BEFORE THE
STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
PUBLIC UTILITIES COMMISSION

IN RE: THE NARRAGANSETT ELECTRIC COMPANY d/b/a NATIONAL GRID REVIEW OF POWER PURCHASE AGREEMENT PURSUANT TO R.I. GENERAL LAWS §39-31-1 TO 9	))))))	Docket No. 4929

DIRECT TESTIMONY OF
DR. JURGEN WEISS
THE BRATTLE GROUP
ON BEHALF OF
DWW REV I, LLC

April 5, 2019

I. Introduction

Q. Please state your name and business address.

A. My name is Jurgen Weiss and my business address is One Beacon Street, Boston, MA 02118.

Q. By whom are you employed and in what capacity?

A. I am a Principal with The Brattle Group, an energy and economic consulting firm.

Q. Please describe your qualifications and experience.

A. I am an energy economist with a Ph.D. in Business Economics from Harvard University. I also hold a Master of Business Administration from Columbia Business School. After my MBA, I worked as an Associate for Booz Allen & Hamilton, where I developed models to forecast electricity prices in restructured U.S. electricity markets. Since the completion of my doctorate in 1998, I have been working as a consultant in the electricity industry, focusing on the areas of market design and the interface between energy and environmental issues. I have significant experience evaluating the economics of various types of renewable energy resources and contracts, including offshore wind. My work in the offshore wind area resulted in reports submitted in regulatory proceedings, my serving as an expert witness, and several public reports on various aspects of the industry. My CV provides additional information on my qualifications (See Exhibit 1).

Q. Have you previously testified before the Rhode Island Public Utilities Commission or other state or federal regulatory commissions?

A. No, I have not filed testimony with the Rhode Island Public Utilities Commission before. However, I have testified on related issues in front of regulatory bodies in several New England states. Specifically, I testified on behalf of the Attorney General of Massachusetts before the Massachusetts Department of Public Utilities in several previous proceedings related to procurements under Section 83 of the Green

Communities Act, including the proceeding seeking PPA approval for Cape Wind. I was also a testifying expert for the New Hampshire Attorney General before the New Hampshire Siting Evaluation Committee in the Northern Pass proceeding.

Q. Given your experience, do you consider yourself to be an experienced power market analyst?

A. Yes.

Q. What is the purpose of your testimony?

A. The purpose of this testimony is to support the request of DWW REV I, LLC (DWW) that the Rhode Island Public Utilities Commission (Commission) approve the power purchase agreement (PPA) between The Narragansett Electric Company, d/b/a National Grid (National Grid) and DWW. In particular, I have been asked to render an opinion as to whether the terms and pricing of the PPA are "commercially reasonable" as that term is defined in R.I.G.L. § 39-31-1, et. seq., the Affordable Clean Energy Security Act (ACES Act).

Q. What is your conclusion?

A. Based on my review of the PPA and the provisions of the ACES Act, it is my opinion that the terms and pricing of the PPA terms are reasonably consistent with what an experienced power market analyst would expect to see in transactions involving regional-energy resources and regional-energy infrastructure.

II. Review Of The ACES Act And The PPA

Q. How did you determine that the PPA is commercially reasonable?

A. My first step was to review the ACES Act to understand its provisions and how it defines "commercially reasonable."

Q. What is the standard of review for commercially reasonable in the ACES Act?

A. The ACES Act states that as related to terms and pricing of the PPA, "commercially reasonable" means "terms and pricing that are reasonably consistent with what an experienced power market analyst would expect to see in transactions involving regional-energy resources and regional-energy infrastructure."

The scope for concluding commercial reasonableness under ACES potentially differs from the standard for the Long-Term Contracting Standard for Renewable Energy, under which "'Commercially reasonable' means terms and pricing that are reasonably consistent with what an experienced power market analyst would expect to see in transactions involving newly developed renewable energy resources."[1] National Grid has stated that under its interpretation of ACES, "regional-energy resources and regional-energy infrastructure" includes domestic or international large or small-scale hydroelectric power, eligible renewable energy resources, including wind, incremental natural-gas pipeline infrastructure and capacity, and electric-transmission infrastructure.[2]

However, applying this broader standard in practice is not easy since, for projects other than either offshore wind or other renewable resources, the "products" with potential market or societal value differ significantly from those of a renewable (or even more specifically an offshore wind) project. Also, at any given time, the number of such projects can be relatively small and, for reasons I explain in more detail below, a comparison of prices and terms of projects proposed at different times adds additional complexity. The bulk of my evaluation therefore concerned other offshore wind and renewables projects. I also compared the proposed PPA to the terms of the project recently selected by Massachusetts to bring hydroelectric power from Quebec to Massachusetts and this comparison highlights some of the difficulties I just mentioned.

[1] TITLE 39, Public Utilities and Carriers CHAPTER 39-26.1, Long-Term Contracting Standard for Renewable Energy, SECTION 39-26.1-2

[2] See National Grid Response to PUC DR 2-34

Q. Please explain how you determined that the terms and pricing of the PPA meet this standard.

A. To conclude that the terms and pricing of the proposed PPA meet the commercial reasonableness standard, I compared the terms of the proposed PPA with those of similar PPAs that other regional state regulators have approved. To conclude that the pricing of the proposed PPA is commercially reasonable, I compared the pricing of this PPA to the pricing of other regional projects that are broadly comparable with this project.

Q. Please elaborate on how you determined that the terms of the PPA meet this standard.

A. To conclude that the terms of the proposed PPA meet the standard, I reviewed the terms of the proposed PPA and compared it to the terms included in other PPAs available to me that have been proposed and approved by other regulators in the region. Specifically, I reviewed the PPA between DWW and Connecticut Light and Power Company (CLP) for energy and RECs from the same offshore wind project, executed on October 1, 2018 and approved by the State of Connecticut Public Utilities Regulatory Authority. Apart from the pricing and the fact that the PPA with CLP involves a smaller capacity, the terms of the two PPAs are very similar. The products sold under both PPAs are the same.

I also reviewed the changes agreed by National Grid and DWW to the draft PPA that I understand was used by National Grid in connection with the solicitation.[3] My experience is that there are always reasons to modify a draft PPA to make it applicable to the particular contracting situation. Recognizing that I am not a lawyer and therefore cannot opine on changes in certain legal language, as a power market analyst I noted that the changes were relatively limited and conclude that the changes generally reflect the need to adjust the draft PPA to the requirements of the State of Rhode Island and the

[3] This review consisted of a comparison of two documents: (i) the "Draft PPA (National Grid)" provided in connection with the Massachusetts 83C offshore wind solicitation, and available online at: https://macleanenergy.com/83c/83c-documents/; and (ii) the final PPA filed in this Proceeding.

terms and conditions offered in DWW's Proposal. I also understand that the changes to the draft PPA correspond to those of the PPA between DWW and CLP and approved by Connecticut's Public Utilities Regulatory Authority. Hence, based on my review of the terms of the PPA, I find those terms to be reasonable.

