20settlement%20between%20Duke,The%20proposal%2C%20released%20Sept.

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MINIMIZING DISRUPTION TO THE SOLAR INDUSTRY, AS CALLED FOR IN ACT 62. DO YOU AGREE WITH THIS RECOMMENDATION?

A. No, I don't think that would be a wise course of action and I believe it is in direct contradiction with the intent of the General Assembly. Act 62 specifically calls for the Companies to reduce the cost shift to the greatest extent practicable while also minimizing disruption to the solar industry. Unlike the ORS's recommendation, Act 62 does not prioritize one goal over the other. Conversely, the proposed Stipulation balances the intent and direction in Act 62.

Q. ARE THE "ZERO COST SHIFT TARIFFS" RECOMMENDED BY WITNESS HORII SUPPORTED BY SOUTH CAROLINA LEGISLATION AND THE COMMISSION?

A. No. As noted earlier, Act 62 calls for balancing the need to minimize cost shifts while encouraging customer adoption of rooftop solar panels. The agreement proposed by the Companies in the Stipulation virtually eliminates the cost shift without disrupting the growing market for customer-scale distributed energy resources.

Additionally, the proposed tariffs were designed based on the most recent cost of service methodology that was approved by the Commission. Witness Horii, using a different methodology which has not been vetted with any intervenors or approved by the Commission, has produced tariffs that are much higher than the ones proposed by the Companies. In Witness Horii's testimony on page 29, line 11, and on the two tables on page 30, he is suggesting the Companies' tariffs be raised by 40.8% for DEP and 77.3% for DEC. In Table 4 on that page, which is reproduced

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below, he is also suggesting that the minimum bill of $30 a month be raised to $42 for DEP and to $53 for DEC.

Table 4: Zero Cost Shift Tariffs

	Settlement		Zero Cost Shift	
	DEP	DEC	DEP	DEC
Energy Prices ($/kWh)				
Peak	$0.15843	$0.15176	$0.22314	$0.26907
Off Peak	$0.09529	$0.08759	$0.13421	$0.15529
Super Off Peak	$0.06994	$0.06027	$0.09850	$0.10686
Critical Peak	$0.25000	$0.25000	$0.35210	$0.44325
Monthly Grid Access Fee GAF $/kW-dc month	$3.95	$5.86	$5.56	$10.39
Minimum Bill ($/month)	$30	$30	$42	$53
Monthly excess net exports	Sch SC	Sch PP	Sch SC	Sch PP

Such significant rate hikes will put the Stipulation at risk, which would be detrimental to the Companies' customers. The average retail rate for the Companies' residential customers is around 10 cents/kWh[14] which equals Witness Horii's proposed super off-peak tariff in Table 4. Not only are these proposed increases unwarranted and not based on approved cost of service studies, it is unlikely that these proposed tariffs will be supported by the Settling Parties since they are likely to disrupt the growing market for customer-scale distributed energy resources. If the Stipulation falls apart, the intent of Act 62 will not be met.

[14] The energy charge in DEP-SC is 10.861 c/kWh except for usage above 800 kWh from Nov-June when it's 9.861 c/kWh. For DEC-SC, Rate Schedule RS (which applies to roughly 55% of the population) has energy rates of 10.1788 c/kWh and 10.8691 c/kWh for usage above 1,000 kWh. Rate Schedule RE (which applies to 45% of the population) has energy rates of 8.8020 c/kWh and 9.3717 c/kWh for usage above 1,000 kWh.

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III. RATE DESIGN ASPECTS OF THE STIPULATION

Q. DOES WITNESS HORII'S ANALYSIS RECOGNIZE THAT THE PROPOSED RATE DESIGNS ARE UNIQUE?

A. No. Witness Horii's analysis ignores the ingenuity of the rate designs in this case. I don't know of any other utility which has combined so many rate design measures so effectively to mitigate cost shifts from solar to non-solar customers, promote energy efficiency, promote demand response while also supporting the deployment of rooftop solar panels. In most cases, utilities levy simple two-part rates with a low fixed charge and a flat energy charge. A few levy a TOU rate or a demand charge and a few levy a minimum bill. I don't know of any utility that levies a CPP rate for its rooftop solar customers.

Q. PLEASE FURTHER EXPLAIN THE UNIQUE RATE DESIGN ASPECTS OF THE STIPULATION.

A. The Stipulation involves the use of two innovative rate designs, a TOU rate and a CPP rate. The prices are shown below.

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Table 1: Summary of Residential Solar TOU

		R-STOU-61 Solar Time-of-Use		R-STOU (SC) Solar Time-of-Use	
1	Basic Facilities Charge per month	$	14.630	$	13.090
2	Energy Charges				
	Critical Peak (per kWh)	$	0.253	$	0.250
	On-Peak (per kWh)	$	0.162	$	0.152
	Off-Peak (per kWh)	$	0.099	$	0.088
	Super-Off-Peak (per kWh)	$	0.073	$	0.060
3	Non-bypassable Charge per month	$	0.490	$	0.420
4	Grid Access Fee per month (per kW above 15 kW)	$	3.950	$	5.860
5	Customer and Distribution Energy Charges				
	On-Peak (per kWh)	$	0.029	$	0.037
	Off-Peak (per kWh)	$	0.023	$	0.025
	Super-Off-Peak (per kWh)	$	0.019	$	0.018
6	Minimum bill	$	30.000		

In addition, NEM customers will pay a minimum monthly bill of $30. If the size of their solar panels exceeds 15 kW, NEM customers will also pay a grid access charge of $3.95/kW or $5.86/kW depending on their TOU plan.

NEM customers are also provided an incentive to install a smart thermostat and to pair it with a CPP rate which charges $0.25 per kWh for 60 hours during the winter season. If they do that installation, they are provided an additional incentive of 39 cents/watt of installed solar capacity.

These rate designs serve a two-fold purpose: (a) eliminate cost shifts from solar to non-solar customers and (b) encourage efficient use of the Companies' generation, transmission and distribution assets –thereby lowering electricity costs for all customers. All in all, these proposed solar choice rates enable market-driven

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investment in customer-scale distributed energy resources, which Witness Horii does not acknowledge.

Q. BEGINNING ON PAGE 33, LINE 1, WITNESS HORII NOTES THAT THE "FORM AND COMPONENTS USED IN THE PROPOSED PERMANENT TARIFFS ARE REASONABLE . . . [BUT] SOME DEMAND-BASED CHARGES MAY BE PREFERABLE." IN YOUR VIEW DO THE SOLAR CHOICE TARIFFS PROPOSED IN THE STIPULATION CONTAIN THE IDEAL RATE DESIGN?

A. In my view, the proposed tariff comes pretty close to being the ideal. I have argued elsewhere that the ideal rate design would reflect the cost structure of producing and delivering electricity and would consist of a fixed charge, a demand charge to reflect capacity costs, and a time-varying energy charge.[15] The Stipulation tariff includes a fixed charge, a TOU rate, a dynamic CPP rate, and a minimum bill (which can serve as a proxy for a demand charge). If the size of the solar panels exceeds 15 kW, a grid access fee is imposed in addition to the other charges.

IV. EMBEDDED COST ALLOCATION METHODOLOGY

Q. WITNESS HORII PROPOSES THE USE OF A DIFFERENT COST ALLOCATOR IN THIS PROCEEDING. HAVE YOU EVER SEEN A

[15] "Rate Design 3.0 – Future of Rate Design," *Public Utilities Fortnightly*, May 2018. https://www.fortnightly.com/fortnightly/2018/05/rate-design-30; "Rate Design 3.0 and The Efficient Pricing Frontier," presented at the EUCI 2018 Residential Demand Charges Conference, Nashville, TN, May 15, 2018; "Does Dynamic Pricing of Electricity Eliminate the Need for Demand Charges?" presented at the Harvard Electricity Policy Group's (HEPG) 89th Plenary Session, January 25, 2018.

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COMMISSION USE A DIFFERENT ALLOCATOR FOR JUST NEM CUSTOMERS?

A. No, I have not seen that and believe Witness Horii's proposal is a fundamental ratemaking mistake, as detailed by the Companies' Witness Janice Hager.

