

**Before the
Rhode Island Public Utilities Commission**

Proceeding on the Narragansett Electric)
Company d/b/a National Grid Proposed)
FY 2019 Electric Infrastructure, Safety,)
And Reliability Plan)

Docket No. 4783

**Direct Testimony of
Tim Woolf and Melissa Whited**

On the Topic of
National Grid's Advanced Metering Functionality Pilot

On Behalf of
The Division of Public Utilities and Carriers

February 22, 2018

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1 **1. INTRODUCTION AND QUALIFICATIONS**

2 **Q. Please state your name, title, and employer.**

3 A. **Mr. Woolf:** My name is Tim Woolf. I am the Vice President at Synapse Energy
4 Economics, located at 485 Massachusetts Avenue, Cambridge, MA 02139.

5 A. **Ms. Whited:** My name is Melissa Whited. I am a Principal Associate at Synapse Energy
6 Economics, located at 485 Massachusetts Avenue, Cambridge, MA 02139.

7 **Q. Please describe Synapse Energy Economics.**

8 A. Synapse Energy Economics is a research and consulting firm specializing in electricity
9 and gas industry regulation, planning, and analysis. Our work covers a range of issues,
10 including economic and technical assessments of demand-side and supply-side energy
11 resources; energy efficiency policies and programs; integrated resource planning;
12 electricity market modeling and assessment; renewable resource technologies and
13 policies; and climate change strategies. Synapse works for a wide range of clients,
14 including state attorneys general, offices of consumer advocates, trade associations,
15 public utility commissions, environmental advocates, the U.S. Environmental Protection
16 Agency, U.S. Department of Energy, U.S. Department of Justice, the Federal Trade
17 Commission, and the National Association of Regulatory Utility Commissioners.
18 Synapse has over 25 professional staff with extensive experience in the electricity
19 industry.

20 **Q. Please summarize your professional and educational experience.**

21 A. **Mr. Woolf:** Before joining Synapse Energy Economics, I was a commissioner at the
22 Massachusetts Department of Public Utilities (DPU) from 2007 through 2011. In that

1 capacity, I was responsible for overseeing a substantial expansion of clean energy
2 policies, including significantly increased ratepayer-funded energy efficiency programs;
3 an update of the DPU energy efficiency guidelines; the implementation of decoupled
4 rates for electric and gas companies; the promulgation of net metering regulations; review
5 and approval of smart grid pilot programs; and review and approval of long-term
6 contracts for renewable power. I was also responsible for overseeing a variety of other
7 dockets before the Commission, including several electric and gas utility rate cases.

8 Prior to being a commissioner at the Massachusetts DPU, I was employed as the Vice
9 President at Synapse Energy Economics; a Manager at Tellus Institute; the Research
10 Director at the Association for the Conservation of Energy; a Staff Economist at the
11 Massachusetts Department of Public Utilities; and a Policy Analyst at the Massachusetts
12 Executive Office of Energy Resources.

13 I hold a Masters in Business Administration from Boston University, a Diploma in
14 Economics from the London School of Economics, a BS in Mechanical Engineering and
15 a BA in English from Tufts University. My resume is attached as Exhibit TW-1.

16 A. **Ms. Whited:** I have seven years of experience in economic research and consulting. At
17 Synapse, I have worked extensively on issues related to utility regulatory models, rate
18 design, policies to address distributed energy resources (DER), and market power. I have
19 testified before the Massachusetts Department of Public Utilities, the Hawaii Public
20 Utilities Commission, the Public Service Commission of Utah, the Public Utility
21 Commission of Texas, the Virginia State Corporation Commission, and the Federal
22 Energy Regulatory Commission.

1 I hold a Master of Arts in Agricultural and Applied Economics and a Master of Science
2 in Environment and Resources, both from the University of Wisconsin-Madison. Prior to
3 rejoining Synapse, I published in the Journal of Regional Analysis and Policy an article
4 regarding the economic impacts of water transfers, analyzed state water efficiency
5 policies while at the Wisconsin Public Service Commission, and conducted econometric
6 analyses of energy efficiency cost-effectiveness. My resume is attached as Exhibit MW-
7 1.