Q. Please elaborate on how you determined that the pricing of the PPA meets the commercially reasonable standard.

A. To conclude that the pricing of the proposed PPA meets the standard, I compared the pricing of the proposed PPA with pricing for other regional projects likely eligible under ACES as long as pricing was available.

Comparing the pricing of different projects is not always straightforward because a) the terms of associated PPAs can differ between projects in ways that affect pricing; b) pricing for projects with substantially different in-service dates for rapidly evolving technologies can be hard to compare, not least because of the presence of learning effects that make the pricing of a later project in part a function of the existence of earlier projects; c) projects can differ with respect to the benefits they provide; and d) reasonableness must also be assessed in the context of other state objectives.

In general, the fact that two prices for projects with the same technology procured at the same time are different does not mean that the project with the higher of the two prices would not be deemed commercially reasonable. Rather, since the costs of such projects would still differ for many reasons, competitive procurements such as the ones conducted in Massachusetts under Section 83 or the one in Connecticut that resulted in the selection of the Revolution Wind Project would result in bids that reflect such cost differences. Then, if there is a procurement target that exceeds the size of the highest scoring project or if it is deemed that the benefits of multiple projects exceed their costs, the prices of

more than one project (of the same or different technology) would be commercially reasonable even if their prices differ.

More specifically, under ACES a project is commercially reasonable if "terms and pricing that are reasonably consistent with what an experienced power market analyst would expect to see in transactions involving regional-energy resources and regional-energy infrastructure."[4] While ACES does not limit what specific technologies are to be considered regional energy resources or regional energy infrastructure, the legislative findings suggest that ACES is intended to support no- or low-emissions resources and infrastructure. I have therefore focused my review on such resources. The most direct comparison is among various regional offshore wind projects. For that reason, I reviewed the pricing in the proposed PPA with pricing of other regional offshore wind PPAs approved by regulatory agencies, of which there are so far relatively few. I also reviewed PPAs or support systems for other technologies potentially eligible under ACES and which were approved by regulatory agencies. Those technologies would almost certainly include land-based wind projects, solar PV projects and likely at least some hydro projects.

Q. How does the proposed PPA price compare to other non-offshore wind procurements in the region?

A. Even though not fully approved, the most recent clean energy procurement in Massachusetts resulted in an award of a 20-year PPA for energy and environmental attributes to H.Q Energy Services (U.S.) Inc. for a price starting at $51.51 and escalating over time to $82.35 in year 20.[5] Converting this escalating price into a constant nominal price over the contract duration results in a price of $62.30/MWh.[6] Ignoring differences

[4] R.I.G.L § 39-31-3.
[5] D.P.U. 18-64/18-65/18-66, Exhibit JU-3-A, Exhibit D
[6] The calculation involved finding the equivalent constant nominal price that would result in the same net present value as the escalating contract price. I used a discount rate of 6.99% (nominal WACC) for this

in the terms of the PPA and the fact that the different production profile of this PPA compared to the output profile reduces the direct comparability of the respective PPA prices, the "environmental attributes" of this PPA do not match the environmental attributes of offshore wind. In particular, large-scale hydro does currently not qualify as a Class I renewable resource to meet the targets of renewable portfolio standards (RPS) in New England. Renewable portfolio standards also generally require that qualifying resources be newly constructed, which was not the case with the procurement of large-scale hydro under Section 83(D). Including the value of renewable attributes not delivered by the hydro project approved by Massachusetts would narrow the gap between the two projects substantially. While I did not independently value Class I RECs, I note that the proposed PPA includes pricing in case the Revolution Wind Project does not qualify as a Class I resource. In that case, the purchase price is $71.925/MWh[7] or approximately within 15% of the hydro PPA price.

Also, when comparing the prices of energy from different technologies, a determination of whether a price is reasonable when compared to prices of alternative technologies requires additional considerations. Given that different technologies are at different stages of maturity, that they have different output profiles and different non-energy benefits, PPA price alone tends to be insufficient for a comparison. Given Rhode Island's near term and longer term clean energy goals, the result that any given PPA price is more expensive than another price paid for clean or renewable energy elsewhere in the region is not per se an indicator that the price under consideration is commercially unreasonable. In all likelihood, a variety of technologies will contribute to meeting Rhode Island's clean energy goals. At any given moment in time, the costs and prices associated with these

calculation, which is the discount rate used by Tabors Caramanis Rudkovich in its comparison of the total benefits provided by Section 83C offers (Massachusetts D.P.U. 18-76/18-77/18-78, Exhibit JU-4 (Redacted), July 2018)

[7] See National Grid, Review of Power Purchase Agreements Pursuant to R.I. Gen. Laws § 39-31, February 7, 2018, Exhibit D.

technologies may differ, but they may still all be needed to meet existing goals or targets. For example, Rhode Island also procures renewable energy through its Renewable Energy Growth program. Compensation for eligible projects has been decreasing, but there remain important price differences across the various programs and many of the projects are compensated at rates substantially above the prices of the proposed PPA. For example, the compensation for eligible small-scale solar projects proposed is between 24.95 cents/kWh and 27.65 cents/kWh, or between approximately $250/MWh and $277/MWh, for 20 year terms.[8] Ceiling prices for larger scale projects differ by technology but range from approximately $150/MWh (large-scale solar PV) to approximately $300/MWh (car port solar). In 2018, 20-year contract prices for awarded projects ranged from $111/MWh to $249.50/MWh.[9]

These comparisons indicate that the (approved) prices associated with regional infrastructure projects that are at least somewhat comparable to the proposed Revolution Wind Project can be both higher and lower than the proposed PPA price. This confirms that whether or not such a project is commercially reasonable depends on both price and non-price factors and that projects with a relatively wide range of prices can be commercially reasonable once such factors are taken into account. The same also holds true for offshore wind projects as a category. Since for those projects at least the technology is the same, prices for offshore wind PPAs do in my opinion provide the best indicator of whether or not the proposed PPA price is reasonably consistent with what I would expect to see in a transaction of this type.