Q. WHAT ARE THE PITFALLS OF USING A DIFFERENT ALLOCATOR FOR A SUBCLASS OF CUSTOMERS AS SUGGESTED BY WITNESS HORII?

A. Using a different allocator for a sub-class outside of a base rate case will create an imbalance of cost recovery and could lead to the Companies over- or under-collecting their revenue requirement. I believe the Commission should be concerned that Witness Horii's proposed change may have unintended consequences if done in a piecemeal fashion.

Q. WITNESS HORII RECOMMENDS THAT THE COMPANIES USE A WINTER 1CP OR A LOSS OF LOAD EXPECTATION ("LOLE") METHODOLOGY. HOW CERTAIN IS IT THAT THE COMPANIES WOULD ADOPT A WINTER 1 CP METHODOLOGY OR ONE BASED ON LOLE IN THE FUTURE?

A. That would be a decision that the Companies would have to make in a future base rate case where all interested parties participated. It's unlikely that such a decision would be made simply in a NEM proceeding since any change in allocators would affect all classes of customers. The decision would include analysis to review load shape and cost of service data and may conclude that the current method is appropriate or that a new method is needed. Based on this analysis the Companies

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may propose using an entirely new methodology, for example a 12 CP method that applies to the entire year. Witness Horii's proposal is not reasonable and it is a direct contradiction to ratemaking principles to arbitrarily modify an allocator outside of a base rate case.

Q. WITNESS HORII PROVIDES ANALYSIS OF THE IMPACT OF TOU AND CPP RATES ON PEAK DEMAND. WHAT IS YOUR EXPERIENCE IN ANALYZING THE IMPACT OF TOU AND CPP RATES ON PEAK DEMAND?

A. I have been working on time-varying rates since 1979. In my first project, while working at EPRI, I analyzed the results of the first generation of TOU experiments. These were carried out under the auspices of the Federal Energy Administration ("FEA"), which was later the US Department of Energy. I summarized the results of 12 FEA experiments in a paper.[16] Later, I managed a project to analyze the results of the five best FEA experiments. After the California energy crisis in 2000-01, a second generation of experiments was launched. I helped design experiments involving time-varying rates (including TOU, CPP and PTR) in California, Connecticut, Florida, Illinois, Maryland and Michigan in the US and also analyzed

[16] "The Residential Demand for Electricity by Time-of-Use: A survey of twelve experiments with peak load pricing," with J. Robert Malko, *Energy: The International Journal*, Volume 8, Issue 10, October 1983, pp. 781-795. https://www.sciencedirect.com/science/article/abs/pii/036054428390052X.

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their results.[17] I also analyzed the impact of the province-wide deployment of TOU rates in Ontario over a three-year period.[18] Finally, I designed and evaluated the impact of PTR in Hong Kong and New Zealand. The US Department of Energy funded a third generation of experiments through its Smart Grid Investment Gants ("SGIG") program. I was on the advisory panel run for the SGIG program by the Lawrence Berkeley National Labs for two of those experiments in Michigan and Ohio. Over time, I have kept track of pilots involving time-varying rates that have been carried out in North America, Europe and Asia. I have obtained information on the rate structures and associated reductions in peak demand from these pilots and entered them in a database called *Arcturus*.[19] I have done a meta-analysis of the data and established a relationship between the ratio of peak to off-peak prices

[17] A summary of 15 dynamic pricing experiments is provided in this paper. "Household response to dynamic pricing of electricity–a survey of 15 experiments," with Sanem Sergici, *Journal of Regulatory Economics* (2010), 38:193-225. https://link.springer.com/article/10.1007/s11149-010-9127-y. I have also published impact evaluations of pilots carried out in California, Connecticut, Florida, Maryland and Michigan. "Quantifying Customer Response to Dynamic Pricing," with Stephen S. George, *Electricity Journal*, May 2005. 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. "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.
"Dynamic pricing of electricity in the mid-Atlantic region: econometric results from the Baltimore gas and electric company experiment," with Sanem Sergici, *Journal of Regulatory Economics*, 40:1, August 2011, pp. 82-109; "Dynamic Pricing Works in a Hot, Humid Climate," with Neil Lessem and Sanem Sergici, *Public Utilities Fortnightly*, May 2017. https://www.fortnightly.com/fortnightly/2017/05/dynamic-pricing-works-hot-humid-climate

[18] "The Impact of Time-of-Use Rates in Ontario," with Neil Lessem, Sanem Sergici, and Dean Mountain, *Public Utilities Fortnightly*, February 2017. https://www.fortnightly.com/fortnightly/2017/02/impact-time-use-rates-ontario; "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

[19] "Arcturus 2.0: A meta-analysis of time-varying rates for electricity," with Sanem Sergici and Cody Warner, *The Electricity Journal*, 30:10, December 2017, pp. 64-72. https://www.sciencedirect.com/science/article/pii/S1040619017302750.

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and reduction in peak demand.[20] This analysis is being constantly updated as new results become available.

Q. BASED ON YOUR EXPERIENCE, WHAT WILL BE THE IMPACT OF THE TOU RATES THAT THE COMPANIES HAVE PROPOSED IN THE STIPULATION?

The immediate impact will be the mitigation of the cost shift from solar to non-solar customers. Additionally, the mandatory TOU rate will provide solar customers an incentive to consume less during the peak period and more during the off-peak period. The Companies are carrying out a pilot with TOU and CPP rates in North Carolina that sheds light on how much customers change their load profiles. As referenced in the Companies' Witness Lon Huber, the preliminary findings from DEC's pilot CPP design in North Carolina found a winter peak load reduction of 11.7% to 17% during a CPP event occurring on a winter morning.

Q. WHAT IS GOING TO BE THE LIKELY IMPACT OF THE CPP RATE WHICH IS PAIRED WITH A SMART THERMOSTAT?

A. Using the *Arcturus* database, I would expect non-solar customers on CPP to display a reduction in consumption of about 9% in response to the CPP rate. If they are coupled with a smart thermostat, the reduction would rise to 15%. I would expect solar customers to display a similar response thereby further eliminating a cost shift.

[20] A summary of the results can be found in this article. https://energycentral.com/c/em/transformative-power-time-varying-rates.

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Q. WOULD THE IMPACTS OF THE TOU AND CPP RATES ON PEAK DEMAND REDUCE THE WINTER PEAK AND AFFECT THE RESULTS THAT WOULD FLOW FROM THE 1 WINTER CP METHOD WITNESS HORII SUGGESTS THE COMPANIES USE?

A. Most probably yes.

Q. DOES WITNESS HORII RECOGNIZE THE IMPACT OF TOU AND CPP RATES IN HIS RECOMMENDATIONS?

A. No. While Witness Horii does agree that TOU and CPP rates would incent customer-generators to reduce winter peak demand, thereby providing a winter benefit, he admits that these benefits are not considered in his recommendations to the Commission.

V. CONCLUSION

Q. WITNESS HORII EXPRESSED CONCERNS OVER THE PROPOSED STIPULATION AGREEMENT. DO YOU THINK THE STIPULATION IS A REASONABLE APPROACH AND SHOULD BE APPROVED BY THE COMMISSION?

A. Yes, I believe this Stipulation is a very reasonable and innovative approach which represents a constructive pathway forward not only for South Carolina but also for other states. I recommend that the Commission approve it and the Company's proposed Solar Choice Tariffs in these dockets. I also recommend that the Commission not approve the tariffs offered by Witness Horii as they are not based on approved cost of service methodologies or sound ratemaking practices.

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Additionally, if they are approved, they will be in direct contradiction of the intent of Act 62.

Q. DOES THIS CONCLUDE YOUR PRE-FILED REBUTTAL TESTIMONY?

A. Yes, it does.

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Ahmad Faruqui
Principal

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Dr. Faruqui is an energy economist whose consulting practice encompasses rate design, demand response, distributed energy resources, demand forecasting, decarbonization, electrification and energy efficiency and load flexibility.

In his career, Dr. Faruqui has advised some 150 clients in 12 countries on 5 continents and appeared before regulatory bodies, governments, and legislative councils in Alberta (Canada), Arizona, Arkansas, California, Colorado, Connecticut, Delaware, District of Columbia, Egypt, FERC, Georgia, Illinois, Indiana, Iowa, Jamaica, Kansas, Kentucky, Michigan, Maryland, Minnesota, Missouri, Nevada, New Brunswick (Canada), Nova Scotia (Canada), Ohio, Oklahoma, Ontario (Canada), Pennsylvania, the Philippines, Saudi Arabia (ECRA), Texas, and Washington.

