BEFORE THE NORTH CAROLINA UTILITIES COMMISSION
DOCKET NO. E-100, SUB 158

In the Matter of:	**)**
Biennial Determination of Avoided	**)**
Cost Rates for Electric Utility	**)**
Purchases from Qualifying Facilities –	**)**
2018	**)**

DIRECT TESTIMONY OF
R. THOMAS BEACH
ON BEHALF OF
NORTH CAROLINA SUSTAINABLE ENERGY ASSOCIATION

I. INTRODUCTION

Q. PLEASE STATE YOUR NAME, TITLE, AND EMPLOYER.

A. My name is R. Thomas Beach. I am principal consultant of the consulting firm Crossborder Energy. My business address is 2560 Ninth Street, Suite 213A, Berkeley, California 94710.

Q. PLEASE STATE YOUR EDUCATIONAL AND OCCUPATIONAL EXPERIENCE.

A. My experience and qualifications are described in my *curriculum vitae*, attached here to as **Exhibit 1**. As reflected in my CV, I have more than 35 years of experience in the natural gas and electricity industries. I began my career in 1981 on the staff at the California Public Utilities Commission ("CPUC"), working on the implementation of the Public Utilities Regulatory Policies Act of 1978 ("PURPA"). Since 1989, I have had a private consulting practice on energy issues and have testified on numerous occasions before state regulatory commissions in eighteen states. My CV includes a list of the testimony that I have sponsored in various state regulatory proceedings concerning electric and gas utilities.

Q. PLEASE DESCRIBE MORE SPECIFICALLY YOUR EXPERIENCE ON AVOIDED COST ISSUES, PARTICULARLY AS THEY APPLY TO RENEWABLE AND DISTRIBUTED GENERATION PROJECTS.

A. In addition to working on the initial implementation of PURPA while on the staff at the CPUC, in private practice I have represented the full range of qualifying facility ("QF") technologies – both renewable small power producers as well as gas-fired cogeneration QFs – on avoided cost pricing issues before the utilities commissions in California, Oregon, Nevada, Montana, and North Carolina (in Docket No. E-100, Sub 140). With respect to the renewable generation issues under consideration in this case, I have testified on solar economics in Arizona, California, Colorado, Idaho, Massachusetts, Minnesota, New Hampshire, New Mexico, Oregon, and Virginia. Since 2013, I have co-authored cost-benefit studies of distributed solar generation ("DSG") in Arizona, Arkansas, California, New Hampshire, and North Carolina.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING?

A. I am testifying on behalf of North Carolina Sustainable Energy Association ("NCSEA"), an intervenor in this proceeding.

Q. HAVE YOU TESTIFIED PREVIOUSLY BEFORE IN FRONT OF THE NORTH CAROLINA UTILITIES COMMISSION?

A. Yes, I have. I testified for NCSEA in 2014 in Docket No. E-100, Sub 140, including preparing direct, response, and rebuttal testimony.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. The purpose of my testimony is to present NCSEA's position on a specific set of issues in this docket, as identified in the Commission's *Order Scheduling Evidentiary Hearing and Establishing Procedural Schedule* (Hearing Order) in this docket, issued April 24, 2019. The direct testimony and exhibits of the North Carolina utilities on these issues was filed on May 21, 2019. Finally, on May 21, 2019 Duke Energy Carolinas ("DEC"), Duke Energy Progress ("DEP"), and the

North Carolina Utilities Commission – Public Staff ("Public Staff") filed a *Stipulation of Partial Settlement Regarding Solar Integration Services Charge* ("Integration Stipulation"). This testimony will address the following issues in the Hearing Order:

c. Duke's Quantification of Ancillary Services Cost of Integrating QF Solar;

d. Duke's Proposed Solar Integration Charge "Average Cost" Rate Design and Biennial Update;

e. Dominion's Proposed Re-Dispatch Charge; and

f. NCSEA's and Public Staff's Proposals Related to Differing Ancillary Services Costs for Innovative QFs.

All of these issues are related to the costs of integrating higher amounts of solar generation into the systems of the North Carolina utilities. Finally, I will comment on the Integration Stipulation between DEC/DEP and the Public Staff.

Q. HAVE YOU PREVIOUSLY SUBMITTED INFORMATION AND ANALYSIS FOR THE RECORD IN THIS DOCKET?

A. Yes. On February 12, 2019 NCSEA submitted its initial comments in this docket, which included as Attachment 2 an affidavit that I prepared with a report (Report) on certain avoided cost issues under review in this case.

Q. WHAT INFORMATION DID YOU REVIEW IN PREPARING THIS TESTIMONY?

A. I have reviewed the North Carolina utilities' filings in this docket proposing their avoided cost rates to become effective in 2019, including the direct testimony and exhibits filed on May 21, 2019. I have also reviewed elements of their workpapers as well as their responses to certain discovery requests propounded by NCSEA and other parties, as documented in my Report and its workpapers. I also used additional documents and studies as listed in my Report and in this testimony, as well as the results of analyses performed by me or by my staff under my direction. That analytic work is discussed in my Report and available in my workpapers.

Q. PLEASE PROVIDE A SUMMARY OF YOUR TESTIMONY.

A. This testimony provides the Commission with a broader context in which to evaluate the proposals of the utilities to adopt integration charges that would be subtracted from the avoided cost rates paid to future QFs on their systems. The integration cost study that DEC and DEP submitted, for example, shows increasing integration costs per MWh of solar output, as solar penetration increases. However, the actual experience of system operators in states, such as California, with higher penetrations of solar than North Carolina do not substantiate the results of the DEC/DEP study, which is based on a simulation and not actual experience. This testimony presents data on the actual ancillary service costs experienced by the California Independent System Operator (CAISO), which shows that ancillary service costs have not changed over a period in which the amount of wind and solar resources integrated by the CAISO has increased nine-fold. Similarly, I discuss several traditional vertically-integrated utilities that each have performed a series of wind and solar integration studies as the penetration of these resources on their systems has grown, with successive studies showing declining integration costs per MWh of renewable output.

The broader context of actual experience with solar integration is that system operators and utilities in the U.S. are "learning by doing," and developing ways to integrate large amounts of wind and solar generation without increasing ancillary service costs. These techniques can include improved solar forecasting, better use of real-time data from solar facilities, and greater cooperation with neighboring utilities, including the trading of imbalances within the hour through new market mechanisms such as the Energy Imbalance Market ("EIM") that has been so successful in the western U.S. Further, as the penetration of renewables with zero variable costs increases, the impact is to unload marginal gas-fired resources that become available to provide ancillary services, increasing the supply and reducing the costs for such services.

Q. WHAT ARE YOUR RECOMMENDATIONS TO THE COMMISSION?

A. My primary recommendation is that the Commission should not adopt the integration charges proposed by DEC, DEP, and Virginia Electric and Power Company d/b/a Dominion Energy North Carolina ("DENC"). Any costs to integrate the growing penetration of solar resources in North Carolina will be offset by other benefits of these new resources that the utilities have not recognized, including lower market prices and avoided transmission and distribution capacity costs, as discussed in more detail in my previously-submitted Report. Instead of implementing an integration charge, the Commission should direct the utilities under its jurisdiction that operate balancing areas in North Carolina to study the benefits of forming an EIM with the nearby PJM Interconnection.

If the Commission does adopt an integration charge, existing and committed QFs should be exempt from the charge, and the charge should be capped at no more than what the Commission determines to be the average integration cost for this tranche of solar studied. This would recognize the experience that actual integration costs per MWh of solar output do not appear to increase with solar penetration, if the system operator takes proactive steps to minimize integration costs. Finally, if an integration charge is adopted, I support the direction of one provision of the stipulation on integration cost issues that the Public Staff and DEC/DEP filed on May 21, 2019 – the provision that would not apply an integration charge to any QF that materially reduces the need for additional ancillary services by using physical energy storage, contractual dispatch capabilities, or other innovative mechanisms. I recommend that the Commission provide more specific details on qualifying for this exemption so that prospective QFs understand the additional investment or operating constraints that will be required to qualify.

II. INTEGRATION ISSUES

Q. ALL OF THE ISSUES CITED ABOVE CONCERN THE INTEGRATION COST ANALYSES SUBMITTED BY DED/DEP AND DNCP. PLEASE EXPLAIN YOUR PERSPECTIVE ON THE INTEGRATION COST ISSUE.

A. My Report did not address the technical details of the utilities' integration cost studies. Instead, I focused on the broader contexts for these studies. North Carolina obviously is not the only state in the U.S. with a rapidly-growing penetration of renewable resources. As a result, there is a growing body of evidence on both the benefits and costs of integrating new renewables, as utilities and system operators have "learned by doing" in integrating growing fleets of wind and solar resources and as there is more evidence on the market impacts of these new resources with zero variable costs. The utilities' integration studies at best only examine one aspect of integrating solar resources – the impact on the utilities' ancillary service costs – and even then, the results are not consistent with the actual experience of utilities elsewhere in the U.S. that also are integrating large amounts of solar resources. In addition, as my Report emphasizes, the Commission also needs to consider the benefits of integrating distributed solar generation that are not included in avoided cost rates. The Astrapé study for DEC/DEP fails to quantify or consider these benefits. These benefits include:

- **Lower market prices.** It is widely acknowledged that the growth of zero-variable-cost renewables, plus lower natural gas prices, has resulted in a broad reduction in electric market prices that has undermined the economics of baseload coal and nuclear resources.[1] Avoided cost rates have declined steadily in North Carolina for the last three years, due in significant part to lower natural gas and electric market prices. The studies cited in my Report indicate that the current penetration of renewables

[1] In https://ei.haas.berkeley.edu/research/papers/WP292.pdf, James Bushnell and Kevin Novan of the University of California at Davis find that renewable investment in California has been responsible for the majority of price declines in the California Independent System Operator's (CAISO) energy market over the last five years. Similarly, Lawrence Berkeley National Laboratory (LBNL) researchers have identified significant impacts on wholesale market prices from increasing penetration of renewables; see, http://eta-publications.lbl.gov/sites/default/files/report_pdf_0.pdf. MIT's Paul Joskow has also written about the impacts of rapid wind and solar penetration on wholesale markets, and the resulting challenges of retaining existing generators through market incentives alone; see https://economics.mit.edu/files/16650.

could easily account for a 4% reduction in energy market prices in the state, which would substantially offset the proposed solar integration charge.[2]

- **Avoided transmission and distribution capacity costs**, as discussed at length in Section III.C of my Report.