[8] See National Grid, 2019 RENEWABLE ENERGY GROWTH PROGRAM, November 15, 2018, RIPUC Docket No. 4892

[9] http://www.ripuc.org/eventsactions/docket/NGrid-REG-EnrollmentRepts.html

Q. What do you conclude from comparing the proposed PPA price to other regional offshore wind PPAs.

A. In my opinion, the proposed PPA price is commercially reasonable when compared to other offshore wind PPAs. Since offshore wind is still a relatively immature industry in the United States, there are not many existing (and approved) PPAs, to which the price of the proposed PPA can be compared.

The most obvious comparison is to the price of the PPA for a 200MW portion of the same Revolution offshore wind project approved by Connecticut regulators in December 2018. The price of that PPA was for $99.50/MWh for energy and RECs for a 20-year term,[10] *i.e.,* slightly above the $98.425/MWh for the proposed PPA. I reviewed the decision by Connecticut's Public Utilities Regulatory Authority (PURA) approving PPAs with various clean energy resources including with a portion of the same Revolution offshore wind project.[11] In its decision, PURA approves PPAs with five clean energy projects: 200 MW of the Revolution offshore wind project and four fuel cell projects with a total capacity of 52 MW. In its scoring, which included a quantitative and a qualitative assessment of the bids received, the Revolution offshore wind project ranked second behind an anaerobic digester project, which ultimately did not receive a contract due to that project's inability to provide security requirements. PURA concluded that, relative to market prices, the bid from the Revolution project was "slightly" above projected values of energy and RECs, but that other factors including greenhouse gas and local economic impacts resulted in benefits that made a contract beneficial for Connecticut ratepayers.[12]

[10] RPS Class I Renewable Generation Unit Power Purchase Agreement between The Connecticut Light and Power Company d/b/a Eversource Energy and DWW Rev I, LLC, as of October 1, 2018, Execution Version, Exhibit D.

[11] State of Connecticut, Public Utilities Regulatory Authority, Decision DOCKET NO. 18-06-37, December 19, 2018

[12] Ibid, page 9.

There are three other regional offshore wind price points that can be used to assess the commercial reasonableness of the proposed PPA: The Cape Wind project, the Block Island Wind Farm project and the Vineyard Wind project. The PPA for the Cape Wind project with National Grid was approved by the Massachusetts Department of Public Utilities in 2010. The price of the PPA was $187/MWh, increasing by 3.5% per year for 15 years.[13] A comparison of the price of the Cape Wind PPA with the price of the proposed PPA must take into account that projects currently being developed benefit from significant cost reductions that have occurred over time, both due to international (primarily European) learning and scaling and because of the learning that has occurred even in the United States. The Cape Wind PPA also included the sale of capacity in addition to the sale of energy and RECs.[14] However, it is important to note that the approval of the project as "reasonable" occurred even though, at the time, the contract price was significantly above the cost of alternative electricity and even renewable electricity supplies. One of the arguments made in the process was that to reach Massachusetts' long-term clean energy goals offshore wind would likely be needed and that there would never be a robust offshore wind industry without an initial project such as Cape Wind.

A second PPA with an offshore wind project is the PPA for the Block Island Wind Farm project approved by the Rhode Island Public Utilities Commission in Docket 4185. Recognizing that the approval was based several factors other than price, the originally approved PPA price for this project was $244/MWh, also escalating at 3.5% per year for 20 years, was also both significantly above projected market prices for energy and RECs and significantly above the proposed PPA price for the Revolution wind project in this docket.

[13] Massachusetts D.P.U. Docket 10-54.

[14] Massachusetts D.P.U, Order approving the Contract between Nantucket and Cape Wind Associate, D.P.U. 10-54, November 22, 2010

Finally, the Massachusetts D.P.U. approved two PPAs with the winning bidder in its first solicitation for offshore wind projects under Section 83(C) of the Green Communities Act, Vineyard Wind. The two PPAs represent two phases of the same 800 MW project (each phase representing 400 MW of capacity). Each PPA is for a duration of 20 years. The prices are $74/MWh and $65/MWh respectively, escalating by 2.5% per year. The two phases of the project have commercial operating dates that are one year apart. Simply averaging the PPA price over time results in a price of $95.79/MWh for Phase 1 and of $89.41/MWh for combined phases 1 and 2.[15] The price of the proposed PPA for Revolution Wind is $98.425/MWh without escalation. Using a simple comparison, it is between 2.7% and 10.1% above the Vineyard Wind PPA price. Given my above discussion related to the fact that bids for renewable projects in a competitive auction are typically not identical, given underlying cost differences, but that it may well be reasonable to procure projects with bid prices above the lowest bid as long as total benefits exceed total cost, the slightly higher price of the proposed PPA when compared to the Vineyard Wind projected selected by Massachusetts does not mean that the proposed PPA is commercially unreasonable. Rather, the opposite is the case. This is because policy goals or mandates may make it necessary to procure resources from more than one project, in which case additional procurements may well occur at prices that are higher than the lowest bidder. Also other factors that can make procurements at higher prices commercially reasonable. Those reason include, for example, that projects with different prices have different economic impacts such as producing output during periods of higher electricity prices or are have higher local impacts such that their total benefits may equal or exceed those of a lower priced project.

[15] Using the same levelization approach I applied above results in a levelized price of the Phase 1 project of $89.50/MWh and of $85.79/MWh for the combined project. For the combined project, I assumed the second phase would start one year after the first. Since both phases are of equal size, I calculated the NPV over a 21-year period and applied half the year 1 project of Phase 1 and half the year 21 project of Phase 2.

Q. Have you had an opportunity to review the Advisory Opinion filed by the Rhode Island Office Of Energy Resources (OER) in this Docket?

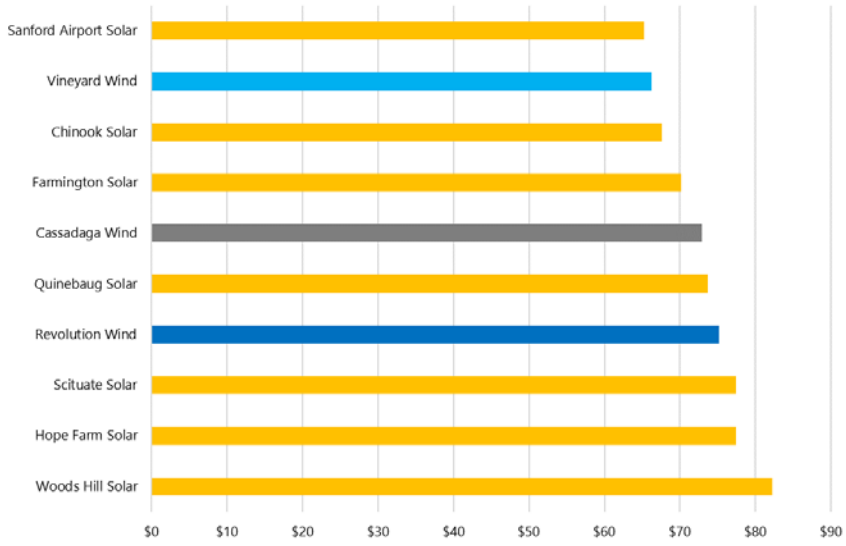
A. Yes, I have.