He has authored or coauthored more than 150 papers in peer-reviewed and trade journals and co-edited 5 books on industrial structural change, customer choice, and electricity pricing. His innovations have been cited in *Bloomberg*, *Businessweek*, *The Economist*, *Forbes*, and *National Geographic*, in addition to news outlets including the *Los Angeles Times*, *The New York Times*, *San Francisco Chronicle*, *San Jose Mercury News*, and the *Washington Post*. He has also appeared on Fox Business News and NPR.

He has taught economics at San Jose State University, the University of California, Davis, and the University of Karachi and delivered guest lectures at Carnegie Mellon, Harvard, Idaho, MIT, New York University, Northwestern, Rutgers, Stanford, UC Berkeley, and UC Davis. He has also given seminars on energy issues on 20 countries on 6 continents.

EDUCATION

- BA (highest honors) and MA (highest honors) in economics, mathematics, and statistics, University of Karachi
- MA in agricultural economics and PhD in economics, The University of California at Davis
- Regents' Fellowship, The University of California at Davis
- Dissertation Grant, Kellogg Foundation

SELECTED AWARDS & RECOGNITION

- *Who's Who Legal*: Energy Experts 2020
- Association of Energy Services Professionals (AESP): 30 Game Changers in the Last 30 Years (1990–2020)

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AREAS OF EXPERTISE

Expert witness

Dr. Faruqui has testified or appeared before state commissions in Arizona, Arkansas, California, Colorado, Connecticut, Delaware, the District of Columbia, FERC, Illinois, Indiana, Iowa, Kansas, Michigan, Maryland, Minnesota, Nevada, Ohio, Oklahoma, Ontario (Canada), Pennsylvania, Nova Scotia (Canada), and Texas. He has been engaged by regulatory bodies in Alberta (Canada), FERC, Hawaii, New Brunswick (Canada), Ontario (Canada) and Saudi Arabia (ECRA).

He has made presentations to the California Energy Commission, the California Senate, the Congressional Office of Technology Assessment, the Indiana General Assembly, the Kentucky Commission, the Michigan Commission, the Minnesota Department of Commerce, the Minnesota Senate, the Missouri Public Service Commission, and the Electricity Pricing Collaborative in Washington State.

Innovative pricing

He has identified, designed and analyzed the efficiency and equity benefits of introducing innovative pricing designs such as three-part rates, including fixed monthly charges, demand charges and time-varying energy charges; dynamic pricing rates, including critical peak pricing, variable peak pricing and real-time pricing; time-of-use pricing; and inclining block rates.

Regulatory strategy

Dr. Faruqui 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 grid modernization**. 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 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.

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- **Hedging, risk management, and market design**. He has helped design a 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.
- **Academic experience**. He has given lectures at the University of California, Berkeley, University of California, Davis, Harvard University, University of Idaho, Massachusetts Institute of Technology, Michigan State University, Northwestern University, University of San Francisco, Stanford University, University of Virginia, and University of Wisconsin-Madison. Additionally, he has led a variety of professional seminars and workshops on public utility economics around the world. Finally, he has taught economics at San Jose State University, University of California, Davis, and the University of Karachi.

EXPERIENCE

Innovative Pricing

- **Cost of service and tariff design study.** For a large electric utility in South-East Asia, Brattle provided consulting services for their cost of service and tariff design studies for incentive-based regulation, covering regulatory period 2 (2018–2020). Our work focused on understanding the cost drivers, reviewing the extent to which the current tariffs reflect the cost drivers, and developing new tariffs that better align with current and projected costs.
- **Impact analysis for TOU rates in Ontario.** Measured the impacts of a system-wide Time of Use (TOU) deployment in the province of Ontario, Canada, on behalf of the Ontario Power Authority. To account for the lack of a designated control group, Brattle created a quasi-experimental design that took advantage of differences in the timing of the TOU rollout.

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- **Measurement and evaluation for in-home displays, home energy controllers, smart appliances, and alternative rates for Florida Power & Light (FPL).** Carried out a 2-year impact evaluation of a dynamic and enabling technology pilot program. Used econometric methods to estimate the changes in load shapes, changes in peak demand, and changes in energy consumption for three different treatments. The results of this study were shared with Department of Energy to fulfil the data reporting requirements of FPL's Smart Grid Investment Grant.
- **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 reviewed 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 discussed ways in which dynamic pricing could 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 included 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 was international regulators in regions that were 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). 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. 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.

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- **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 in real-time prices. The 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.
- **Analyzed the economics of self-generation of steam.** 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 the probability of self-generation 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.

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- **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. Cataloged 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 staff 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.

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- 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 the 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

- **Combined heat and power generation study.** Investigated the economic potential for combined heat and power and regulatory policies to unlock that potential in a Middle Eastern country.
- **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.
- **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, as required by the Energy Independence and Security Act.
- **Demand response program review for Integrated Resource Plan development.** In response to legislation requiring the Connecticut utilities to jointly prepare a 10-year integrated resource plan, we conducted the analysis and helped prepare the plan. In coordination with the two leading utilities in the state, we conducted a detailed analysis of alternative resource solutions (both supply- and demand-side), drafted the report, and presented it to the Connecticut Energy Advisory Board. The analysis involved a detailed review and critique of the companies' proposed DR programs.
- **Integration of DR into wholesale energy markets.** Developed a whitepaper, "Fostering Economic Demand Response in the Midwest ISO," evaluating alternative approaches to efficiently integrating DR into its energy markets while encouraging increased participation. This work involved interviewing market participants and analyzing several approaches to economic DR regarding economic efficiency, participation rates, operational fit with other ISO rules, and susceptibility to state-level and ISO-level implementation barriers. This work involved an extensive survey of DR programs (qualification criteria, bidding rules, incorporation into market clearing software, measurement and verification, and settlement) in ISO/ Regional Transmission Organization (RTO) markets around the country. The project also required a detailed review of existing DR program tariffs for utilities in the RTO's service territory and development of a matrix for summarizing the various characteristics of these programs.

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- **Integration of DR into resource adequacy constructs.** For the Midwest ISO, assisted in developing qualification criteria for DR as a capacity resource (we also developed estimates of likely future contributions of DR to resource adequacy, for use by their transmission planning group). For PJM, as part of our review of its capacity market, we developed recommendations on how to treat DR comparably to generation resources while accounting for the special attributes of DR. Our recommendations addressed product definition, auction rules, and penalty provisions. For the Connecticut utilities in their integrated resource planning, we evaluated future resource needs given various levels of demand response programs.
- **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 the 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).

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- **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

- **Electricity sales and peak demand forecasting study:** For a large electric utility in South-East Asia, Brattle provided consulting services that involved assessing the performance of their load forecasting methodology and developing new models that provided more accurate forecasts.
- **Electricity consumption and maximum demand forecasting:** For a medium-sized utility in Asia-Pacific, Brattle provided consulting services on forecasting electricity consumption and maximum demand. Our work focused on analyzing drivers of growth in electricity sales, reviewed model performance, identified best practices and provided recommended approaches for analyzing trends in electricity sales and load forecasting.
- **Forecasting review.** Evaluated and critiqued the process conducted by an Australian utility company's electricity market forecasting, including the forecasting of electricity demand, supply, and price.
- **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.

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- **Analyzed downward trend: Western utility.** Conducted a strategic review of why sales had been lower than forecast in a year when economic activity had been brisk. 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. 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. 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, developed a base case forecast and several alternative case forecasts of electric energy consumption by end use and sector. 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.

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- **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 were likely to operate in a competitive market, such as third-party energy service companies (ESCO's) 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 product size. 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 of more than 200 end-use technologies and a model of customer decision making.

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- **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

- Rebuttal Testimony before the Arizona Corporation Commission on behalf of Arizona Public Service Company, in the matter of *Stacey Champion, et al., v Arizona Public Service Corporation*, Docket No. E-01345A-18-0002, August 17, 2018.
- Direct Testimony before the Arizona Corporation Commission on behalf of Arizona Public Service Company, in the matter of *Stacey Champion, et al., v Arizona Public Service Corporation*, Docket No. E-01345A-18-0002, July 31, 2018.
- Direct Testimony before the Arizona Corporation Commission on behalf of Arizona Public Service Company, in the matter of the Application of Arizona Public Service Company for a Hearing to Determine the Fair Value of the Utility Property of the Company for Ratemaking Purposes, to Fix a Just and Reasonable Rate of Return Thereon, to Approve Rate Schedules Designed To Develop Such Return, Docket No. E-01345A-16-0036, June 1, 2016.
- 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.
- Testimony before the Board of Directors on behalf of Salt River Project, in the matter of "An Evaluation of SRP's Electric Rate Proposal for Residential Customers with Distributed Generation," December 31, 2014.