These benefits will more than offset any integration costs.

A. Learning by Doing

Q. PLEASE DISCUSS WHY THE UTILITIES' STUDIES ARE INCONSISTENT WITH THE ACTUAL OBSERVED COSTS OF INTEGRATING A HIGH PENETRATION OF SOLAR RESOURCES.

A. The DEC/DEP study from Astrape is based entirely on production cost simulations of each utility's individual control area, adding must-take solar generation to each utility's existing portfolios of on-system resources. The utilities have not introduced evidence of what their actual ancillary service costs are today or of how those costs have been impacted, if at all, by the growing amounts of solar generation on their systems. These simulation studies do not consider ways in which the utilities may adapt their system operations to minimize the cost of integrating solar generation – steps that can include improved solar forecasting, better use of real-time data from solar facilities, and greater cooperation with neighboring utilities (including the greater trading of imbalances within the hour). In fact, nothing that

---

[2] A 4% reduction in energy market prices in the range of $30 to $40 per MWh would substantially reduce or eliminate the integration costs proposed by DEC ($1.10 per MWh) and DEP ($2.39 per MWh). Four percent is the level of the market price suppression benefit of solar calculated from studies in the market of the New England Independent System Operator, as discussed on page 19, footnotes 36 and 37, of my Report.

Duke has provided in this proceeding exhibits its own efforts to mitigate intermittency issues on the grid, and, instead, pushes the entirety of the cause and the proposed solution onto future QF developers.

Nor do the utility studies recognize or consider that the changes in the avoided cost rate design that may result from this proceeding – shifting the peak avoided costs into late summer afternoons and winter mornings – will result in an increased use of solar tracking systems and storage. The addition of these technologies will reduce the variability of solar output and allow a significant portion of solar output to be dispatched into the time-of-use periods when power is most valuable to the system. The Commission should not adopt integration cost studies premised on an erroneous assumption that the solar to be built in the future in North Carolina will resemble the solar that has been installed to date.

Q. CAN YOU PROVIDE EVIDENCE OF A STATE WITH A LARGE PENETRATION OF SOLAR RESOURCES THAT HAS NOT EXPERIENCED SIGNIFICANT INTEGRATION COSTS?

A. Yes. Today, California has 20,000 MW of installed solar on the grid of the California Independent System Operator (CAISO) plus 6,700 MW of wind. Of the 20,000 MW of solar on the CAISO system, 12,000 MW are wholesale, utility-scale projects and 8,000 MW are behind-the-meter solar installed by almost one million utility customers.[3] The recent annual peak demands on the CAISO grid have been

[3] See, http://www.caiso.com/informed/Pages/CleanGrid/default.aspx. The data on behind-the-meter solar is from https://www.californiadgstats.ca.gov/.

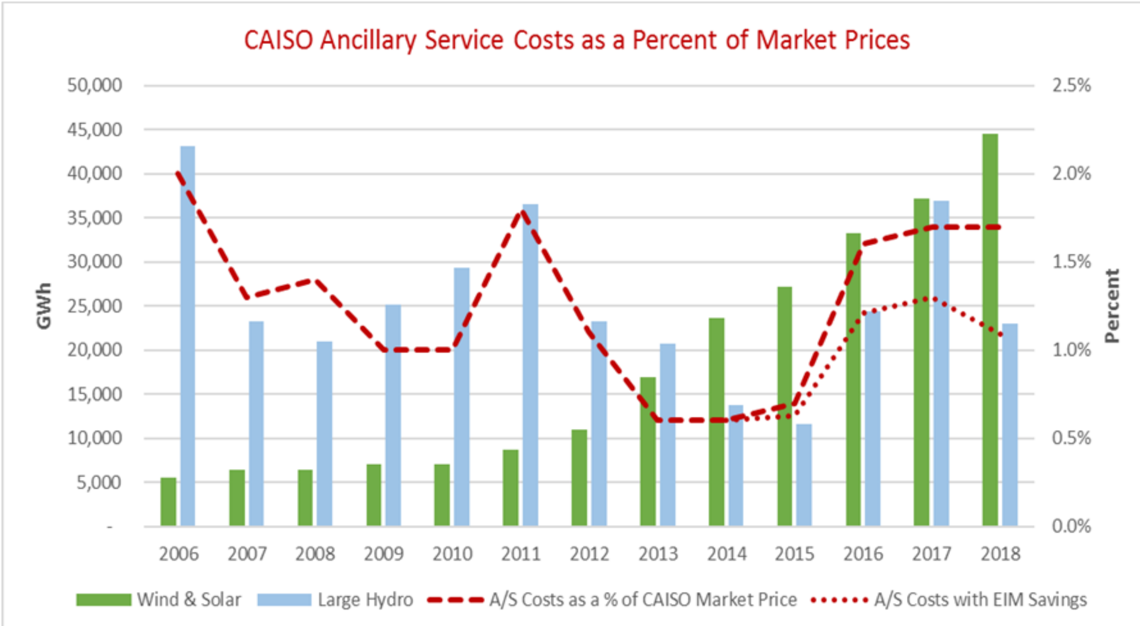
in the range of 46,000 to 50,000 MW.[4] Wind and solar now supply about one-quarter (25%) of the electricity on the CAISO system.[5] This is a much higher penetration of wind and solar than exists in North Carolina today or than has been modeled for North Carolina in any of the scenarios examined in this case.[6] The CAISO has integrated this high penetration of wind and solar resources without a discernable increase in its costs for ancillary services, which it obtains from a market for those services. **Figure 1** below shows the history of ancillary service costs on the CAISO system from 2006-2018 (red dashed line), expressed as a percentage of the CAISO energy market costs in each year. The figure also shows the growth of wholesale wind and solar generation in California (green bars); these resources have increased nine-fold (from about 5,000 GWh/year in 2006 to 45,000 GWh per year in 2018).[7] Ancillary service costs for the CAISO have fluctuated between 0.5% to 2.0% of CAISO energy market costs over this period.[8] The primary cause for these fluctuations has been the availability of large hydro resources (blue bars). Ancillary service costs increase in wet years when hydro generation is abundant (such as 2011 and 2017), because hydro resources are

[4] See, http://www.caiso.com/Documents/CaliforniaISOPeakLoadHistory.pdf.
[5] This includes about 19% of the wholesale generation and 6% of loads served by on-site solar.
[6] The DEC/DEP Astapé study modeled a maximum of 3,020 MW of solar on DEC and 4,610 MW of solar on DEP, for a total of 7,630 MW on a system with a coincident peak of about 32,000 MW. See DEC/DEP Direct Testimony (Wintermantel), at Figure 2. This is similar to the penetration of wholesale solar on the CAISO system today, but the CAISO also integrates 8,000 MW of grid-connected, behind-the-meter solar.
[7] From the California Energy Commission's website with power source data for California: https://www.energy.ca.gov/almanac/electricity_data/total_system_power.html. Note that this is wholesale generation, and does not include the generation from on-site, behind-the-meter solar, which supplied approximately 15,000 GWh per year of load in 2018.
[8] Data on ancillary service costs as a percentage of CAISO energy market costs is from the CAISO's *Annual Report on Market Issues and Performance* over this period. These reports can be accessed on the CAISO website at http://www.caiso.com/market/Pages/MarketMonitoring/AnnualQuarterlyReports/Default.aspx.

operated to produce energy rather than to supply ancillary services. In dry years, when hydro production is low, the hydro operators participate more actively in the ancillary services market because that is the best way to maximize the revenue from the limited water stored behind the dams. As a result, in those years ancillary service costs fall, as shown by the low ancillary service costs during the recent drought years of 2014-2015. Thus, as Figure 1 shows, ancillary service costs are strongly correlated with hydro conditions.

However, there has not been a discernable trend toward higher ancillary service costs despite the glaring fact that wind and solar generation *has grown by a factor of nine*. The dotted red line in Figure 1 for 2014-2018 shows the CAISO's ancillary service costs in these years including the CAISO's share of the intra-hour savings in balancing costs from the western Energy Imbalance Market ("EIM"). The EIM savings have reduced significantly the CAISO's costs to operate the California grid, even as the penetration of wind and solar has reached new highs and continues to grow.