Q. Did OER's opinion compare prices for recently contracted renewable energy resources?

A. Yes, according to the OER's advisory opinion: "At OER's direction, Power Advisory compared the Revolution Wind contract pricing against other recent renewable energy power purchase agreements. This comparison included Massachusetts' 800 MW Vineyard Wind selection and Commission-approved contracts that resulted from a Multi-State Clean Energy RFP (w/ MA & CT and approved in Rhode Island on February 9, 2018 in Docket #4764)." The advisory opinion contained the following table summarizing the comparison:

Figure 1

Price Comparison of Recently-Contracted Renewable Energy Resources (Real Levelized 2018$/MWh)



OER's advisory opinion went on to state:

> "Figure 1 above indicates that the proposed pricing for Revolution Wind compares favorably with other renewable energy projects recently contracted by National Grid on behalf of Rhode Island consumers and approved by the Commission. However, this comparison is of the *cost* of the proposals, not of their respective value or *benefits* and how these compare to the costs. With higher capacity factors during the winter period, when New England's fuel security risks are greatest and market prices highest, the output of offshore wind generation is particularly valuable."

Q. Do you concur?

A. I have not independently verified the results of Figure 1 above, but they are consistent with my own review of pricing for various regional renewable energy projects above, which showed that there are even procurements, mostly for smaller scale renewable projects, that occur at prices significantly above those highlighted in Figure 1. OER's argument about commercial reasonableness depending not just on cost, but also on benefits (such as the value of production including during unusual events) is also consistent with the arguments made above.

III. Conclusion

Q. Does this conclude your testimony?

A. Aside from reviewing testimony from any other party in this Docket, yes it does.

EXHIBIT 1

JÜRGEN WEISS

Principal

Boston, MA and Brussels, Belgium | +1.617.864.7900 | Jurgen.Weiss@brattle.com

Dr. Jürgen Weiss is an energy and industrial organizations economist with 20 years of consulting experience in the United States, Europe and the Middle East. He specializes in issues broadly motivated by climate change concerns, such as electrification of transportation (and heating) and deep decarbonization of the power sector and the impact these changes have on existing assets, market structures, long-term planning needs and business models for electric utilities in North America, Europe, and the Middle East. He also works frequently on antitrust and competition issues in Europe and the United States.

Dr. Weiss has consulted and written substantially on renewable energy issues including offshore wind, electrification, carbon pricing and carbon and electricity market design, energy efficiency, conservation, storage, retail rates, renewable power and Renewable Portfolio Standards. Dr. Weiss has testified in U.S. state and federal courts, as well as in state regulatory proceedings. He has served on advisory councils as diverse as one for California's Low Carbon Fuel Standard, the King Abdullah City of Atomic and Renewable Energy in Saudi Arabia and the Department of Energy's Wind Vision Task Force.

Prior to joining The Brattle Group, Dr. Weiss was a co-founder and managing director of Watermark Economics. In addition, he was previously the managing director of Point Carbon's global advisory practice and a director at LECG. Dr. Weiss is currently a senior non-resident fellow at Boston University's Institute for Sustainable Energy.

AREAS OF EXPERTISE

- Climate Change and Deep Decarbonization Economics
- Electric Power
- Competition, Market Design and Valuation

EDUCATION

Dr. Weiss holds a B.A. in European Business Administration from ESB Reutlingen (Germany) and CESEM Reims (France), an MBA from Columbia University and a Ph.D. in Business Economics from Harvard University.

EXPERIENCE

Renewable Energy, Climate Change and Deep Decarbonization

- For EPRI, Dr. Weiss is currently part of a Brattle team including Nobel Prize Laureate and Brattle Principal Prof. Dan McFadden developing of a discrete choice-based electric vehicle adoption model. (ongoing)
- For EEI, Dr. Weiss is currently part of a Brattle team supporting EEI in developing a paper on EV charge rate design options for DC fast charging infrastructure available to utilities, based on existing rates or rate proposals in the United States. (ongoing)
- For the developer of various offshore wind facilities, Dr. Weiss is conducting various economic assessments of the impact of individual wind projects on energy markets and the economy in several states on the Atlantic seaboard. (ongoing)
- For the New Hampshire Attorney General's Office, Dr. Weiss was serving as an expert witness evaluating the energy, capacity and environmental benefits of the Northern Pass transmission project, a proposed HVDC transmission line linking the Canadian Province of Quebec with the New England power system. (2017-18)
- For the New York Independent System Operator (NYISO), Dr. Weiss is part of a Brattle team developing a proposal to use an ISO-based carbon price as a tool to reach 2030 State decarbonization goals. (ongoing)
- For the Office of Energy Resources of the State of Rhode Island, Dr. Weiss and his colleague Dr. Berkman performed an economic and environmental impact analysis of the State's Renewable Energy Growth (REG) Program. (2017)
- For a coalition of municipal utilities, Dr. Weiss assessed the Scoping Plan Update proposed by the California Air Resources Board (CARB) to meet the greenhouse gas reduction targets under Senate Bill 350 (SB350) for the purposes of allowing the coalition to make comments to CARB. (2017)
- For a power cooperative in Kentucky, Dr. Weiss and Brattle colleague Jamie Read helped develop a voluntary retail tariff that allows coop members to participate in a shared community scale solar PV facility selling output into wholesale markets. Tariff was approved by the Kentucky Public Utility Commission. (2016)
- For Hawaiian Electric, Dr. Weiss was part of a Brattle team heling HECO's prepare a proposed integrated resource plan for the Hawaiian Public Utilities Commission to meet with required full decarbonization goal by 2045. (2016)