Arkansas

- Direct Testimony before the Arkansas Public Service Commission on behalf of Entergy Arkansas, Inc., in the matter of Entergy Arkansas, Inc.'s Application for an Order Finding the Deployment of Advanced Metering Infrastructure to be in the Public Interest and Exemption from Certain Applicable Rules, Docket No. 16-060-U, September 19, 2016.

California

- Testimony before the Board of Directors on behalf of SMUD, in the matter of "Encouraging Rooftop Solar without Creating Cross-subsidies," April 30, 2019.

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- 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.

Canada

- Presented before the Nova Scotia Utility and Review Board in the Matter of The Public Utlities Act, R. S. N. S. 1989, c380, as amended. Time-Varying Pricing Tariff Application No. M09777. November 20,2020.
- Presented before the Nova Scotia Utility and Review Board to provide an assessment of Nova Scotia Power, Inc.'s proposed Extra Large Industrial Active Demand Control (ELIADC) tariff for Port Hawkesbury Paper (PHP). February 2020.

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.

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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.

Georgia

- Direct testimony before the State of Georgia Public Service Commission on behalf of Georgia Power Company, in the matter of Georgia Power Company's 2019 Base Rate Case, Docket No. 42516, June 28, 2019.

Idaho

- Rebuttal Testimony before the Idaho Public Utilities Commission on behalf of Idaho Power Company (Idaho Power), in the matter of the Application of Idaho Power Company for Authority to Establish New Schedules for Residential and Small General Service Customers with On-Site Generation, Case No. IPC-E-17-13, January 26, 2018.

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 Illinois Commerce Commission on behalf of Commonwealth Edison Company regarding the evaluation of experimental residential real-time pricing program, 11-0546, April 2012.
- Rebuttal Testimony before the Illinois Commerce Commission on behalf of Commonwealth Edison Company in the matter of the Petition to Approve an Advanced Metering Infrastructure Pilot Program and Associated Tariffs, No. 09-0263, August 14, 2009.
- 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.

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Kansas

- Rebuttal testimony before the State Corporation Commission of the State of Kansas on behalf of Evergy Kansas Central, Inc. and Evergy Kansas South, Inc. in the matter of the Joint Application of Westar Energy, Inc. and Kansas Gas and Electric Company to Make Certain Changes in Their Charges for Electric Services, Docket No. 18-WSEE-328-RTS, December 04, 2020.
- Direct testimony before the State Corporation Commission of the State of Kansas on behalf of Evergy Kansas Central, Inc. and Evergy Kansas South, Inc. in the matter of the Joint Application of Westar Energy, Inc. and Kansas Gas and Electric Company to Make Certain Changes in Their Charges for Electric Services, Docket No. 18-WSEE-328-RTS, October 13, 2020.
- Rebuttal testimony before the State Corporation Commission of the State of Kansas, on behalf of Westar Energy, in the matter of the Joint Application of Westar Energy, Inc. and Kansas Gas and Electric Company for Approval to Make Certain Changes in their Charges for Electric Services, Docket No. 18-WSEE-328-RTS, July 3, 2018.
- Direct testimony before the State Corporation Commission of the State of Kansas, on behalf of Westar Energy, in the matter of the Joint Application of Westar Energy, Inc. and Kansas Gas and Electric Company for Approval to Make Certain Changes in their Charges for Electric Services, Docket No. 18-WSEE-328-RTS, February 1, 2018.
- Reply affidavit before the State Corporation Commission of the State of Kansas, on behalf of Westar Energy, in the matter of the General Investigation to Examine Issues Surrounding Rate Design for Distributed Generation Customers, Docket No. 16-GIME-403-GIE, May 5, 2017.
- 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.

Louisiana

- Rebuttal testimony before the Council of the City of New Orleans on behalf of Entergy New Orleans, LLC, in the matter of Application of Entergy New Orleans, LLC for a Change in Electric and Gas Rates Pursuant to Council Resolutions R-15-194 and R-17-504 and for Related Relief, Docket No. UD-18-07, March 2019.
- Direct testimony before the Council for the City of New Orleans on behalf of Entergy New Orleans, LLC, in the matter of Application of Entergy New Orleans, LLC for a Change in Electric and Gas Rates Pursuant to Council Resolutions R-15-194 and R-17-504 and for Related Relief, Docket No. UD-18-07, July 2018.

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- Direct testimony before the Louisiana Public Service Commission on behalf of Entergy Louisiana, LLC, in the matter of Approval to Implement a Permanent Advanced Metering System and Request for Cost Recovery and Related Relief in accordance with Louisiana Public Service Commission General Order dated September 22, 2009, R-29213, November 2016.
- Direct testimony before the Council of the City of New Orleans, on behalf of Entergy New Orleans, Inc., in the matter of the Application of Energy New Orleans, Inc. for Approval to Deploy Advanced Metering Infrastructure, and Request for Cost Recovery and Related Relief, October 2016.

Maryland

- Direct Testimony before the Maryland Public Service Commission, on behalf of Potomac Electric Power Company in the matter of the Application of Potomac Electric Power Company for Adjustments to its Retail Rates for the Distribution of Electric Energy, April 19, 2016.
- Rebuttal Testimony before the Maryland Public Service Commission on behalf of Baltimore Gas and Electric Company in the matter of the Application of Baltimore Gas and Electric Company for Adjustments to its Electric and Gas Base Rates, Case No. 9406, March 4, 2016.
- 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.

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Mississippi

- Direct testimony before the Mississippi Public Service Commission, on behalf of Entergy Mississippi, Inc., in the matter of Application for Approval of Advanced Metering Infrastructure and Related Modernization Improvements, EC-123-0082-00, November 2016.

Missouri

- Direct testimony before the Missouri Public Service Commission, on behalf of Union Electric Company d/b/a Ameren Missouri, in the matter of Union Electric Company d/b/a Ameren Missouri's Tariffs to Increase Its Revenues for Electric Service, ER-2019-0335, July 3, 2019.

Montana

- Rebuttal testimony before the Public Service Commission of the State of Montana on behalf of NorthWestern Energy, in the matter of NorthWestern Energy's Application for Authority to Increase Retail Electric Utility Service Rates and for Approval of Electric Service Schedules and Rules and Allocated Cost of Service and Rate Design, Docket No. D2018.2.12, April 2019.
- Prefiled direct testimony before the Public Service Commission of the State of Montana on behalf of NorthWestern Energy, in the matter of NorthWestern Energy's Application for Authority to Increase its Retail Electric Utility Service Rates and for Approval of its Electric Service Schedules and Rules, Docket No. D2018.2.12, September 28, 2018.

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.

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Oklahoma

- Rebuttal Testimony before the Corporation Commission of Oklahoma on behalf of Oklahoma Gas and Electric Company in the matter of the Application of Oklahoma Gas and Electric Company for an Order of the Commission Authorizing Applicant to modify its Rates, Charges and Tariffs for Retail Electric Service in Oklahoma, Cause No. PUD 201500273, April 11, 2016.
- Direct Testimony before the Corporation Commission of Oklahoma on behalf of Oklahoma Gas and Electric Company in the matter of the Oklahoma Gas and Electric Company for an Order of the Commission Authorizing Applicant to modify its Rates, Charges and Tariffs for Retail Electric Service in Oklahoma, Cause No. PUD 201500273, December 18, 2015.
- Responsive Testimony before the Corporation Commission of Oklahoma on behalf of Oklahoma Gas and Electric Company 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, May 13, 2015.

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.

Washington

- Pre-filed Direct Testimony before the Washington Utilities and Transportation Commission on Behalf of Puget Sound Energy, Dockets UE-151871 and UG-151872, February 25, 2016.

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.