Figure 1



Including the EIM savings, the CAISO's ancillary service costs over the last five years have averaged 1.0% of energy market costs; this is below the long-term average (2006-2018) of 1.2% of energy market costs. Thus, there is no evidence that the high penetration of wind and solar resources that the CAISO system has integrated in recent years has increased ancillary service costs. Although the California Public Utilities Commission began a process to develop wind and solar integration charges, it has not seen the need to complete that process and permanently adopt such charges.[9]

In early 2006, the CAISO increased the amount of regulation that it purchases, from 300-400 MW to 600 MW (in both directions), due to a concern

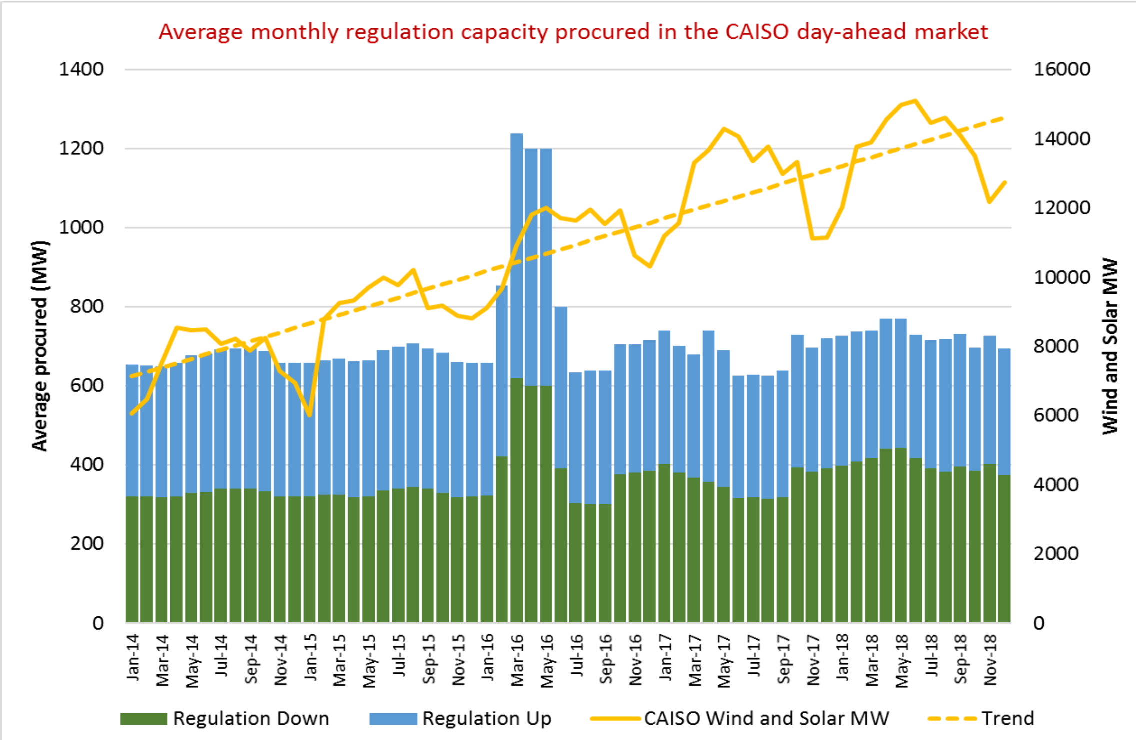
[9] The California commission has had a series of rulemaking proceedings to administer the state's Renewable Portfolio Standard ("RPS") program. The rulemaking initiated in 2015 (R. 15-02-020) included as an issue the continuing development of integration cost adders (see R. 15-02-020, at p. 6), but this issue was dropped in the next RPS rulemaking initiated in 2018 (R. 18-07-003).

with the increasing amounts of variable wind and solar generation. This increase in regulation accounts for part of the increase in ancillary service costs in 2016 over 2015 shown in Figure 1 (the rest of that increase appears due to wetter hydro conditions). However, after a few months in 2016 the CAISO refined its algorithm for the amount of regulation that it procures, and has been able to return to the use of just 300-400 MW of regulation, even with the steady increase in wind and solar resources over the last five years. This data on the CAISO's procurement of regulation from 2014-2018 is shown in **Figure 2** below.[10] This is another example of the "learning by doing" that is enabling system operators to minimize the integration costs associated with growing penetrations of variable renewables.

---

[10] The regulation up and down quantities are day-ahead procurement data from the CAISO's monthly market performance reports, at http://www.caiso.com/market/Pages/ReportsBulletins/Default.aspx. For example, Table 6 at page 16 or 45 of the CAISO's December 2018 monthly report is at http://www.caiso.com/Documents/MarketPerformanceReportforDecember2018.pdf. The wind and solar output data are monthly maximums of hourly CAISO wind and solar outputs (to show a measure of the amount of wind and solar capacity), from the CAISO's renewables watch output data files, which are available at http://www.caiso.com/market/Pages/ReportsBulletins/RenewablesReporting.aspx.

Figure 2



Q. ARE YOU AWARE OF TRADITIONAL, VERTICALY-INTEGRATED UTILITIES THAT HAVE PERFORMED A SERIES OF WIND OR SOLAR INTEGRATION STUDIES OVER TIME, AS THE PENETRATION OF WIND OR SOLAR RESOURCES ON THEIR SYSTEMS HAS INCREASED?

A. Yes. Both PacifiCorp and Idaho Power have performed several solar or wind integration studies over time, as these utilities have added significant amounts of these renewable resources to their systems.

The following **Tables 1 and 2** summarize these studies, which generally show that integration cost estimates have declined over time, even as more renewables have been added by these traditional utilities.

Table 1: *PacifiCorp Integration Costs ($ per MWh)*[11]

Resource	Date of Study		
	2012	**2014**	**2017**
Wind	$2.55	$3.06	$0.44
Solar	n/a	n/a	$0.60
	Resources (MW)		
Wind	2,126	2,543	2,793
Solar	n/a	n/a	1,000

Table 2: *Idaho Power Integration Costs ($ per MWh)*[12]

Resource	Date of Study	
	2014	**2016**
Solar	0-100 MW: $0.40 0-300 MW: $1.20 0-500 MW: $1.80 0-700 MW: $2.50	0-400 MW: $0.27 0-800 MW: $0.57 0-1,200 MW: $0.69 0-1,600 MW: $0.85
	Resources (MW)	
Solar	0	325

There are a variety of factors that account for the much lower integration costs in the most recent PacifiCorp and Idaho Power studies, including (a) methodological improvements, (b) reduced market prices, and (c) the increased availability of regulation-capable gas-fired resources displaced by new renewables. Significantly, the most recent studies from both PacifiCorp and Idaho Power included review by a technical review committee of outside experts from institutions such as the National Renewable Energy Laboratory ("NREL"), the Western Renewable Energy Generation Information System ("WREGIS"), and the Utility Wind Interest

---

[11] The 2012 and 2014 wind integration costs are from PacifiCorp's 2015 Integrated Resource Plan (IRP), at Appendix H, Table H.3. The 2017 wind integration costs are from PacifiCorp's 2017 IRP, Volume II, at Appendix F, pp. 120-123, esp. Tables F.14 and F.16.

[12] For the 2014 results, see Idaho Power, Direct Testimony of Philip B. Devol, Idaho PUC Case No. IPC-E-14-18 (July 1, 2014), at p. 5. For the 2016 solar integration costs, see Idaho Power, *Solar Integration Study Report*, (April 2016), at pp. vi and 21, esp. Tables 2 and 9.

Group ("UWIG").[13] Idaho Power also reached a settlement with stakeholders concerning the design of its most recent integration study.[14] DEC and DEP did not take either step in preparing their integration study for this proceeding. I recommend that the Commission require stakeholder consultation and a technical review group for any future integration studies. Finally, I note that the most recent PacifiCorp and Idaho Power studies do not include consideration of the intra-hour balancing savings that both PacifiCorp and Idaho Power are realizing in the western EIM, which are further reducing their intra-hour costs for the load following resources needed to integrate renewables. As discussed in greater detail below, a market of this type applied in the Carolinas could result in significant benefits for Duke and its ratepayers.

B. No Utility Is An Island

Q. ONE OF YOUR CENTRAL CRTIQUES OF THE DEC/DEP INTEGRATION STUDY IS ITS ASSUMPTION THAT DEC AND DEP ARE INDIVIDUAL BALANCING AREAS NOT CONNECTED TO THE REST OF THE EASTERN INTERCONNECTION. IN RESPONSE, THE DUKE UTILITIES RE-RAN THE STUDY FOR THE COMBINATION OF BOTH DEC AND DEP, IN OTHER WORDS, RECOGNIZING THAT THEY ARE INTERCONNECTED AND HAVE A JOINT OPERATING AGREEMENT. PLEASE COMMENT ON THE RESULTS OF THIS NEW ANALYSIS.

[13] See the 2017 PacifiCorp and 2016 Idaho Power studies referenced in footnotes 10 and 11.
[14] See the stipulation approved by the Idaho PUC in Order No. 33227 in February 2015 (Case No. IPC-E-14-18).

A. Not surprisingly, integration costs dropped by about 15% when the two utilities were analyzed together.[15] This demonstrates, on a small scale, what the EIM is demonstrating across the entire Western Interconnection – the costs of integrating renewables decline when utilities cooperate to integrate renewables across as wide a footprint as possible. I fully expect that integration costs would decline further if other adjacent utilities were added and if those utilities cooperated to reduce load following costs on a mutually-beneficial basis. It is my understanding that Duke is already in the business of making market purchases and sales with neighboring utilities, so there should be a pathway via those relationships to working with these neighboring utilities to reduce intra-hour balancing costs.

Q. DEC AND DEP DISMISS NCSEA'S COMMENTS ON THE BENEFITS OF AN EIM BECAUSE "NO SUCH MARKET CONSTRUCT EXISTS ACROSS THE ENTIRE EASTERN INTERCONNECTION."[16] PLEASE COMMENT.