- For the Singapore Electricity Market Authority, Dr. Weiss led a Brattle team to explore the impact of increasing levels of solar PV penetration on the ancillary service requirements of the Singapore Market, resulting in a set of recommendations concerning options for charging for such incremental reserves once solar PV penetration reaches certain levels. (2016)
- For the Advanced Energy Economy Institute, Dr. Weiss led a Brattle effort to investigate best practices in the integration of renewable energy through two cases studies of U.S. systems with relatively high shares of renewable energy, namely Xcel Colorado on ERCOT. (2015)
- Dr. Weiss assisted the Australian Energy Market Commission in developing options for the development of a Safeguard Mechanism to assure that greenhouse gas emissions from existing power plants will not exceed baseline emissions in the future. (2015)
- For the Advanced Energy Economy Institute, Dr. Weiss led a team of Brattle experts to assess the North American Electric Reliability Corporation's (NERC) initial reliability assessment of the U.S. Environmental Protection Agency's Clean Power Plan, which is designed to lower greenhouse gas emissions from existing power plants. The project involved assessing NERC's review and providing a range of options for providing reliability while complying with the Clean Power Plan. (2015)
- For the Saudi Arabian electricity regulator, Dr. Weiss developed a roadmap for combined heat and power projects, which involves technology screening, cost-benefit analysis, market sizing, identification of regulatory barriers and the proposal of regulatory and policy solutions to increase the penetration of economically beneficial CHP applications in industry, seawater desalination and district cooling. (2014/15)
- For the Solar Energy Industry Association, Dr. Weiss authored a report examining the experience with Germany's solar PV support programs in detail. The report evaluated the impact of Germany's system of feed-in tariffs (FITs) on the cost of solar, retail rates, macroeconomic competitiveness, greenhouse gas emissions and system reliability, with an eye towards lessons that can be learned from the German experience. (2014)
- For the Office of Energy Resources of the State of Rhode Island, Dr. Weiss and his colleague Dr. Berkman performed an economic and environmental impact analysis of the State' distributed energy and renewable energy fund programs. (2013-2014)
- For the European Bank for Reconstruction and Development (EBRD) and as part of a team led by the law firm Pierce Atwood LLP, Dr. Weiss was responsible for developing an economic and environmental impact assessment of a large number of proposed changes to the laws of

Kazakhstan in the areas of water, waste and energy/air emissions designed to move the country toward a Green Economy. (2013-2014)

- For the Texas Clean Energy Coalition, Dr. Weiss was a co-author of several reports analyzing in detail the potential performance of natural gas-fired versus wind and solar generation in ERCOT using a novel modeling approach combining long-term capacity expansion modeling and very short-term production costing modeling including various ancillary services markets. A 2014 update examined the implications for the same trade off once combined heat and power as well as demand response programs were more carefully evaluated. (2013/2014)
- On behalf of Great River Energy, a large mid-western generation and transmission utility, Dr. Weiss developed a proposal to use an ISO-based carbon pricing mechanism as a way to comply with Section 111(d) of the United States Clean Air Act ("Existing Source Rule") (2013-2014)
- For the Saudi Arabian electricity regulator, Dr. Weiss helped evaluate the implications of Saudi Arabia's ambitious renewable energy goals on the existing and future Saudi electric system, including an analysis of appropriate incentive structures, transmission upgrades and regulatory changes (2013).
- On behalf of a group of not-for-profit organizations including the Center for American Progress, the Sierra Club, the Clean Energy States Alliance and the US Offshore Wind Collaborative, Dr. Weiss lead a study on the economic impact of scaling offshore wind energy to the point where it might reach grid parity with conventional sources of electricity (2013).
- For a private renewable energy developer, Dr. Weiss co-authored a study on the impact of long-term contracting for renewable energy projects on the levelized costs of such projects and the resulting potential resulting benefits to ratepayers from acquiring renewable energy through bundled long-term contracts rather than either contracts for only individual attributes or merchant sales (2013).
- Dr. Weiss co-authored a report for the Bipartisan Policy Center analyzing the domestic and international experience with various forms or renewable energy support, drawing lessons about key elements of a successful U.S. renewable support policy (2012).
- Dr. Weiss led a Brattle team on two reports for the Solar Energy Industry Association analyzing the hypothetical impact of additional amounts of PV capacity on wholesale prices, customer payments and greenhouse gas emissions in Texas and New York respectively (2012).

- For a major California electric utility, Dr. Weiss helped develop an experimental simulation design to test the market rules of the proposed greenhouse gas cap and trade market scheduled to begin operations in the fall of 2012 (2012).
- Dr. Weiss served on the Advisory Panel on the Low Carbon Fuel Standard for the California Air Resources Board (2011).
- Dr. Weiss served as a member of the Advisory Panel to KA-CARE (King Abdullah City of Atomic and Renewable Energy), where he helped the Kingdom of Saudi Arabia evaluate various proposals to foster the development of renewable energy in the context of the construction of a new city (2011).
- Dr. Weiss evaluated several renewable power long-term power purchasing agreements for the MA Office of the Attorney General and served as an expert witness in related regulatory proceedings before the Massachusetts Department of Public Utilities (2010/2011/2013).
- For a major European electric utility, Dr. Weiss prepared and presented an analysis of various approaches to financing energy efficiency projects, including an assessment of their ability to address various perceived barriers to the widespread deployment of energy efficiency programs (2011).
- For the trading operation of a major German electric utility, Dr. Weiss prepared and presented an analysis of the impact of a 100% fossil-free energy supply on various aspects of wholesale electricity markets, both in the long-run and along a transition path of increased penetration of intermittent renewable resources (2011).
- Dr. Weiss co-authored two reports with Dr. Mark Sarro based on Brattle's analysis of the impact of AB 32 on small businesses in California. The study, commissioned by the Union of Concerned Scientists, analyzed both the impact of AB 32 on various energy prices such as electricity, natural gas and transportation fuels and the impact such price increases might have on small businesses, based on overall small business statistics as well as discounted cash flow analyses of two specific small businesses (2010).
- On behalf of the Massachusetts Attorney General Dr. Weiss served as an expert witness in the Cape Wind proceeding, in which approval of a 15-year power purchasing agreement for the output from the 468MW offshore wind project was sought. The analysis focused on a comparison of the terms of the proposed PPA to the costs of comparable offshore wind projects and contracts in the United States and Europe (2010).