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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

Articles and Papers

- "Flexible Demand Side Grid Assets" by Matthew Schuerger, Public Utilities Fortnightly, December 2020.
  https://www.fortnightly.com/fortnightly/2020/12/flexible-demand-side-grid-assets
- "Resiliency in the West" by Ann Rendahl, Public Utilities Fortnightly, December 2020.
  https://www.fortnightly.com/fortnightly/2020/12/resiliency-west
- "The Road to Net Zero: Decorbonizing Household Consumption," by Clark Gellings and Ahmad Faruqui, *Public Utilities Fortnightly*, December 2020.
- "Bridging the Chasm Between Pilots and Full-scale Deployment of Time-of-Use Rates," with Sanem Sergici and Long Lam, *The Electricity Journal*, Volume 33, Issue 10, December 2020.
  https://www.sciencedirect.com/science/article/abs/pii/S1040619020301494
- "Factors Behind the Information of Community Choice Aggregation," with Mariko Geronimo Aydin, and John Higham, *The Electricity Journal*, Volume 33, Issue 10, December 2020.
  https://www.sciencedirect.com/science/article/abs/pii/S1040619020301548
- "Conceptual Discussion on a Potential Hidden Cross-Seasonal Storage: Cross-Seasonal Load Shift in Industrial Sectors," with Yingxia Yang and Jared DeFrain, *The Electricity Journal,* Volume 33, Issue 8, October 2020.
  https://www.sciencedirect.com/science/article/pii/S104061902030138X?dgcid=author

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- "Alberta Commission Chair Retires and Reflects on Regulatory Career: A conversation with Mark Kolesar," *Public Utilities Fortnightly,* Volume 158, September 2020. https://www.fortnightly.com/fortnightly/2020/09/alberta-commission-chair-retires-and-reflects-regulatory-career
- "Avoiding Blackouts in California Through Load Flexibility," with Ryan Hledik, *Utility Dive*, September 2020. https://www.utilitydive.com/news/avoiding-blackouts-in-california-through-load-flexibility/585139/
- "Avoiding Blackouts," *Energy Central*, September 2020. https://energycentral.com/c/em/avoiding-blackouts
- "The Coming Transformation of the Electricity Sector: A conversation with Amory Lovins," *The Electricity Journal,* Volume 33, Issue 7, August–September 2020. https://www.sciencedirect.com/science/article/pii/S1040619020301196
- "The Tariffs of Tomorrow: Innovations in Rate Designs," with Cecile Bourbonnais, *IEEE Power and Energy Magazine*, Volume 18, Issue 3, May–June 2020.
- "Time of Use Rates: An International Perspective," with Cecile Bourbonnais, *Energy Regulation Quarterly*, Volume 8, Issue 2, June 2020. https://www.energyregulationquarterly.ca/articles/time-of-use-rates-an-international-perspectives#sthash.tNurCwB7.IH1irft2.dpbs
- "Enhancing Rate Design Choices for Ontarians," *Energy Central*, June 2020. https://energycentral.com/c/em/enhancing-rate-design-choices-ontarians
- "6 Reasons Why California Needs to Deploy Dynamic Pricing by 2030," *Utility Dive*, May 2020. https://www.utilitydive.com/news/6-reasons-why-california-needs-to-deploy-dynamic-pricing-by-2030/578156/
- "Refocusing on the Consumer: Utilities regulation needs to prepare for the "prosumer" revolution," *Regulation,* March 2020. https://www.cato.org/sites/cato.org/files/2020-03/regv43n1-6.pdf
- "Why Dynamic Pricing Gets Back Seat in California: A dialogue with Commissioner Mike Peevey," *Public Utilities Fortnightly*, March 2020. https://www.fortnightly.com/fortnightly/2020/03/why-dynamic-pricing-gets-back-seat-california
- "Double Down on Efficiency," with Ralph Cavanagh, *Public Utilities Fornightly*, December 2019.

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- "A New Paradigm for Utilities: Electrification of the Transportation and Heating Sectors," with Ryan Hledik, Jürgen Weiss, Michael Hagerty and Long Lam, *American Association Bar*, November 13, 2019.
- "Quantifying Net Energy Metering Subsidies," with Sanem Sergici, Yingxia Yang, and Maria Castañer, *The Electricity Journal*, Volume 32, Issue 8, October 2019.
- "Reducing electricity prices and establishing electricity markets in China: Dos and don'ts," with Yingxia Yang, *The Electricity Journal,* Volume 32, Issue 8, October 2019.
- "2040: A Pricing Odyssey: How to price electricity when the grid goes 100 percent green," *Public Utilities Fortnightly*, June 1, 2019.
- "Expanding Customer Choices in a Renewable Energy Future," with Mariko Geronimo Aydin, *Leadership in Rate Design*, May–June 2019.
- "Emerging Landscape of Residential Rates for EVs – Creative design ahead," with Ryan Hledik and John Higham, *Public Utility Fortnightly*, May 2019. https://www.fortnightly.com/fortnightly/2019/05/emerging-landscape-residential-rates-evs
- "Transitioning to Modern Residential Rate Designs," with Lea Grausz and Cecile Bourbonnais, *Public Utility Fortnightly*, January 2019. https://www.fortnightly.com/fortnightly/2019/01/transitioning-modern-residential-rate-designs
- "Status of Residential Time-of-Use Rates in the U.S.," with Ryan Hledik and Cody Warner, *Public Utilities Fortnightly*, November 1, 2018. https://www.fortnightly.com/fortnightly/2018/11/status-residential-time-use-rates-us
- "Net Metering FAQ – Rate design and subsidies," with Steve Mitnick, *Public Utilities Fortnightly,* October 2018. https://www.fortnightly.com/fortnightly/2018/10/net-metering-faq
- "Rate Design 3.0 – Future of Rate Design," *Public Utilities Fortnightly*, May 2018. https://www.fortnightly.com/fortnightly/2018/05/rate-design-30
- Book Review – 'Modernizing America's Electricity Infrastructure' by Mason Wilrich, *Public Utilities Fortnightly*, May 2018. https://www.fortnightly.com/fortnightly/2018/05/mason-willrichs-modernizing-americas-electricity-infrastructure
- "Do Load Shapes of PV Customers Differ?" with Walter Graf, *Public Utilities Fortnightly*, February 2018. https://www.fortnightly.com/fortnightly/2018/02/do-load-shapes-pv-customers-differ
- " Fixed Charges in Electric Rate Design: A Survey," with Kirby Leyshon, *The Electricity Journal*, Volume 30, Issue 10, December, 2017, pp. 32-43. https://www.sciencedirect.com/science/article/abs/pii/S1040619017302828

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- "Arcturus 2.0: A meta-analysis of time-varying rates for electricity," with Sanem Sergici and Cody Warner, *The Electricity Journal*, 30:10, December 2017, pp. 64-72. https://www.sciencedirect.com/science/article/pii/S1040619017302750
- "Moving Forward with Tariff Reform," with Mariko Geronimo Aydin, *Energy Regulation Quarterly*, Volume 5, Issue 4, December 2017. http://www.energyregulationquarterly.ca/articles/moving-forward-with-tariff-reform#sthash.ZADdmZ2h.D2l1yz9z.dpbs
- "Innovations in Pricing: Giving Customers What They Want," *Electric Perspectives*, September/October 2017.
- "Moving Forward with Electricity Tariff Reform," with Mariko Geronimo Aydin, *Regulation*, Fall 2017. https://object.cato.org/sites/cato.org/files/serials/files/regulation/2017/9/regulation-v40n3-5.pdf
- "Enhancing Customer-Centricity," with Henna Trewn, *Public Utilities Fortnightly*, August 2017. https://www.fortnightly.com/fortnightly/2017/08/enhancing-customer-centricity
- "The Public Benefits of Leasing Energy Efficient Equipment," with Neil Lessem and Henna Trewn, *The Electricity Journal*, 30:6, July 2017, pp. 8-16. http://www.sciencedirect.com/science/article/pii/S1040619017301513
- "Rethinking Customer Research in the Utility Industry," with Henna Trewn, *Public Utilities Fortnightly*, July 2017. https://www.fortnightly.com/fortnightly/2017/07/rethinking-customer-research
- "Do Manufacturing Firms Relocate in Response to Rising Electric Rates?" with Sanem Sergici, *Energy Regulation Quarterly*, 5:2, June 2017. http://www.energyregulationquarterly.ca/articles/do-manufacturing-firms-relocate-in-response-to-rising-electric-rates#sthash.uLnrPMwh.dpbs
- "Dynamic Pricing Works in a Hot, Humid Climate," with Neil Lessem and Sanem Sergici, *Public Utilities Fortnightly*, May 2017. https://www.fortnightly.com/fortnightly/2017/05/dynamic-pricing-works-hot-humid-climate
- "The impact of advanced metering infrastructure on energy conservation: A case study of two utilities," with Kevin Arritt and Sanem Sergici, *The Electricity Journal*, 30:3, April 2017, pp. 56-63. http://www.sciencedirect.com/science/article/pii/S1040619017300726
- "The impact of AMI-enabled conservation voltage reduction on energy consumption and peak demand," with Kevin Arritt and Sanem Sergici, *The Electricity Journal*, 30:2, March 2017, pp. 60-65. http://www.sciencedirect.com/science/article/pii/S1040619016302536