A. No such market exists because utilities and system operators have not taken the initiative to create one, and because regulators have yet to encourage them to create the market construct needed to realize these ratepayer savings. The western EIM began with an agreement in 2014 between just the CAISO and PacifiCorp, but since then has spread across almost the entire Western Interconnection and now includes utilities in every state in the WECC except Colorado and Texas. There are several important reasons for the success and rapid spread of the western EIM:

---

[15] DEC/DEP Reply Comments, at pp. 92-94.
[16] *Ibid.*, at p. 90.

- First and foremost, since its inception, **the EIM has saved money for every participating utility.** These benefits are not "anecdotal," as DEC/DEP assert;[17] they are tracked and documented by the EIM participants in quarterly reports.[18] The cumulative benefits to EIM participants have reached $650 million as of the end of the first quarter of 2019.[19]
- The EIM is an overlay on, and does not change, traditional hourly scheduling processes. Each balancing area continues to be run by the existing operator.
- The EIM can be used by balancing areas and system operators that operate under a variety of market and regulatory structures. Western EIM participants include investor-owned utilities, publicly-owned utilities, and an independent system operator that are located across ten states and a Canadian province.
- The EIM is simply a balancing mechanism that seeks out beneficial trades of resources within the hour to reduce balancing and load following costs for participants and to decrease renewable curtailments. This is "found money" for all participants, who now have a means to seek out and resolve inefficiencies in the intra-hour dispatch of their resources.

---

[17] *Ibid.*
[18] See, https://www.westerneim.com/Pages/About/QuarterlyBenefits.aspx.
[19] See, https://www.westerneim.com/Pages/About/QuarterlyBenefits.aspx.

I note the recent announcement that the Southwest Power Pool (SPP) is planning to form an EIM on its footprint.[20] The western EIM in the WECC plus this new EIM in SPP would provide access to an EIM for utilities in the entire western half of the U.S. Clearly, there are system operators in the East, such as the PJM Interconnection, that have the experience and technical expertise to run an EIM. The Duke utilities would be logical partners to start an EIM with PJM given the growth of solar resources in North Carolina (and of both wind and solar elsewhere in the East) and the clear need to maximize the efficiency of intra-hour dispatch to address renewable variability. I expect that there will be interest in joining such an EIM from other utilities in the South, such as Georgia Power, that have seen significant solar development in their service territories. It is my recommendation that, in lieu of implementing an integration charge on solar QFs, this Commission should direct the utilities under its jurisdiction that run balancing areas in North Carolina to study the benefits of forming an EIM with the nearby PJM system.

[20] See, https://www.spp.org/newsroom/press-releases/spp-proposes-western-energy-imbalance-service-market-to-bring-cost-savings-and-grid-modernization-to-the-west/.

C. Stipulation on Integration Costs

Q. PLEASE ADDRESS THE STIPULATION ON INTEGRATION COST ISSUES THAT THE PUBLIC STAFF AND DEC/DEP FILED ON MAY 21, 2019.

A. The principal issues with this stipulation are (1) it fails to address the benefits of renewables that offset any integration costs and (2) it accepts the flawed DEC/DEP integration cost study that assumes the Duke utilities are islands and is based on inaccurate solar modeling (as discussed in the report "Modeling the Impact of Solar Energy on the System Load and Operations of Duke Energy Carolinas and Duke Energy Progress" attached to NCSEA's initial comments). Beyond those concerns, the stipulation is positive in exempting existing and committed QFs (i.e. those that committed to sell before November 1, 2018 or that bid into the CPRE Tranche 1 RFP) and in capping the integration charge so that prospective QFs have certainty in the integration costs that they will face during the term of their contract. However, it is inappropriate to cap the integration charge at the level of the calculated incremental cost for integrating the last 100 MW of solar additions, instead of at the level of the average integration charge for the whole tranche of solar studied. These caps of $3.22 per MWh for DEC and $6.70 per MWh for DEP are far too high and well above, to my knowledge, the solar integration charges adopted elsewhere in the U.S. As I have discussed above, the experience elsewhere has been that integration costs fall over time, as utilities gain experience operating their systems with higher penetrations of renewables and implement new forecasting, operating, and market processes to minimize those costs. Further, the growth of renewables will displace energy from flexible, gas-fired resources, which will increase the supply (and thus lower the cost) of resources available to provide the load following capacity and ancillary services needed to integrate renewables. As a result, the integration charge, if one is adopted, should be capped at no more than the average integration cost for this tranche of solar studied, that is, at $1.10 per MWh for DEC and $2.39 per MWh for DEP based on the Astrapé study (or at whatever lower average integration cost the Commission adopts after review of the critiques of that study).

Q. IS THE STIPULATION CONSISTENT WITH NCSEA'S PROPOSAL WITH RESPECT TO "DIFFERING ANCILLARY SERVICES COSTS FOR INNOVATIVE QFS"?

A. The stipulation proposes that the integration charge should apply prospectively to new solar QFs "unless those solar generators can demonstrate that the facility is capable of operating, and shall contractually agree to operate, in a manner that materially reduces or eliminates the need for additional ancillary services requirements (as reasonably determined by the Companies) through inclusion of energy storage devices, dispatchable contracts, or other mechanisms that materially reduce or eliminate the intermittency of the output from the solar generators ("controllable solar generators")."

This provision is headed in the right direction, in my opinion, but lacks needed specificity so that prospective QFs understand more precisely the requirements necessary to avoid the integration charge. For example, my Report recommended that solar projects that include significant storage (a four-hour discharge capacity equal to at least 50% of the AC solar nameplate) should not be assessed integration costs. The Commission also should recognize that the new peak periods and structure for avoided cost rates are likely to result in less variability and more control in solar output even without explicit requirements, as generators add storage and dispatchability in response to the new pricing periods.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

BEFORE THE NORTH CAROLINA UTILITIES COMMISSION
DOCKET NO. E-100, SUB 158

In the Matter of:	)	
Biennial Determination of Avoided Cost	)	**DIRECT TESTIMONY OF**
Rates for Electric Utility Purchases from	)	**R. THOMAS BEACH**
Qualifying Facilities – 2018	)	
	)	

Exhibit 1

Mr. Beach is principal consultant with the consulting firm Crossborder Energy. Crossborder Energy provides economic consulting services and strategic advice on market and regulatory issues concerning the natural gas and electric industries. The firm is based in Berkeley, California, and its practice focuses on the energy markets in California, the U.S., and Canada.

Since 1989, Mr. Beach has had an active consulting practice on policy, economic, and ratemaking issues concerning renewable energy development, the restructuring of the gas and electric industries, the addition of new natural gas pipeline and storage capacity, and a wide range of issues concerning independent power generation. From 1981 through 1989 he served at the California Public Utilities Commission, including five years as an advisor to three CPUC commissioners. While at the CPUC, he was a key advisor on the CPUC's restructuring of the natural gas industry in California, and worked extensively on the state's implementation of the Public Utilities Regulatory Policies Act of 1978.

AREAS OF EXPERTISE

- *Renewable Energy Issues:* extensive experience assisting clients with issues concerning Renewable Portfolio Standard programs, including program structure and rate impacts. He has also worked for the solar industry on rate design and net energy metering issues, on the creation of the California Solar Initiative, as well as on a wide range of solar issues in many other states.

- *Restructuring the Natural Gas and Electric Industries:* consulting and expert testimony on numerous issues involving the restructuring of the electric industry, including the 2000 - 2001 Western energy crisis.

- *Energy Markets:* studies and consultation on the dynamics of natural gas and electric markets, including the impacts of new pipeline capacity on natural gas prices and of electric restructuring on wholesale electric prices.

- *Qualifying Facility Issues:* consulting with QF clients on a broad range of issues involving independent power facilities in the Western U.S. He is one of the leading experts in California on the calculation of avoided cost prices. Other QF issues on which he has worked include complex QF contract restructurings, standby rates, greenhouse gas emission regulations, and natural gas rates for cogenerators. Crossborder Energy's QF clients include the full range of QF technologies, both fossil-fueled and renewable.

- *Pricing Policy in Regulated Industries:* consulting and expert testimony on natural gas pipeline rates and on marginal cost-based rates for natural gas and electric utilities.

EDUCATION

Mr. Beach holds a B.A. in English and physics from Dartmouth College, and an M.E. in mechanical engineering from the University of California at Berkeley.

ACADEMIC HONORS

Graduated from Dartmouth with high honors in physics and honors in English.
Chevron Fellowship, U.C. Berkeley, 1978-79

PROFESSIONAL ACCREDITATION

Registered professional engineer in the state of California.