- For a developer of HVDC transmission lines, Dr. Weiss prepared a report assessing the comparable cost of various renewable energy options to be delivered into the Southeastern United States, including the delivery of wind resources from within or outside the region and through existing AC transmission networks and/or new DC transmission lines. The analysis involved a comparison of levelized costs of various options as well as a calculation of GHG reductions resulting from increased renewable generation (2010).
- Dr. Weiss participated in the preparation of a report for a large European industry association, which made several suggestions regarding the design of auctions for Phase III of the European Union Emissions Trading Scheme (EU ETS). The analysis addressed issues such as price discovery, price certainty, avoidance of market manipulation, tools for allowing participation to smaller emitters, etc. (2010).
- For a US-based not-for profit organization, Dr. Weiss helped develop a report on the potential scope for a United States "green bank" with particular emphasis on the ability of such an entity to address energy efficiency market failure issues (2009/2010).
- For a US-based merchant power developer, Dr. Weiss evaluated the levelized costs of a range of technologies including nuclear, new conventional coal fired generation, new CCGTs, onshore wind, offshore wind and photovoltaic power in comparison with a proposed Integrated Gasification Combined Cycle plant (2009).
- For a number of private and public clients, Dr. Weiss participated in the development of a global model of carbon pricing under a variety of policy assumptions (2008).
- For the National Roundtable on the Environment and the Economy (NRTEE) of Canada, Dr. Weiss helped develop a report analyzing the non-price barriers to the deployment of various energy efficiency technologies in Canada as part of Canada's efforts to lower greenhouse gas emissions, including in particular ground source heat pumps (2008).
- For the California Public Utilities Commission, Dr. Weiss provided consulting support for the development of a tradable Renewable Energy Certificates (REC) scheme within the context of California's existing Renewable Portfolio Standard (2007).

Competition / Market Design / Valuation

- Dr. Weiss has been serving as an expert on behalf of a major elevator manufacturer on a number of merger and competition cases involving the elevator industry in various European countries (2010 to present).

- For a larger private equity firm, Dr. Weiss helped evaluate the potential value of a large group of Midwestern combined cycle gas turbines covered by a complex power purchasing agreement, the value of which depended on a number of factors such as the potential retirement of various coal plants in the region (2012).
- Dr. Weiss assisted a Chinese power company in evaluating various options to develop and economically operate electricity storage systems in China (2011).
- Dr. Weiss was a testifying expert on international assets in a litigation matter brought by a successor to Mirant against the Southern Company. Dr. Weiss testified to the value and value drivers of assets in Germany, the United Kingdom, the Philippines, China, Argentina, Chile, Brazil and several Caribbean countries. The assets considered included single power plants (mostly with PPAs), vertically integrated electric utilities and electric distribution utilities (2007/2008).
- Dr. Weiss was a testifying expert in a litigation case over a Power Purchasing Agreement between a major U.S. electric utility and a power marketer. In his testimony, Dr. Weiss analyzed the value of replacement power offered during a construction delay of the associated co-generation facility (2005).
- On two separate occasions, Dr. Weiss valued a proposed PPA in the context of the contemplated sale of Vermont Yankee Nuclear Plant. The testimony involved the comparison of price and terms of a proposed PPA to alternative market payments (2000, 2002).

TESTIMONY

Direct Prefiled Testimony and Report entitled „Electricity Market Impacts of the Proposed Northern Pass Transmission Project: Supplemental Report", submitted by Dr. Samuel Newell and Dr. Jurgen Weiss, prepared for The New Hampshire Counsel for the Public and filed in front of the New Hampshire Site Evaluation Committee in Docket No. 2015-06. (April 17, 2017)

Direct Prefiled Testimony and Report entitled „Electricity Market Impacts of the Proposed Northern Pass Transmission Project", submitted by Dr. Samuel Newell and Dr. Jurgen Weiss, prepared for The New Hampshire Counsel for the Public and filed in front of the New Hampshire Site Evaluation Committee in Docket No. 2015-06. (February 10, 2017)

„Technische Innovationen in der Aufzugsindustrie zwischen 1995 und 2005", submitted by Dr. Jürgen Weiss and Dr. Robert J. Reynold. (September 2015)

Direct Prefiled Testimony and Exhibits of Judy W. Chang and Jurgen Weiss, Ph.D. in Response to Fitchburg Gas and Electric Company's Petition for Approval of a Purchase Power and Renewable Energy

Certificate Contract in accordance with the requirements of Section 83A of the Massachusetts Green Communities Act and the Request for Proposal Process approved by the Department of Public Utilities in D.P.U. 13-57, in front of the Massachusetts Department of Public Utilities, Docket No. D.P.U. 13-146 (November 2013).

Direct Prefiled Testimony and Exhibits of Judy W. Chang and Jurgen Weiss, Ph.D. in Response to Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid's Petition for Approval of a Purchase Power and Renewable Energy Certificate Contract in accordance with the requirements of Section 83A of the Massachusetts Green Communities Act and the Request for Proposal Process approved by the Department of Public Utilities in D.P.U. 13-57, in front of the Massachusetts Department of Public Utilities, Docket No. D.P.U. 13-147 (November 2013).

Direct Prefiled Testimony and Exhibits of Judy W. Chang and Jurgen Weiss, Ph.D. in Response to NSTAR Electric Company's Petition for Approval of a Purchase Power and Renewable Energy Certificate Contract in accordance with the requirements of Section 83A of the Massachusetts Green Communities Act and the Request for Proposal Process approved by the Department of Public Utilities in D.P.U. 13-57, in front of the Massachusetts Department of Public Utilities, Docket No. D.P.U. 13-148 (November 2013).

Direct Prefiled Testimony and Exhibits of Judy W. Chang and Jurgen Weiss, Ph.D. in Response to Western Massachusetts Electric Company's Petition for Approval of a Purchase Power and Renewable Energy Certificate Contract in accordance with the requirements of Section 83A of the Massachusetts Green Communities Act and the Request for Proposal Process approved by the Department of Public Utilities in D.P.U. 13-57, in front of the Massachusetts Department of Public Utilities, Docket No. D.P.U. 13-149 (November 2013).

Direct Prefiled Testimony of Judy Chang and Dr. Jurgen Weiss in Response to Fitchburg Gas and Electric Company's Petitions for Approval of a Purchase Power and Renewable Energy Certificate Contract in accordance with the requirements of the Act Relative to Green Communities (St. 2008, c. 169, § 83) and the Request for Proposal Process approved by the Department of Public Utilities in D.P.U. 10-76, in front of the Massachusetts Department of Public Utilities, Docket No. 11-30 (July 2011).

Direct Prefiled Testimony of Judy Chang and Dr. Jurgen Weiss in Response to Western Massachusetts Electric Company's Petitions for Approval of a Purchase Power and Renewable Energy Certificate Contract in accordance with the requirements of the Act Relative to Green Communities (St. 2008, c. 169, § 83) and the Request for Proposal Process approved by the Department of Public Utilities in D.P.U. 10-76, in front of the Massachusetts Department of Public Utilities, Docket No. 11-12 (June 2011).

Direct Testimony of Judy Chang and Dr. Jurgen Weiss in Response to NSTAR Electric Company's Petitions for Approval of a Purchase Power and Renewable Energy Certificate Contract in accordance with the requirements of the Act Relative to Green Communities (St. 2008, c. 169, § 83) and the Request for Proposal Process approved by the Department of Public Utilities in D.P.U. 10-76, in front of the Massachusetts Department of Public Utilities, Dockets No. 11-05, 11-06 and 11-07 (June 2011).