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- "Overcoming the Over-Forecasting Bias of Pure Econometric Models: A utility case study," with Josephine Duh and Ingrid Rohmund, *Electricity Policy*, February 2017.
- "The Impact of Time-of-Use Rates in Ontario," with Neil Lessem, Sanem Sergici, and Dean Mountain, *Public Utilities Fortnightly*, February 2017. https://www.fortnightly.com/fortnightly/2017/02/impact-time-use-rates-ontario
- "Competing Perspectives on Demand Charges," with Ryan Hledik, *Public Utilities Fortnightly*, September 2016. https://www.fortnightly.com/fortnightly/2016/09/competing-perspectives-demand-charges
- "An Economist's Dilemma: To PV or Not to PV, That Is the Question," *Electricity Policy*, March 2016. http://files.brattle.com/files/5834_2016_to_pv_or_not_to_pv__faruqui14march2016.pdf
- "Response to King-Datta Re: Time-Varying Rates," *Public Utilities Fortnightly*, March 2016. https://www.fortnightly.com/fortnightly/2016/03/response-king-datta-re-time-varying-rates
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- *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.

Presentations

- "Utilities Need to Modernize their Tariffs to Enhance the Customer Experience: A National Perspective," presented to the 21st Century Energy Policy Task Force, Indiana, October 1, 2020.
- "Are Consumers Upending the Utility Business Model?" presented at the Florence School of Regulation, September 9, 2020.
- "Designing Tariffs for Tomorrow's Customer: The Innovation Imperative," presented to the Electricity Authority, September 2, 2020.

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- "Designing Pilots and Proceeding with Full Scale Deployment," presented at the Washington Utilities and Transportation Commission, June 8, 2020.
- "The Five "Immortal Objections" to Time-of-Use Rates," presented at the PLMA Load Management Dialogue, May 28, 2020.
- " Stakeholder recommendations on rate design reform: Matter 357," with Cecile Bourbonnais, presented at the New Brunswick Energy and Utilities Board, May 12, 2020.
- "Moving Ahead with Time-Varying Rates (TVR): US and Global Perspectives," presented at the MI Power Grid: Energy Programs and Technology Pilots Stakeholder Meeting, April 16, 2020.
- "Moving Ahead with Time-Varying Rates (TVR): US and Global Perspective," presented to the NARUC Staff Subcommittee on Rate Design, April 6, 2020.
- "Demand on Demand," presented at the AESP Annual Conference, February 20, 2020.
- "Empirical Assessment of the Demand for Residential Solar Distributed Generation and the Impact of Electricity Rate Design Reform," with Agustin J. Ros and Cecile Bourbonnais, presented at the Rutgers University Center for Research in Regulated Industries, January 17, 2020.
- "Assessment of APS's Bill Comparison Web Tool: Methodology and Findings," with Ryan Hledik and Cecile Bourbonnais, December 10, 2019.
- "A Survey of Residential Time-of-Use (TOU) Rates," with Ryan Hledik and Sanem Sergici, November 12, 2019.
- "Advancing the Practice of Rate Design," presented at the 40th PLMA Conference, November 6, 2019.
- "The Total Value Test (TVT) for Assessing Electrification Programs," with Ryan Hledik and Omar Siddiqui, presented at the California Efficiency + Demand Management Council (CEDMC), October 24, 2019.
- "A Conversation about Customer Centricity," presented at Virtual Speaker Forum, October 21, 2019.
- "Encouraging Rooftop Solar without Creating Cross-Subsidies," presented to SMUD, April 30, 2019.
- "Post-Modern Rate Design: The 'Secret Sauce' in Customer Engagement," presented at the Entergy Regulatory Conference, April 9, 2019.
- "Valuing and Compensating Distributed Energy Resources in ERCOT," with Ira Shavel and Yingxia Yang, prepared for the Texas Clean Energy Coalition, March 28, 2019.
- "2040: A Pricing Odyssey," presented at the EEI Spring Rates and Regulatory Affairs Committee Meeting, March 25, 2019.

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- "Reinventing Demand Response for the Age of Renewable Energy," with Ryan Hledik, December 14, 2018.
- "Enabling Grid Modernization through Alternative Rates and Alternative Regulation," with Sanem Sergici and William P. Zarakas, presented at the Energy Policy Roundtable in the PJM Footprint, November 29, 2018.
- "Modernizing Distribution Tariffs for Households," presented to the Energy Consumers Association in Sydney, Australia, November 9, 2018.
- "The State of Electric Vehicle Home Charging Rates," with Ryan Hledik and John Higham, presented to Colorado PUC, October 2018.
- "Rate Design to Enable Flexible Loads," with Mariko Geronimo Aydin, presented at APPA Business & Financial Conference 2018, September 18, 2018.
- "Customer-driven Rate Design is the Wave of the Future," presented at the Colorado Rural Electric Association Managers Association Meeting, September 10, 2018.
- "Understanding the Costs and Benefits of Electrification: Electrification Cost-Benefit Case Studies," presented at the Electric Power Research Institute (EPRI) Electrification 2018 International Conference & Exposition, August 23, 2018.
- "Do Load Shapes of PV Customers Differ From Other Customers?" with Walter Graf, Presented at the Center for Research in Regulated Industries (CRRI) 31st Annual Western Conference, June 28, 2018.
- "Tariffs of the Future for Gas Utilities," with Léa Grausz, Henna Trewn, and Cecile Bourbonnais, presented at the Center for Research in Regulated Industries (CRRI) 31st Annual Western Conference, June 28, 2018.
- "Collecting Allowed Revenues When Demand is Declining," with Henna Trewn and Léa Grausz, presented at the Center for Research in Regulated Industries (CRRI) 31st Annual Western Conference, June 28, 2018.
- "Incentivizing the Adoption of Gas-Fueled Emerging Technologies with Pricing Tools," with Léa Grausz, presented at the 27th World Gas Conference, June 25, 2018.
- "Estimating the Impact of Innovative Rate Designs," presented to Southern California Edison, June 7, 2018.
- "Rate Design 3.0 and The Efficient Pricing Frontier," presented at the EUCI 2018 Residential Demand Charges Conference, Nashville, TN, May 15, 2018.
- "Does Dynamic Pricing of Electricity Eliminate the Need for Demand Charges?" presented at the Harvard Electricity Policy Group's (HEPG) 89th Plenary Session, January 25, 2018.
- "Dynamic Pricing: What Can We Learn from Other Jurisdictions?" presented at the California Public Utilities Commission's (CPUC) Electric Rate Forum, December 12, 2017.

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- "Demand Charges and Dynamic Pricing Are Complements, Not Substitutes," presented at the California Public Utilities Commission's (CPUC) Electric Rate Forum, December 11, 2017.
- "Dynamic Pricing Works in a Hot and Humid Climate: Evidence from Florida," with Sanem Sergici and Neil Lessem, presented at the International Energy Policy & Programme Evaluation Conference, November 2, 2017.
- "A Hybrid Model for Forecasting Electricity Sales and Peak Demand: A Case Study of TNB in Malaysia," with Sanem Sergici and Neil Lessem, presented at the International Energy Policy & Programme Evaluation Conference, November 2, 2017.
- "Workshop on Pricing Reforms," with Neil Lessem, Presented to Energy Networks Association (ENA), October 17, 2017.
- "A Walk on the Frontier of Rate Design," with Cody Warner, presented to the Western Farmers Electric Cooperative's Residential Demand Workshop, October 5, 2017.
- "The Future of Tariff Reform: A Global Survey," with Léa Grausz and Hallie Cramer, presented to the Indiana Energy Association's (IEA) Annual Energy Conference, September 28, 2017.
- "Forecasting the Impact of DSM on Energy Sales," with Zhen Wang, presented to the Edison Electric Institute (EEI), September 14, 2017.
- "A Global Survey of Customer-centric Tariff Reforms," with Neil Lessem, presented to the Commerce Commission, Wellington, New Zealand, August 24, 2017.
- "The Public Benefits of Leasing Energy Efficient Equipment: A Utility Case Study," with Henna Trewn and Neil Lessem, presented at the Center for Research in Regulated Industries' (CRRI) 30th Annual Western Conference, June 30, 2017.
- "Estimating the Impact of DSM on Energy Sales Forecasts: A Survey of Utility Practices," with James Hall and Zhen Wang, presented at the Center for Research in Regulated Industries' (CRRI) 30th Annual Western Conference, June 29, 2017.
- "Moving Forward with Tariff Reform," presented during the EEI Webinar on Rate Design, April 6, 2017.
- "An Irreverent Take on Customer Research in Our Industry," presented at the EPRI Workshop: Understanding Customer Preferences for and Adoption of New Services and Technology, April 4, 2017.
- "The Tariffs of Tomorrow," presented at the University of California, Davis Energy Efficiency Center Seminar, January 11, 2017.