EXPERT WITNESS TESTIMONY BEFORE THE CALIFORNIA PUBLIC UTILITIES COMMISSION

1. Prepared Direct Testimony on Behalf of **Pacific Gas & Electric Company/Pacific Gas Transmission** (I. 88-12-027 — July 15, 1989)

   - *Competitive and environmental benefits of new natural gas pipeline capacity to California.*

2. a. Prepared Direct Testimony on Behalf of the **Canadian Producer Group** (A. 89-08-024 — November 10, 1989)
   b. Prepared Rebuttal Testimony on Behalf of the **Canadian Producer Group** (A. 89-08-024 — November 30, 1989)

   - *Natural gas procurement policy; gas cost forecasting.*

3. Prepared Direct Testimony on Behalf of the **Canadian Producer Group** (R. 88-08-018 — December 7, 1989)

   - *Brokering of interstate pipeline capacity.*

4. Prepared Direct Testimony on Behalf of the **Canadian Producer Group** (A. 90-08-029 — November 1, 1990)

   - *Natural gas procurement policy; gas cost forecasting; brokerage fees.*

5. Prepared Direct Testimony on Behalf of the **Alberta Petroleum Marketing Commission and the Canadian Producer Group** (I. 86-06-005 — December 21, 1990)

   - *Firm and interruptible rates for noncore natural gas users*

6. a. Prepared Direct Testimony on Behalf of the **Alberta Petroleum Marketing Commission** (R. 88-08-018 — January 25, 1991)
   b. Prepared Responsive Testimony on Behalf of the **Alberta Petroleum Marketing Commission** (R. 88-08-018 — March 29, 1991)

   - *Brokering of interstate pipeline capacity; intrastate transportation policies.*

7. Prepared Direct Testimony on Behalf of the **Canadian Producer Group** (A. 90-08-029/Phase II — April 17, 1991)

   - *Natural gas brokerage and transport fees.*

8. Prepared Direct Testimony on Behalf of **LUZ Partnership Management** (A. 91-01-027 — July 15, 1991)

   - *Natural gas parity rates for cogenerators and solar thermal power plants.*

9. Prepared Joint Testimony of R. Thomas Beach and Dr. Robert B. Weisenmiller on Behalf of the **California Cogeneration Council** (I. 89-07-004 — July 15, 1991)

   - *Avoided cost pricing; use of published natural gas price indices to set avoided cost prices for qualifying facilities.*

10. a. Prepared Direct Testimony on Behalf of the **Indicated Expansion Shippers** (A. 89-04-033 — October 28, 1991)
    b. Prepared Rebuttal Testimony on Behalf of the **Indicated Expansion Shippers** (A. 89-04-0033 — November 26,1991)

    - *Natural gas pipeline rate design; cost/benefit analysis of rolled-in rates.*

11. Prepared Direct Testimony on Behalf of the **Independent Petroleum Association of Canada** (A. 91-04-003 — January 17, 1992)

    - *Natural gas procurement policy; prudence of past gas purchases.*

12. a. Prepared Direct Testimony on Behalf of the **California Cogeneration Council** (I.86-06-005/Phase II — June 18, 1992)
    b. Prepared Rebuttal Testimony on Behalf of the **California Cogeneration Council** (I. 86-06-005/Phase II — July 2, 1992)

    - *Long-Run Marginal Cost (LRMC) rate design for natural gas utilities.*

13. Prepared Direct Testimony on Behalf of the **California Cogeneration Council** (A. 92-10-017 — February 19, 1993)

    - *Performance-based ratemaking for electric utilities.*

14. Prepared Direct Testimony on Behalf of the **SEGS Projects** (C. 93-02-014/A. 93-03-053 — May 21, 1993)

    - *Natural gas transportation service for wholesale customers.*

15 a. Prepared Direct Testimony on Behalf of the **Canadian Association of Petroleum Producers** (A. 92-12-043/A. 93-03-038 — June 28, 1993)
   b. Prepared Rebuttal Testimony of Behalf of the **Canadian Association of Petroleum Producers** (A. 92-12-043/A. 93-03-038 — July 8, 1993)

    - *Natural gas pipeline rate design issues.*

16. a. Prepared Direct Testimony on Behalf of the **SEGS Projects** (C. 93-05-023 — November 10, 1993)
    b. Prepared Rebuttal Testimony on Behalf of the **SEGS Projects** (C. 93-05-023 — January 10, 1994)

    - *Utility overcharges for natural gas service; cogeneration parity issues.*

17. Prepared Direct Testimony on Behalf of the **City of Vernon** (A. 93-09-006/A. 93-08-022/A. 93-09-048 — June 17, 1994)

    - *Natural gas rate design for wholesale customers; retail competition issues.*

18. Prepared Direct Testimony of R. Thomas Beach on Behalf of the **SEGS Projects** (A. 94-01-021 — August 5, 1994)

    - *Natural gas rate design issues; rate parity for solar thermal power plants.*

19. Prepared Direct Testimony on Transition Cost Issues on Behalf of **Watson Cogeneration Company** (R. 94-04-031/I. 94-04-032 — December 5, 1994)

    - *Policy issues concerning the calculation, allocation, and recovery of transition costs associated with electric industry restructuring.*

20. Prepared Direct Testimony on Nuclear Cost Recovery Issues on Behalf of the **California Cogeneration Council** (A. 93-12-025/I. 94-02-002 — February 14, 1995)

    - *Recovery of above-market nuclear plant costs under electric restructuring.*

21. Prepared Direct Testimony on Behalf of the **Sacramento Municipal Utility District** (A. 94-11-015 — June 16, 1995)

    - *Natural gas rate design; unbundled mainline transportation rates.*

22. Prepared Direct Testimony on Behalf of **Watson Cogeneration Company** (A. 95-05-049 — September 11, 1995)

    - *Incremental Energy Rates; air quality compliance costs.*

23. a. Prepared Direct Testimony on Behalf of the **Canadian Association of Petroleum Producers** (A. 92-12-043/A. 93-03-038/A. 94-05-035/A. 94-06-034/A. 94-09-056/A. 94-06-044 — January 30, 1996)
    b. Prepared Rebuttal Testimony on Behalf of the **Canadian Association of Petroleum Producers** (A. 92-12-043/A. 93-03-038/A. 94-05-035/A. 94-06-034/A. 94-09-056/A. 94-06-044 — February 28, 1996)

    - *Natural gas market dynamics; gas pipeline rate design.*

24. Prepared Direct Testimony on Behalf of the **California Cogeneration Council and Watson Cogeneration Company** (A. 96-03-031 — July 12, 1996)

    - *Natural gas rate design: parity rates for cogenerators.*

25. Prepared Direct Testimony on Behalf of the **City of Vernon** (A. 96-10-038 — August 6, 1997)

    - *Impacts of a major utility merger on competition in natural gas and electric markets.*

26. a. Prepared Direct Testimony on Behalf of the **Electricity Generation Coalition** (A. 97-03-002 — December 18, 1997)
    b. Prepared Rebuttal Testimony on Behalf of the **Electricity Generation Coalition** (A. 97-03-002 — January 9, 1998)

    - *Natural gas rate design for gas-fired electric generators.*

27. Prepared Direct Testimony on Behalf of the **City of Vernon** (A. 97-03-015 — January 16, 1998)

    - *Natural gas service to Baja, California, Mexico.*

28. a. Prepared Direct Testimony on Behalf of the **California Cogeneration Council and Watson Cogeneration Company** (A. 98-10-012/A. 98-10-031/A. 98-07-005 — March 4, 1999).
    b. Prepared Direct Testimony on Behalf of the **California Cogeneration Council** (A. 98-10-012/A. 98-01-031/A. 98-07-005 — March 15, 1999).
    c. Prepared Direct Testimony on Behalf of the **California Cogeneration Council** (A. 98-10-012/A. 98-01-031/A. 98-07-005 — June 25, 1999).

    - *Natural gas cost allocation and rate design for gas-fired electric generators.*

29. a. Prepared Direct Testimony on Behalf of the **California Cogeneration Council and Watson Cogeneration Company** (R. 99-11-022 — February 11, 2000).
    b. Prepared Rebuttal Testimony on Behalf of the **California Cogeneration Council and Watson Cogeneration Company** (R. 99-11-022 — March 6, 2000).
    c. Prepared Direct Testimony on Line Loss Issues of behalf of the **California Cogeneration Council** (R. 99-11-022 — April 28, 2000).
    d. Supplemental Direct Testimony in Response to ALJ Cooke's Request on behalf of the **California Cogeneration Council and Watson Cogeneration Company** (R. 99-11-022 — April 28, 2000).
    e. Prepared Rebuttal Testimony on Line Loss Issues on behalf of the **California Cogeneration Council** (R. 99-11-022 — May 8, 2000).

    - *Market-based, avoided cost pricing for the electric output of gas-fired cogeneration facilities in the California market; electric line losses.*

30. a. Direct Testimony on behalf of the **Indicated Electric Generators** in Support of the Comprehensive Gas OII Settlement Agreement for Southern California Gas Company and San Diego Gas & Electric Company (I. 99-07-003 — May 5, 2000).
    b. Rebuttal Testimony in Support of the Comprehensive Settlement Agreement on behalf of the **Indicated Electric Generators** (I. 99-07-003 — May 19, 2000).

    - *Testimony in support of a comprehensive restructuring of natural gas rates and services on the Southern California Gas Company system. Natural gas cost allocation and rate design for gas-fired electric generators.*

31. a. Prepared Direct Testimony on the Cogeneration Gas Allowance on behalf of the **California Cogeneration Council** (A. 00-04-002 — September 1, 2000).
    b. Prepared Direct Testimony on behalf of **Southern Energy California** (A. 00-04-002 — September 1, 2000).

    - *Natural gas cost allocation and rate design for gas-fired electric generators.*

32. a. Prepared Direct Testimony on behalf of **Watson Cogeneration Company** (A. 00-06-032 — September 18, 2000).
    b. Prepared Rebuttal Testimony on behalf of **Watson Cogeneration Company** (A. 00-06-032 — October 6, 2000).

    - *Rate design for a natural gas "peaking service."*

33. a. Prepared Direct Testimony on behalf of **PG&E National Energy Group & Calpine Corporation** (I. 00-11-002—April 25, 2001).
    b. Prepared Rebuttal Testimony on behalf of **PG&E National Energy Group & Calpine Corporation** (I. 00-11-002—May 15, 2001).