Direct Prefiled Testimony of Judy Chang and Dr. Jurgen Weiss in Response to NSTAR Electric Company's Petitions for Approval of a Purchase Power and Renewable Energy Certificate Contract in accordance

with the requirements of the Act Relative to Green Communities (St. 2008, c. 169, § 83) and the Request for Proposal Process approved by the Department of Public Utilities in D.P.U. 10-76, in front of the Massachusetts Department of Public Utilities, Dockets No. 11-05, 11-06 and 11-07 (May 2011).

Gutachterliche Stellungnahme zum Gutachten von Mag. Dr. Dr. Doris Hildebrand, LL.M. der EE&MC GmbH "Schadensberechnung österreichisches Aufzugs- und Fahrtreppenkartell: Teil A" von Dr. Robert J. Reynolds und Dr. Mag. Mag. Jürgen Weiss, (October 2010).

Gutacherliche Stellungnahme zum Gutachten vom November 2009 von O. Univ.-Prof. Dr. Hanns Abele und Ao. Univ.-Prof. Dr. Guido Schäfer bezüglich Schadensersatz von Uniqa, Dr. Robert J. Reynolds und Dr. Jürgen Weiss, (October 2010).

Gutacherliche Stellungnahme zum Gutachten von Prof. Hanns Abele und Prof. Guido Schäfer betreffend Die ökonomischen Konsequenzen der Kartellbildung Aufzugbranche in Österreich – Ermittlung der Kartellpreisaufschläge (Juni 2009)", Dr. Robert J. Reynolds und Dr. Jürgen Weiss, (September 2010).

Direct Testimony of Dr. Jurgen Weiss and Judy Chang in Response to the Petition of Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid for approval by the Department of Public Utilities of amended power purchase agreements between National Grid and Cape Wind Associates, LLC., in front of the Massachusetts Department of Public Utilities, Docket No. 10-54 (September, 2010).

Direct Prefiled Testimony of Dr. Jurgen Weiss and Judy Chang in Response to the Petition of Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid for approval by the Department of Public Utilities of amended power purchase agreements between National Grid and Cape Wind Associates, LLC., in front of the Massachusetts Department of Public Utilities, Docket No. 10-54 (August 20, 2010).

Deposition of Dr. Jurgen Weiss in MC ASSET RECOVERY, LLC, Plaintiff, v. THE SOUTHERN COMPANY, Defendant, CIVIL ACTION No. 1:06-CV-0417-BBM (February 2008).

Expert Report of Dr. Jurgen Weiss in MC ASSET RECOVERY, LLC, Plaintiff, v. THE SOUTHERN COMPANY, Defendant, CIVIL ACTION No. 1:06-CV-0417-BBM (December 2007).

Deposition in re: Welding Rod Products Liability Litigation, Case No. 1:03-CV-17000 MDL Docket No. 1535 (May 2005).

Deposition in Tractebel Energy Marketing, Inc., Plaintiff, against AEP Power Marketing, Inc., American Electric Power Company, Inc., and Ohio Power Company, defendants, 03 CIV.6731(HB)(JCF); and Ohio Power Company and AEP Power Marketing, Inc., Plaintiff, against Tractebel Energy Marketing, Inc. and Tractebel S.A. (now known as Suez-Tractebel S.A.), Defendants. 03 CIV.6770(HB)(JCF) (March 2005).

Preliminary Expert Witness Declaration of Jurgen Weiss, Ph.D. in re: Welding Rod Products Liability Litigation, Case No. 1:03-CV-17000 MDL Docket No. 1535 (February 2005).

Rebuttal Report of Dr. Jurgen Weiss in Tractebel Energy Marketing, Inc., Plaintiff, against AEP Power Marketing, Inc., American Electric Power Company, Inc., and Ohio Power Company, defendants, 03 CIV.6731(HB)(JCF); and Ohio Power Company and AEP Power Marketing, Inc., Plaintiff, against Tractebel Energy Marketing, Inc. and Tractebel S.A. (now known as Suez-Tractebel S.A.), Defendants. 03 CIV.6770(HB)(JCF) (February 2005).

Direct Testimony of Dr. Jurgen Weiss in Petition and tariff filing of Green Mountain Power Corporation re: proposed rate design changes to take effect January 1, 2005, in front of the Vermont Public Service Board, Docket No. 6958 (December 2004).

Prefiled Surrebuttal Testimony of Dr. Jurgen Weiss in Petition and tariff filing of Green Mountain Power Corporation re: proposed rate design changes to take effect January 1, 2005, in front of the Vermont Public Service Board, Docket No. 6958 (November 2004).

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Expert Report of Dr. Jurgen Weiss in Keith Lemon and Lori Lemon, Plaintiffs, vs. Daniel P. McNeil and West Lynn Creamery, Defendants, in Superior Court of the Commonwealth of Massachusetts, (August 2004).

Direct Testimony of Dr. Jurgen Weiss in Investigation into General Order No.45 filed by Vermont Yankee Nuclear Power Corporation re: proposed sale of Vermont Yankee Nuclear Power Station and related transactions, in front of the Vermont Public Service Board, Docket No. 6545 (2002).

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PUBLICATIONS AND PUBLIC REPORTS

"The Electrified Future is Shared", Jürgen Weiss, Public Utilities Fortnightly, PUF 2.0, Mid-February 2018

"The electrification accelerator: Understanding the implications of autonomous vehicles for electric utilities", Jürgen Weiss, Ryan Hledik, Roger Lueken, Tony Lee, Will Gorman, The Electricity Journal 30 (2017) 50–57, December 2017

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"Hurry or Wait? Pacing the rollout of renewable energy in the face of climate change risk", Jurgen Weiss and Dean Murphy, Working Paper, Boston University Institute for Sustainable Energy, November 2016

"LNG and Renewable Power: Risk and Opportunity in a Changing World", with Steven Levine, Yingxia Yang and Anul Thapa, January 15, 2016

"The Clean Power Plan: Focus on Implementation and Compliance", with Marc Chupka, Metin Celebi, Judy Chang, Ira Shavel, Kathleen Spees, Pearl Donohoo-Vallett, Michael Hagerty and Michael Kline, The Brattle Group Issue Brief, January 2016

"Hurry or Wait – The Pros and Cons of Going Fast or Slow on Climate Change", with Eleanor Denny, The Economists Voice, 2015, 12(1)

"EPA's Clean Power Plan and Reliability: Assessing NERC's Initial Reliability Review", Jürgen Weiss, Bruce Tsuchida, Michael Hagerty, and Will Gorman, prepared for the Advanced Energy Economy Institute, February 2015.