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- "Residential Demand Charges, Distributional Effects and Energy Storage," with contributions from Ryan Hledik, presented during the Edison Electric Institute (EEI) Grid Talk Webinar, November 17, 2016.
- "Curating the Future of Rate Design," presented at the EUCI's Residential Demand Charges Conference, October 20, 2016.
- "Understanding Residential Customer Response to Demand Charges: Present and Future," with Sanem Sergici and Ryan Hledik, presented at EUCI's Residential Demand Charges Conference, October 20, 2016.
- "Technology's Role, Rates and Customers, 1985-2016," presented at the Wisconsin Public Utility Institute, August 16, 2016.
- "Dynamic Pricing & Demand Response," with Sanem Sergici, presented at IPU's 58th Annual Regulatory Studies Program: The Fundamentals Course, August 11, 2016.
- "Retail Costing and Pricing for Electricity," with Philip Q Hanser and Sanem Sergici, presented at IPU's 58th Annual Regulatory Studies Program: The Fundamentals Course, August 11, 2016.
- "Emerging Issues in Forecasting Energy Consumption," with Josephine Duh and Zhen Wang, Presented at the CRRI Western Conference 2016, June 24, 2016.
- "A Three-Year Impact Evaluation of TOU Rates in Ontario, Canada," with Neil Lessem, presented at the Center for Research in Regulated Industries (CRRI) 29th Annual Western Conference, June 23, 2016.
- "Capturing Smart Meter Enabled Benefits in System Wide Rollouts: June 23, 2016," presented at the Center for Research in Regulated Industries (CRRI) 29th Annual Western Conference, June 23, 2016.
- "Residential Rates for the Utility of the Future," presented at Grid Edge World Forum 2016, June 22, 2016.
- "Residential Rates for the Utility of the Future," presented to the Alternative Rate Design Stakeholder Process for Xcel Energy, May 13, 2016.
- "Modeling Customer Response to Xcel Energy's RD-TOU Rate," with Ryan Hledik, presented to Xcel Energy, April 21, 2016.
- "Residential Demand Charges: An Overview," presented at the EEI Rate Committee Meeting, March 15, 2016.
- "A Conversation about Standby Rates," presented to Standby Rate Working Group Michigan Public Service Commission, January 20, 2016.

- "Competitive Electricity Pricing Strategies: A California Perspective," with J. Robert Malko, and Philip R. Swensen, presented at the Fourteenth Annual Rate Symposium, sponsored by the Missouri Public Service Commission, the University of Missouri-Columbia and Utah Sate University, held in Kansas City, Missouri, February 1988.
- "Response of Residential Electric Loads to Time-of-Use Rates: Evidence from Eleven Pricing Experiments," with J. Robert Malko, presented at Midwest Economics Association Annual Meeting, Louisville, Kentucky, April 1981.

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UTILITY DIVE

DEEP DIVE

Duke-solar industry breakthrough settlement aims to end rooftop solar cost shift debates

Successor tariff deal reshapes solar with dynamic rates, demand response requirements

By Herman K. Trabish

Published Sept. 16, 2020

A landmark settlement between Duke Energy and distributed energy resources (DER) advocates in North and South Carolina could remake the rooftop solar sector and be a model for ending regulatory disputes across the country.

The proposal, released Sept. 16, could calm contention between utilities and solar advocates over the perceived "cost shift" some utilities and policymakers see as a subsidy for rooftop solar paid by non-solar-owning customers. The settlement would, if approved by Duke's North and South Carolina regulators, pair rooftop solar with smart DER devices and time-varying rate designs to add to the utility's demand response capability and give customers an incentive to help address the utility's peak demand challenges.

"This is a totally new framework that treats self-consumed solar paired with demand response as energy efficiency and includes rate design innovations in dynamic pricing," said Duke Energy Vice President for Rate Design and Strategic Solutions Lon Huber. "We eliminate the cost shift, but retain a vibrant solar market,

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which could be a paradigm-changing win in the national net metering debate."

Legislative and regulatory conflicts continue to increase nationally over replacing the retail rate net energy metering (NEM) tariff typically paid to solar owners for electricity exported to utility systems, said North Carolina Clean Energy Technology Center (NCCETC) Senior Policy Program Director Autumn Proudlove. "Some states have delayed action, but the approved changes have reduced compensation."

Successor tariff debates ultimately slow rooftop solar growth, according to Proudlove. But Duke and other utilities who see how customer-owned DER can cost-effectively help reduce peak demand and meet policy goals are working with stakeholders across the country on ways to take advantage of those DER investments without imposing costs on other customers.

The new proposal, developed in response to solar policy directives in South Carolina's 2019-enacted Act 62, and North Carolina's 2017-enacted House Bill 589 (HB589), can accomplish those objectives, according to representatives of Duke, Sunrun, Vote Solar, the Southern Environmental Law Center (SELC) and the North Carolina Sustainable Energy Association (NCSEA) who helped shape the settlement.

Fights over NEM

NEM compensates rooftop solar owners for the generation their arrays send to the grid, and is available in 40 U.S. states and Washington, D.C. Compensation is set at the same retail rate customers pay for electricity, unless successor tariffs are in place that adjust that compensation.

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NEM was deployed state by state to support early renewables growth. Retail rate compensation was a proxy for the value of the exported generation. Since at least 2013, utilities have complained about NEM to regulators, arguing its reduction in solar-owning customers' bills shifts system costs to the rest of the customer base. Solar advocates argue NEM benefits all utility customers by reducing operational costs.

The result is often-heated conflicts between utilities and solar advocates over a successor tariff that would theoretically represent the true value of distributed solar but prevent an undue shift of costs to non-solar-owning customers. The Duke settlement aims to eliminate some of those debates through rate design and smart technologies.

In many states, compensation debates "have been quite contentious" because utilities "want to reduce or eliminate the cost shift and have proposed compensation at avoided costs or wholesale rates," Proudlove said. Solar advocates are "realistic about coming changes," but want cost-benefit or value-of-solar studies to set a compensation that matches the value of their exported generation.

South Carolina's Act 62 required review of the retail rate NEM provision by regulators in 2021 and North Carolina's HB589 required a review by 2027. With successor tariff debates likely and Duke subsidiaries the dominant electricity providers in both states, it made sense for stakeholders to work toward a plan, NCSEA General Counsel Peter Ledford said.

The proposal, which the settlement partners described as "unprecedented" and "paradigm-changing," has special significance because solar has struggled in the Southeast, regulators have been and continue to be hard on NEM

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policies, and installed solar capacity has only recently begun to match the region's resource potential.

Southern Company subsidiary Alabama Power's retail rate is $0.1337/kWh, but based on concerns about a cost shift, pays solar owners only a regulator-approved $0.035/kWh for exported electricity, SELC reported in 2019. And, in July, the utility won regulatory approval for one of the region's "highest solar-specific monthly charges," said SELC Senior Attorney and Solar Power Initiative Leader Lauren Bowen.

In Florida, the 2019 regulatory approval of solar leasing, combined with the state's NEM, led to a boom in rooftop solar, Southern Alliance for Clean Energy (SACE) Energy Policy Attorney for Florida George Cavros reported Sept. 11. By the end of 2019, there were "nearly 60,000 customer-owned net-metered systems." But there was also a call for regulatory review of the NEM policy, Cavros reported.