    - *Terms and conditions of natural gas service to electric generators; gas curtailment policies.*

34. a. Prepared Direct Testimony on behalf of the **California Cogeneration Council** (R. 99-11-022—May 7, 2001).
    b. Prepared Rebuttal Testimony on behalf of the **California Cogeneration Council** (R. 99-11-022—May 30, 2001).

    - *Avoided cost pricing for alternative energy producers in California.*

35. a. Prepared Direct Testimony of R. Thomas Beach in Support of the Application of **Wild Goose Storage Inc.** (A. 01-06-029—June 18, 2001).
    b. Prepared Rebuttal Testimony of R. Thomas Beach on behalf of **Wild Goose Storage** (A. 01-06-029—November 2, 2001)

    - *Consumer benefits from expanded natural gas storage capacity in California.*

36. Prepared Direct Testimony on behalf of the **County of San Bernardino** (I. 01-06-047—December 14, 2001)

    - *Reasonableness review of a natural gas utility's procurement practices and storage operations.*

37. a. Prepared Direct Testimony on behalf of the **California Cogeneration Council** (R. 01-10-024—May 31, 2002)
    b. Prepared Supplemental Testimony on behalf of the **California Cogeneration Council** (R. 01-10-024—May 31, 2002)

    - *Electric procurement policies for California's electric utilities in the aftermath of the California energy crisis.*

38. Prepared Direct Testimony on behalf of the **California Manufacturers & Technology Association** (R. 02-01-011—June 6, 2002)

  - *"Exit fees" for direct access customers in California.*

39. Prepared Direct Testimony on behalf of the **County of San Bernardino** (A. 02-02-012 — August 5, 2002)

  - *General rate case issues for a natural gas utility; reasonableness review of a natural gas utility's procurement practices.*

40. Prepared Direct Testimony on behalf of the **California Manufacturers and Technology Association** (A. 98-07-003 — February 7, 2003)

  - *Recovery of past utility procurement costs from direct access customers.*

41. a. Prepared Direct Testimony on behalf of the **California Cogeneration Council, the California Manufacturers & Technology Association, Calpine Corporation, and Mirant Americas, Inc.** (A 01-10-011 — February 28, 2003)
    b. Prepared Rebuttal Testimony on behalf of the **California Cogeneration Council, the California Manufacturers & Technology Association, Calpine Corporation, and Mirant Americas, Inc.** (A 01-10-011 — March 24, 2003)

  - *Rate design issues for Pacific Gas & Electric's gas transmission system (Gas Accord II).*

42. a. Prepared Direct Testimony on behalf of the **California Manufacturers & Technology Association; Calpine Corporation; Duke Energy North America; Mirant Americas, Inc.; Watson Cogeneration Company; and West Coast Power, Inc.** (R. 02-06-041 — March 21, 2003)
    b. Prepared Rebuttal Testimony on behalf of the **California Manufacturers & Technology Association; Calpine Corporation; Duke Energy North America; Mirant Americas, Inc.; Watson Cogeneration Company; and West Coast Power, Inc.** (R. 02-06-041 — April 4, 2003)

  - *Cost allocation of above-market interstate pipeline costs for the California natural gas utilities.*

43. Prepared Direct Testimony of R. Thomas Beach and Nancy Rader on behalf of the **California Wind Energy Association** (R. 01-10-024 — April 1, 2003)

  - *Design and implementation of a Renewable Portfolio Standard in California.*

44. a. Prepared Direct Testimony on behalf of the **California Cogeneration Council** (R. 01-10-024 — June 23, 2003)
    b. Prepared Supplemental Testimony on behalf of the **California Cogeneration Council** (R. 01-10-024 — June 29, 2003)

    • *Power procurement policies for electric utilities in California.*

45. Prepared Direct Testimony on behalf of the **Indicated Commercial Parties** (02-05-004 — August 29, 2003)

    • *Electric revenue allocation and rate design for commercial customers in southern California.*

46. a. Prepared Direct Testimony on behalf of **Calpine Corporation and the California Cogeneration Council** (A. 04-03-021 — July 16, 2004)
    b. Prepared Rebuttal Testimony on behalf of **Calpine Corporation and the California Cogeneration Council** (A. 04-03-021 — July 26, 2004)

    • *Policy and rate design issues for Pacific Gas & Electric's gas transmission system (Gas Accord III).*

47. Prepared Direct Testimony on behalf of the **California Cogeneration Council** (A. 04-04-003 — August 6, 2004)

    • *Policy and contract issues concerning cogeneration QFs in California.*

48. a. Prepared Direct Testimony on behalf of the **California Cogeneration Council and the California Manufacturers and Technology Association** (A. 04-07-044 — January 11, 2005)
    b. Prepared Rebuttal Testimony on behalf of the **California Cogeneration Council and the California Manufacturers and Technology Association** (A. 04-07-044 — January 28, 2005)

    • *Natural gas cost allocation and rate design for large transportation customers in northern California.*

49. a. Prepared Direct Testimony on behalf of the **California Manufacturers and Technology Association and the Indicated Commercial Parties** (A. 04-06-024 — March 7, 2005)
    b. Prepared Rebuttal Testimony on behalf of the **California Manufacturers and Technology Association and the Indicated Commercial Parties** (A. 04-06-024 — April 26, 2005)

    • *Electric marginal costs, revenue allocation, and rate design for commercial and industrial electric customers in northern California.*

50. Prepared Direct Testimony on behalf of the **California Solar Energy Industries Association** (R. 04-03-017 — April 28, 2005)

   - *Cost-effectiveness of the Million Solar Roofs Program.*

51. Prepared Direct Testimony on behalf of **Watson Cogeneration Company, the Indicated Producers, and the California Manufacturing and Technology Association** (A. 04-12-004 — July 29, 2005)

   - *Natural gas rate design policy; integration of gas utility systems.*

52. a. Prepared Direct Testimony on behalf of the **California Cogeneration Council** (R. 04-04-003/R. 04-04-025 — August 31, 2005)
    b. Prepared Rebuttal Testimony on behalf of the **California Cogeneration Council** (R. 04-04-003/R. 04-04-025 — October 28, 2005)

   - *Avoided cost rates and contracting policies for QFs in California*

53. a. Prepared Direct Testimony on behalf of the **California Manufacturers and Technology Association and the Indicated Commercial Parties** (A. 05-05-023 — January 20, 2006)
    b. Prepared Rebuttal Testimony on behalf of the **California Manufacturers and Technology Association and the Indicated Commercial Parties** (A. 05-05-023 — February 24, 2006)

   - *Electric marginal costs, revenue allocation, and rate design for commercial and industrial electric customers in southern California.*

54. a. Prepared Direct Testimony on behalf of the **California Producers** (R. 04-08-018 – January 30, 2006)
    b. Prepared Rebuttal Testimony on behalf of the **California Producers** (R. 04-08-018 – February 21, 2006)

   - *Transportation and balancing issues concerning California gas production.*

55. Prepared Direct Testimony on behalf of the **California Manufacturers and Technology Association and the Indicated Commercial Parties** (A. 06-03-005 — October 27, 2006)

   - *Electric marginal costs, revenue allocation, and rate design for commercial and industrial electric customers in northern California.*

56. Prepared Direct Testimony on behalf of the **California Cogeneration Council** (A. 05-12-030 — March 29, 2006)

   - *Review and approval of a new contract with a gas-fired cogeneration project.*

57. a. Prepared Direct Testimony on behalf of **Watson Cogeneration, Indicated Producers, the California Cogeneration Council, and the California Manufacturers and Technology Association** (A. 04-12-004 — July 14, 2006)
    b. Prepared Rebuttal Testimony on behalf of **Watson Cogeneration, Indicated Producers, the California Cogeneration Council, and the California Manufacturers and Technology Association** (A. 04-12-004 — July 31, 2006)

    - *Restructuring of the natural gas system in southern California to include firm capacity rights; unbundling of natural gas services; risk/reward issues for natural gas utilities.*

58. Prepared Direct Testimony on behalf of the **California Cogeneration Council** (R. 06-02-013 — March 2, 2007)

    - *Utility procurement policies concerning gas-fired cogeneration facilities.*

59. a. Prepared Direct Testimony on behalf of the **Solar Alliance** (A. 07-01-047 — August 10, 2007)
    b. Prepared Rebuttal Testimony on behalf of the **Solar Alliance** (A. 07-01-047 — September 24, 2007)

    - *Electric rate design issues that impact customers installing solar photovoltaic systems.*

60. a. Prepared Direct Testimony on Behalf of **Gas Transmission Northwest Corporation** (A. 07-12-021 — May 15, 2008)
    b. Prepared Rebuttal Testimony on Behalf of **Gas Transmission Northwest Corporation** (A. 07-12-021 — June 13, 2008)

    - *Utility subscription to new natural gas pipeline capacity serving California.*

61. a. Prepared Direct Testimony on behalf of the **Solar Alliance** (A. 08-03-015 — September 12, 2008)
    b. Prepared Rebuttal Testimony on behalf of the **Solar Alliance** (A. 08-03-015 — October 3, 2008)

    - *Issues concerning the design of a utility-sponsored program to install 500 MW of utility- and independently-owned solar photovoltaic systems.*

62. Prepared Direct Testimony on behalf of the **Solar Alliance** (A. 08-03-002 — October 31, 2008)

- *Electric rate design issues that impact customers installing solar photovoltaic systems.*