"What can (or should) we take away from Germany's renewable experience?" Electricity Daily, January 2015.

"Germany's Energiewende Enjoys Broad Support, But Policy and Technical Challenges Must be Solved", Published in Climate Change Business Journal, Volume VII, December 2014.

"Solar Energy Support in Germany: A Closer Look", Prepared for the Solar Energy Industries Association, July 2014.

"Policy Brief - EPA's Proposed Clean Power Plan: Implications for States and the Electric Industry", Metin Celebi, Kathleen Spees, Michael Hagerty, Samuel A. Newell, Dean M. Murphy, Marc Chupka, Jürgen Weiss, Judy Chang, and Ira H. Shavel, June 2014.

"Mut zum Ausstieg," Jürgen Weiss, *Handelsblatt*, No. 44, March 4, 2013.

"What is the role of cap-and-trade schemes in reducing CO2 and other greenhouse gas emissions?" Jurgen Weiss, in *Comment Visions*, February 7, 2013, http://www.commentvisions.com/#play.

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"Gas Demand Response: Are LDCs and customers ready for dynamic prices?" Ahmad Faruqui and Jurgen Weiss, Fortnightly's SPARK, August 25, 2011, http://spark.fortnightly.com.

"What Does Copenhagen Mean for Investments in Low-Carbon Technologies?," Jürgen Weiss, *The Journal of Environmental Investing*, Beyond Copenhagen, Vol 1, No. 1 (2010), www.thejei.com.

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"Estimating the value of electricity storage in PJM: Arbitrage and some welfare effects," Jürgen Weiss, Ramteen Sioshansi, Paul Denholm, and Thomas Jenkin, *Energy Economics*, Vol 31 (2009), pp.269-277.

"Are REC Markets a Wreck Waiting to Happen?" Jürgen Weiss, *Natural Gas & Electricity*, Vol. 23, No. 4, November 2006.

"A Solution for a Very Old Problem," Jürgen Weiss and Hoff Stauffer, *The Electricity Journal*, Vol. 19 Issue 4, May 2006.

"Market Power and Power Markets," Jürgen Weiss, *Interfaces*, Volume 32, No. 5, September-October 2002, pp (37-46).

"New Economy Litigation: Claims to Intellectual Property and Human Capital in a Global Institutional Environment Changing at the Speed of Thought," Jürgen Weiss, Mark Sarro, and Kenneth D. Gartrell, International Society of New Institutional Economics, September 2001.

"Netzzugang in Deutschland im internationalen Vergleich," Jürgen Weiss, Wolfgang Pfaffenberger, Carlos Lapuerta, Hannes Pfeifenberger, Energiewirtschaftliche Tagesfragen, Band 49, Heft 7, 1999, pp (446-451).

LANGUAGES

Dr. Weiss is trilingual in English, German and French and has been active professionally in all three languages.

CERTIFICATION

I hereby certify that on April 5, 2019, I sent a copy of the within to all parties set forth on the attached Service List by electronic mail and copies to Luly Massaro, Commission Clerk, by electronic mail and by hand delivery.

Name/Address	E-mail Distribution	Phone
National Grid John K. Habib, Esq. Keegan Werlin LLP 99 High Street, Suite 2900 Boston, MA 02110	Jhabib@keeganwerlin.com; MStern@keeganwerlin.com; Jdunne@keeganwerlin.com; Corinne.didomenico@nationalgrid.com; Timothy.brennan@nationalgrid.com; Joanne.scanlon@nationalgrid.com;	617-951-1354
Jon Hagopian, Esq. **Division of Public Utilities & Carriers** 89 Jefferson Blvd. Warwick, RI 02888	Jon.hagopian@dpuc.ri.gov; John.bell@dpuc.ri.gov; Ronald.Gerwatowski@dpuc.ri.gov; Thomas.kogut@dpuc.ri.gov; Jonathan.Schrag@dpuc.ri.gov;	401-784-4775
Office of Energy Resources Andrew Marcaccio, Esq. Carol Grant, Commissioner Christopher Kearns, OER Nicholas Ucci, OER	Andrew.Marcaccio@doa.ri.gov; Christopher.Kearns@energy.ri.gov; Nicholas.Ucci@energy.ri.gov; Carol.Grant@energy.ri.gov;	
John Dalton Carson Robers Power Advisory LLC	crobers@poweradvisoryllc.com; jdalton@poweradvisoryllc.com;	
DWW Rev I, LLC Joseph A. Keough Jr., Esquire Keough + Sweeney, Ltd. 41 Mendon Avenue Pawtucket, Rhode Island 02861	jkeoughjr@keoughsweeney.com;	401-724-3600
Conservation Law Foundation (CLF) James Crowley, Esq. Conservation Law Foundation 235 Promenade St., Suite 560, Mailbox 28 Providence, RI 02908	jcrowley@clf.org;	401-228-1905
File an original & 9 copies w/: Luly E. Massaro, Commission Clerk Cynthia Wilson-Frias, Commission Counsel Public Utilities Commission 89 Jefferson Blvd. Warwick, RI 02888	Luly.massaro@puc.ri.gov; Alan.nault@puc.ri.gov; Todd.bianco@puc.ri.gov; Cynthia.WilsonFrias@puc.ri.gov; Margaret.Hogan@puc.ri.gov;	401-780-2017

Orsted US Offshore Wind: Stacy Tingley David Schwartz Jeffrey Grybowski	STATI@orsted.com; DSCHW@orsted.com; JEFGR@orsted.com;	
Coit, Janet, DEM Director Christina Hoefsmit, Esq.	Janet.Coit@dem.ri.gov; Christina.Hoefsmit@dem.ri.gov; Mary.Kay@dem.ri.gov; Ron.Gagnon@dem.ri.gov; Julia.Livermore@dem.ri.gov;	
Jesse Saglio, RI Commerce Corporation	jesse.saglio@commerceri.com; hilary.fagan@commerceri.com; Kara.Kunst@commerce.ri.gov;	
Tom Carlotto, Esq.	tec@shslawfirm.com;	
Ted Nesi	TNesi@wpri.com;	
Chris Bergenheim	Bergenheim@pbn.com;	

Joseph A. Keough, Jr., Esquire # 4925
KEOUGH + SWEENEY, LTD.
41 Mendon Avenue
Pawtucket, RI 02861
(401) 724-3600
jkeoughjr@keoughsweeney.com