"It is a pattern around the country," Bowen said. "At a certain rooftop solar penetration, the need for a variation on net metering is raised."

The North and South Carolina bills' requirements that retail rate NEM be reviewed make successor tariff debates likely and a new approach practical now, stakeholders said.

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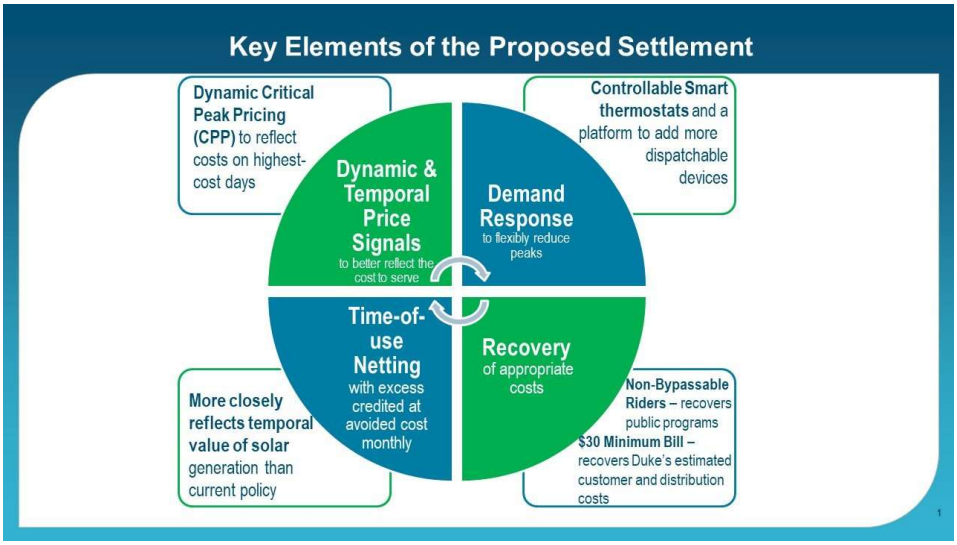

Permission granted by Duke-solar settlement group

A sustainable solution

The settlement participants see the new proposal as a sustainable way to end the NEM and successor tariff debates.

"Collaborations on successor tariffs often produce piecemeal, short-term agreements," Vote Solar Senior Regional Director and Regulatory Counsel Thad Culley said. "This proposal is a comprehensive and paradigm-changing solution and should hold up over the long term."

The settlement proposal brings together time-of-use (TOU) rates, critical peak pricing (CPP) and incentives for participation in Duke's demand response programs, Sunrun Director for Public Policy Tyson Grinstead said. "No one piece is the perfect solution, but the package as a whole preserves the critical underpinnings of net metering."

It offers an upfront rebate for adding a smart thermostat that Duke could use to shed or shift customer usage and manage peak demand, he added. Taken as a whole, the benefits would be "as good as with net metering," Grinstead said.

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The high-level Act 62 objectives required eliminating the cost shift, ensuring the solar market remain uninterrupted and offered the option of time-varying rates and other strategies, Huber said. "The settlement's combination of policy elements addresses those objectives and incorporates best practices for those options from other states into a scalable long-term framework."

The CPP and mandatory TOU rates send solar-owning customers improved price signals to reduce consumption when power prices are high, Huber said. "Along with monthly netting, solar owners will be able to maximize the value of self-consumption. A minimum bill, grid access fee, and non-bypassable charges assure that the cost of public programs and the grid are covered" without imposing costs on other customers.

Models of the settlement plan suggest a 92% or more reduction of the Duke-calculated cost shift from solar owners to non-solar-owners, Huber added. "The plan would increase solar owners' current average payback for their rooftop systems from 11 years to about 14 years, but with the demand response program incentives, it would likely come back in line with today's payback."

NCSEA has crunched the numbers, Ledford said. "This will not work for every customer in every situation, but we think the payback will make rooftop solar a good deal." Vote Solar's Culley agreed the plan "will offer good cost savings," if solar owners respond to price signals, and also noted it has a grandfathering provision that will protect current solar owners.

The plan's incentive will initially be available only to customers with smart thermostats, but eventually other flexible DERs will be eligible, Huber said. "If North Carolina and South Carolina regulators approve the proposal, customers' self-consumed solar and dispatchable demand response would be part

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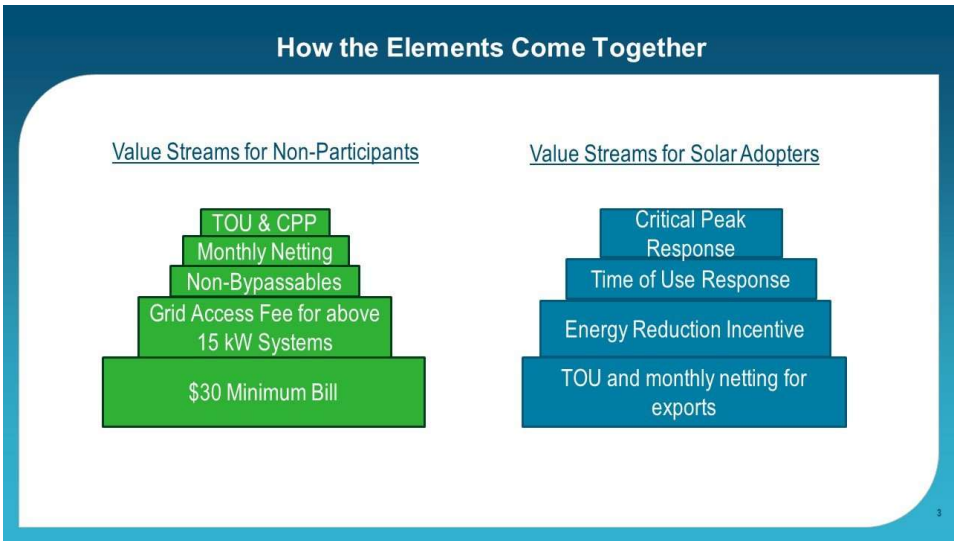
of Duke's 'shared savings' energy efficiency program, making rebates eligible for cost recovery," he added.

If that happens, the utility would be allowed to recover the same 10.6% of the net benefits from utility savings that is allowed for any other technology in Duke's energy efficiency program, he said. And that makes it "in shareholders' interest for Duke customers to add rooftop solar."

DER advocates defended the utility's cost recovery. It is an expenditure "that allows customers to invest their own capital to build a more distributed and reliable grid," Sunrun's Grinstead said. "That is a win-win."

Duke shareholders "should be able to earn on efficiency investments because it puts those investments on a level playing field with other capital investments that shareholders earn returns on," NCSEA's Ledford agreed. That is "a policy decision that was made in North Carolina 15 years ago and has played out well."



Permission granted by Duke-solar settlement group

Will regulators approve?

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The proposal now faces regulatory review from two commissions. "Duke's Carolinas system shares the costs of energy efficiency programs between the states, and both state commissions have to approve them," Huber said. Settlement partners are optimistic South Carolina regulators will approve because the proposal meets Act 62's objectives, but North Carolina approval is less certain, Huber said.

The energy efficiency provision is a key strength in North Carolina "because Duke has never had satisfactory visibility or control of DER on its system and that is a practical operational difficulty," NCSEA's Ledford said. This proposal resolves that because the smart thermostat provides visibility and some control over customer usage, protects the solar market's financial calculus, and protects and benefits customers not interested in solar, he added.

"It is too soon to say the North Carolina commission will approve it, but much of this has been negotiated between the utility and [solar] industry advocates who work in both states," Ledford said. "Opponents may not see this as a perfect solution, but once they look at the numbers, they will understand why it is a good compromise."

There are also uncertainties in South Carolina, said Grinstead, a former aide to Sen. Lindsey Graham, R-S.C. "Four new commissioners will be appointed to the seven-member commission by the legislature later this year and one of the first things they will take up is this settlement."

But the proposal meets Act 62's objectives, which will make approval more likely, VoteSolar's Culley said, agreeing with Huber. And in North Carolina, "if Duke and NCSEA agree on a settlement, as they did with HB589, it is likely to get approval."

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While Huber is cautiously optimistic about approval in the Carolinas, he is also looking ahead. "This can guide the rest of the country on how to look at rooftop solar, and how to move beyond our traditional way of separating rooftop solar from other demand-side resources."