63. a. Phase II Direct Testimony on behalf of **Indicated Producers, the California Cogeneration Council, California Manufacturers and Technology Association, and Watson Cogeneration Company** (A. 08-02-001 — December 23, 2008)
    b. Phase II Rebuttal Testimony on behalf of **Indicated Producers, the California Cogeneration Council, California Manufacturers and Technology Association, and Watson Cogeneration Company** (A. 08-02-001 — January 27, 2009)

- *Natural gas cost allocation and rate design issues for large customers.*

64. a. Prepared Direct Testimony on behalf of the **California Cogeneration Council** (A. 09-05-026 — November 4, 2009)

- *Natural gas cost allocation and rate design issues for large customers.*

65. a. Prepared Direct Testimony on behalf of **Indicated Producers and Watson Cogeneration Company** (A. 10-03-028 — October 5, 2010)
    b. Prepared Rebuttal Testimony on behalf of **Indicated Producers and Watson Cogeneration Company** (A. 10-03-028 — October 26, 2010)

- *Revisions to a program of firm backbone capacity rights on natural gas pipelines.*

66. Prepared Direct Testimony on behalf of the **Solar Alliance** (A. 10-03-014 — October 6, 2010)

- *Electric rate design issues that impact customers installing solar photovoltaic systems.*

67. Prepared Rebuttal Testimony on behalf of the **Indicated Settling Parties** (A. 09-09-013 — October 11, 2010)

- *Testimony on proposed modifications to a broad-based settlement of rate-related issues on the Pacific Gas & Electric natural gas pipeline system.*

68. a. Supplemental Prepared Direct Testimony on behalf of **Sacramento Natural Gas Storage, LLC** (A. 07-04-013 — December 6, 2010)
    b. Supplemental Prepared Rebuttal Testimony on behalf of**Sacramento Natural Gas Storage, LLC** (A. 07-04-013 — December 13, 2010)
    c. Supplemental Prepared Reply Testimony on behalf of **Sacramento Natural Gas Storage, LLC** (A. 07-04-013 — December 20, 2010)

    - *Local reliability benefits of a new natural gas storage facility.*

69. Prepared Direct Testimony on behalf of The Vote Solar Initiative (A. 10-11-015—June 1, 2011)

    - *Distributed generation policies; utility distribution planning.*

70. Prepared Reply Testimony on behalf of the Solar Alliance (A. 10-03-014—August 5, 2011)

    - *Electric rate design for commercial & industrial solar customers.*

71. Prepared Direct Testimony on behalf of the Solar Energy Industries Association (A. 11-06-007—February 6, 2012)

    - *Electric rate design for solar customers; marginal costs.*

72. a. Prepared Direct Testimony on behalf of the Northern California Indicated Producers (R.11-02-019—January 31, 2012)
    b. Prepared Rebuttal Testimony on behalf of the Northern California Indicated Producers (R. 11-02-019—February 28, 2012)

    - *Natural gas pipeline safety policies and costs*

73. Prepared Direct Testimony on behalf of the Solar Energy Industries Association (A. 11-10-002—June 12, 2012)

    - *Electric rate design for solar customers; marginal costs.*

74. Prepared Direct Testimony on behalf of the Southern California Indicated Producers and Watson Cogeneration Company (A. 11-11-002—June 19, 2012)

    - *Natural gas pipeline safety policies and costs*

75. a. Testimony on behalf of the California Cogeneration Council (R. 12-03-014—June 25, 2012)
    b. Repl y Testimony on behalf of the California Cogeneration Council (R. 12-03-014—July 23, 2012)

    - *Ability of combined heat and power resources to serve local reliability needs in southern California.*

76. a. Prepared Testimony on behalf of the Southern California Indicated Producers and Watson Cogeneration Company (A. 11-11-002, Phase 2—November 16, 2012)
    b. Prepared Rebuttal Testimony on behalf of the Southern California Indicated Producers and Watson Cogeneration Company (A. 11-11-002, Phase 2—December 14, 2012)

    - *Allocation and recovery of natural gas pipeline safety costs.*

77. Prepared Direct Testimony on behalf of the Solar Energy Industries Association (A. 12-12-002—May 10, 2013)

    - *Electric rate design for commercial & industrial solar customers; marginal costs.*

78. Prepared Direct Testimony on behalf of the Solar Energy Industries Association (A. 13-04-012—December 13, 2013)

    - *Electric rate design for commercial & industrial solar customers; marginal costs.*

79. Prepared Direct Testimony on behalf of the Solar Energy Industries Association (A. 13-12-015—June 30, 2014)

    - *Electric rate design for commercial & industrial solar customers; residential time-of-use rate design issues.*

80. a. Prepared Direct Testimony on behalf of **Calpine Corporation** and the **Indicated Shippers** (A. 13-12-012—August 11, 2014)
    b. Prepared Direct Testimony on behalf of **Calpine Corporation, the Canadian Association of Petroleum Producers, Gas Transmission Northwest,** and **the City of Palo Alto** (A. 13-12-012—August 11, 2014)
    c. Prepared Rebuttal Testimony on behalf of **Calpine Corporation** (A. 13-12-012—September 15, 2014)
    d. Prepared Rebuttal Testimony on behalf of **Calpine Corporation, the Canadian Association of Petroleum Producers, Gas Transmission Northwest,** and **the City of Palo Alto** (A. 13-12-012—September 15, 2014)

    - *Rate design, cost allocation, and revenue requirement issues for the gas transmission system of a major natural gas utility.*

81. Prepared Direct Testimony on behalf of the Solar Energy Industries Association (R. 12-06-013—September 15, 2014)

    - *Comprehensive review of policies for rate design for residential electric customers in California.*

82. Prepared Direct Testimony on behalf of the Solar Energy Industries Association (A. 14-06-014—March 13, 2015)

    - *Electric rate design for commercial & industrial solar customers; marginal costs.*

83. a. Prepared Direct Testimony on behalf of the Solar Energy Industries Association (A.14-11-014—May 1, 2015)
    b. Prepared Rebuttal Testimony on behalf of the **Solar Energy Industries Association** (A. 14-11-014—May 26, 2015)

    - *Time-of-use periods for residential TOU rates.*

84. Prepared Rebuttal Testimony on behalf of the **Joint Solar** Parties (R. 14-07-002 — September 30, 2015)

    - *Electric rate design issues concerning proposals for the net energy metering successor tariff in California.*

85. Prepared Direct Testimony on behalf of the **Solar** Energy Industries Association (A. 15-04-012—July 5, 2016)

    - *Selection of Time-of-Use periods, and rate design issues for solar customers.*

86. Prepared Direct Testimony on behalf of the **Solar** Energy Industries Association (A. 16-09-003 — April 28, 2017)

    - *Selection of Time-of-Use periods, and rate design issues for solar customers.*

87. Prepared Direct Testimony on behalf of the **Solar** Energy Industries Association (A. 17-06-030 — March 23, 2018)

    - *Selection of Time-of-Use periods, and rate design issues for solar customers.*

EXPERT WITNESS TESTIMONY BEFORE THE ARIZONA CORPORATION COMMISSION

1. Prepared Direct, Rebuttal, and Supplemental Testimony on behalf of **The Alliance for Solar Choice (TASC)**, (Docket No. E-00000J-14-0023, February 27, April 7, and June 22, 2016).

   - *Development of a benefit-cost methodology for distributed, net metered solar resources in Arizona.*

2. Prepared Surrebuttal and Responsive Testimony on behalf of the **Energy Freedom Coalition of America** (Docket No. E-01933A-15-0239 – March 10 and September 15, 2016).

   - *Critique of a utility-owned solar program; comments on a fixed rate credit to replace net energy metering.*

3. Direct Testimony on behalf of the **Solar Energy Industries Association** (Docket No. E-01345A-16-0036, February 3, 2017).

4. Direct and Surrebuttal Testimony on behalf of **The Alliance for Solar Choice and the Energy Freedom Coalition of America** (Docket Nos. E-01933A-15-0239 (TEP), E-01933A-15-0322 (TEP), and E-04204A-15-0142 (UNSE) – May 17 and September 29, 2017).

EXPERT WITNESS TESTIMONY BEFORE THE COLORADO PUBLIC UTILITIES COMMISSION

1. Direct Testimony and Exhibits on behalf of the **Colorado Solar Energy Industries Association** and the **Solar Alliance**, (Docket No. 09AL-299E – October 2, 2009). https://www.dora.state.co.us/pls/efi/DDMS_Public.Display_Document?p_section=PUC&p_source=EFI_PRIVATE&p_doc_id=3470190&p_doc_key=0CD8F7FCDB673F1043928849D9D8CAB1&p_handle_not_found=Y

   - *Electric rate design policies to encourage the use of distributed solar generation.*

2. Direct Testimony and Exhibits on behalf of the **Vote Solar Initiative** and the **Interstate Renewable Energy Council**, (Docket No. 11A-418E – September 21, 2011).

   - *Development of a community solar program for Xcel Energy.*

3. Answer Testimony and Exhibits, plus Opening Testimony on Settlement, on behalf of the **Solar Energy Industries Association**, (Docket No. 16AL-0048E [Phase II] – June 6 and September 2, 2016).

   - *Rate design issues related to residential customers and solar distributed generation in a Public Service of Colorado general rate case.*

EXPERT WITNESS TESTIMONY BEFORE THE GEORGIA PUBLIC SERVICE COMMISSION

1. Direct Testimony on behalf of **Georgia Interfaith Power & Light and Southface Energy Institute, Inc.** (Docket No. 40161 – May 3, 2016).

   - *Development of a cost-effectiveness methodology for solar resources in Georgia.*

EXPERT WITNESS TESTIMONY BEFORE THE IDAHO PUBLIC UTILITIES COMMISSION

1. Direct Testimony on behalf of the Idaho Conservation League (Case No. IPC-E-12-27—May 10, 2013)

   - *Costs and benefits of net energy metering in Idaho.*

2. a. Direct Testimony on behalf of the **Idaho Conservation League and the Sierra Club** (Case Nos. IPC-E-15-01/AVU-4-15-01/PAC-E-15-03 — April 23, 2015)
   b. Rebuttal Testimony on behalf of the **Idaho Conservation League and the Sierra Club** (Case Nos. IPC-E-15-01/AVU-4-15-01/PAC-E-15-03 — May 14, 2015)

   - *Issues concerning the term of PURPA contracts in Idaho.*

2. a. Direct Testimony on behalf of the **Sierra Club** (Case No. IPC-E-17-13 — December 22, 2017)
   b. Rebuttal Testimony on behalf of the **Sierra Club** (Case No. IPC-E-17-13 — January 26, 2018)

EXPERT WITNESS TESTIMONY BEFORE THE MASSACHUSETTS DEPARTMENT OF PUBLIC UTILITIES

1. Direct and Rebuttal Testimony on behalf of **Northeast Clean Energy Council, Inc.** (Docket D.P.U. 15-155, March 18 and April 28, 2016)

   - *Residential rate design and access fee proposals related to distributed generation in a National Grid general rate case.*

EXPERT WITNESS TESTIMONY BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

1. Prepared Direct Testimony on behalf of Vote Solar (Case No. U-18419—January 12, 2018)

2. Prepared Rebuttal Testimony on behalf of the **Environmental Law and Policy Center, the Ecology Center, the Solar energy Industries Association, Vote Solar, and the Union of Concerned Scientists** (Case No. U-18419 — February 2, 2018)

EXPERT WITNESS TESTIMONY BEFORE THE MINNESOTA PUBLIC UTILITIES COMMISSION

1. Direct and Rebuttal Testimony on Behalf of **Geronimo Energy, LLC**. (In the Matter of the Petition of Northern States Power Company to Initiate a Competitive Resource Acquisition Process [OAH Docket No. 8-2500-30760, MPUC Docket No. E002/CN-12-1240, September 27 and October 18, 2013])

    - *Testimony in support of a competitive bid from a distributed solar project in an all-source solicitation for generating capacity.*

EXPERT WITNESS TESTIMONY BEFORE THE MONTANA PUBLIC SERVICE COMMISSION

1. Pre-filed Direct and Supplemental Testimony on Behalf of **Vote Solar and the Montana Environmental Information Center** (Docket No. D2016.5.39,October 14 and November 9, 2016).

    - *Avoided cost pricing issues for solar QFs in Montana.*

EXPERT WITNESS TESTIMONY BEFORE THE PUBLIC UTILITIES COMMISSION OF NEVADA

1. Pre-filed Direct Testimony on Behalf of the **Nevada Geothermal Industry Council** (Docket No. 97-2001—May 28, 1997)

    - *Avoided cost pricing for the electric output of geothermal generation facilities in Nevada.*

2. Pre-filed Direct Testimony on Behalf of **Nevada Sun-Peak Limited Partnership** (Docket No. 97-6008—September 5, 1997)

    - *QF pricing issues in Nevada.*

3. Pre-filed Direct Testimony on Behalf of the **Nevada Geothermal Industry Council** (Docket No. 98-2002 — June 18, 1998)

    - *Market-based, avoided cost pricing for the electric output of geothermal generation facilities in Nevada.*

4. a. Prepared Direct Testimony on behalf of **The Alliance for Solar Choice (TASC)**, (Docket Nos. 15-07041 and 15-07042 –October 27, 2015).
   b. Prepared Direct Testimony on Grandfathering Issues on behalf of **TASC**, (Docket Nos. 15-07041 and 15-07042 –February 1, 2016).

c. Prepared Rebuttal Testimony on Grandfathering Issues on behalf of **TASC**, (Docket Nos. 15-07041 and 15-07042 –February 5, 2016).

- *Net energy metering and rate design issues in Nevada.*

EXPERT WITNESS TESTIMONY BEFORE THE NEW HAMPSHIRE PUBLIC UTILITIES COMMISSION

1. Prepared Direct and Rebuttal Testimony on behalf of **The Alliance for Solar Choice (TASC)**, (Docket No. DE 16-576, October 24 and December 21, 2016).

   - *Net energy metering and rate design issues in New Hampshire.*

EXPERT WITNESS TESTIMONY BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

1. Direct Testimony on Behalf of the **Interstate Renewable Energy Council** (Case No. 10-00086-UT—February 28, 2011)
   http://164.64.85.108/infodocs/2011/3/PRS20156810DOC.PDF

   - *Testimony on proposed standby rates for new distributed generation projects; cost-effectiveness of DG in New Mexico.*

2. Direct Testimony and Exhibits on behalf of the **New Mexico Independent Power Producers** (Case No. 11-00265-UT, October 3, 2011)

   - *Cost cap for the Renewable Portfolio Standard program in New Mexico*

EXPERT WITNESS TESTIMONY BEFORE THE NORTH CAROLINA UTILITIES COMMISSION

1. Direct, Response, and Rebuttal Testimony on Behalf of the North Carolina Sustainable Energy Association. (In the Matter of Biennial Determination of Avoided Cost Rates for Electric Utility Purchases from Qualifying Facilities – 2014; Docket E-100 Sub 140; April 25, May 30, and June 20, 2014)

   - *Testimony on avoided cost issues related to solar and renewable qualifying facilities in North Carolina.*

April 25, 2014:
http://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=89f3b50f-17cb-4218-87bd-c743e1238bc1
May 30, 2014:
http://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=19e0b58d-a7f6-4d0d-9f4a-08260e561443
June 20, 2104:
http://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=bd549755-d1b8-4c9b-b4a1-fc6e0bd2f9a2

EXPERT WITNESS TESTIMONY BEFORE THE PUBLIC UTILITIES COMMISSION OF OREGON

1. a. Direct Testimony of Behalf of **Weyerhaeuser Company** (UM 1129 — August 3, 2004)
   b. Surrebuttal Testimony of Behalf of **Weyerhaeuser Company** (UM 1129 — October 14, 2004)

2. a. Direct Testimony of Behalf of **Weyerhaeuser Company and the Industrial Customers of Northwest Utilities** (UM 1129 / Phase II — February 27, 2006)
   b. Rebuttal Testimony of Behalf of **Weyerhaeuser Company and the Industrial Customers of Northwest Utilities** (UM 1129 / Phase II — April 7, 2006)

   - *Policies to promote the development of cogeneration and other qualifying facilities in Oregon.*

3. Direct Testimony on Behalf of the **Oregon Solar Energy Industries Association** (UM 1910, 1911, and 1912 — March 16, 2018).

EXPERT WITNESS TESTIMONY BEFORE THE PUBLIC SERVICE COMMISSION OF SOUTH CAROLINA

1. Direct Testimony and Exhibits on behalf of **The Alliance for Solar Choice** (Docket No. 2014-246-E – December 11, 2014)
   https://dms.psc.sc.gov/attachments/matter/B7BACF7A-155D-141F-236BC437749BEF85

   - *Methodology for evaluating the cost-effectiveness of net energy metering*

EXPERT WITNESS TESTIMONY BEFORE THE PUBLIC UTILITIES COMMISSION OF TEXAS

1. Direct Testimony on behalf of the **Solar Energy Industries Association** (SEIA) (Docket No. 44941 – December 11, 2015)

   - *Rate design issues concerning net metering and renewable distributed generation in an El Paso Electric general rate case.*

EXPERT WITNESS TESTIMONY BEFORE THE PUBLIC SERVICE COMMISSION OF UTAH

1. Direct Testimony on behalf of the **Sierra Club** (Docket No. 15-035-53—September 15, 2015)

   - *Issues concerning the term of PURPA contracts in Idaho.*

EXPERT WITNESS TESTIMONY BEFORE THE VERMONT PUBLIC SERVICE BOARD

1. Pre-filed Testimony of R. Thomas Beach and Patrick McGuire on Behalf of **Allco Renewable Energy Limited** (Docket No. 8010 — September 26, 2014)

   - *Avoided cost pricing issues in Vermont*

EXPERT WITNESS TESTIMONY BEFORE THE VIRGINIA CORPORATION COMMISSION

Direct Testimony and Exhibits on Behalf of the Maryland – District of Columbia – Virginia Solar Energy Industries Association, (Case No. PUE-2011-00088, October 11, 2011) http://www.scc.virginia.gov/docketsearch/DOCS/2gx%2501!.PDF

- *Cost-effectiveness of, and standby rates for, net-metered solar customers.*

LITIGATION EXPERIENCE

Mr. Beach has been retained as an expert in a variety of civil litigation matters. His work has included the preparation of reports on the following topics:

- The calculation of damages in disputes over the pricing terms of natural gas sales contracts (2 separate cases).
- The valuation of a contract for the purchase of power produced from wind generators.
- The compliance of cogeneration facilities with the policies and regulations applicable to Qualifying Facilities (QFs) under PURPA in California.
- Audit reports on the obligations of buyers and sellers under direct access electric contracts in the California market (2 separate cases).
- The valuation of interstate pipeline capacity contracts (3 separate cases).

In several of these matters, Mr. Beach was deposed by opposing counsel. Mr. Beach has also testified at trial in the bankruptcy of a major U.S. energy company, and has been retained as a consultant in anti-trust litigation concerning the California natural gas market in the period prior to and during the 2000-2001 California energy crisis.