8 **Q. On whose behalf are you testifying in this case?**

9 A. We are testifying on behalf of the Division of Public Utilities and Carriers (the Division).

10 **Q. Have you previously testified before the Rhode Island Public Utilities Commission?**

11 A. **Mr. Woolf:** Yes. I have testified before the Rhode Island Public Utilities Commission
12 (the Commission) many times in the context of the National Grid Energy Efficiency and
13 System Reliability Plans. I was also an active member of the Docket 4600 Working
14 Group, and I assisted the Division with several aspects of the Rhode Island Power Sector
15 Transformation report recently submitted to Governor Raimondo. I am also currently
16 engaged by the Division as an expert witness in National Grid's rate case (Docket 4770)
17 and power sector transformation case (Docket 4780). In that capacity I have attended or
18 monitored technical sessions before the Commission.

19 **Ms. Whited:** No, I have not testified before the Commission.

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

2 A. The purpose of our testimony is to review and comment on the Advanced Metering
3 Infrastructure (AMI) pilot program included in National Grid's (the Company's) 2019
4 Electric Infrastructure, Safety, and Reliability (ISR) Plan.

5 **2. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS**

6 **Q. Please summarize your conclusions.**

7 A. Our conclusions are summarized as follows:

- 8 • There is no question that advanced metering functionality (AMF) will play a
9 critical role in the evolution and transformation of the power sector in Rhode
10 Island over time. AMF can offer multiple benefits to customers by enabling time-
11 varying rates, enabling distributed energy resources, providing customers and
12 third-parties with consumption pattern information, reducing O&M costs,
13 increasing the efficiency of volt-var optimization (VVO) programs, and
14 improving storm outage management.
- 15 • Analysis submitted by National Grid in its rate case (Dockets 4770 and 4780)
16 suggests that company-wide AMF could provide net benefits to customers under
17 the right conditions.
- 18 • The proposed AMF pilot is a critical step towards the realization of company-
19 wide AMF in Rhode Island. This pilot will provide the Company, the
20 Commission, the Division, and others with important information to guide
21 decisions regarding whether, when, and how to roll out company-wide AMF.

- 1 • The proposed pilot offers an opportunity for the Company, the Commission, the
2 Division, and other stakeholders to learn how one application of grid
3 modernization – volt-var optimization – can be deployed in an AMI-enabled
4 distribution environment.

- 5 • The proposed AMF pilot will also provide direct and immediate benefits by
6 increasing the efficiency enhancements provided by the VVO program.

7 **Q. Please summarize your recommendations.**

8 A. We recommend that the Commission approve the AMF pilot program as proposed by
9 National Grid.

10 **3. NATIONAL GRID’S PROPOSED AMF PILOT PROGRAM**

11 **Q. Please summarize the Company’s proposed AMF pilot.**

12 A. Prior to deploying AMF across the state, the Company proposes to conduct a pilot that
13 will test the joint deployment of AMF with Volt/Var Optimization and Conservation
14 Voltage Reduction (VVO/CVR). This pilot would entail replacing approximately 8,000
15 customer meters with AMF meters on six circuits served by the Washington substation
16 and utilizing these meters to achieve additional energy and demand reductions.

17 **Q. Why is the Company proposing to implement an AMF pilot in Rhode Island?**

18 A. In response to PUC-2-9, the Company explains that it views the AMI/VVO pilot as an
19 opportunity to quantify incremental energy and capacity savings from the planned
20 VVO/CVR expansion and gain operational lessons regarding the deployment of AMF
21 infrastructure that can be applied in a future deployment of system-wide AMI.

1 **Q. What benefits is the pilot expected to provide?**

2 A. The Company expects the pilot will provide several types of benefits:

- 3 • Additional data necessary to achieve a 1% incremental reduction in peak demand and
4 energy above the 3 percent already expected from the primary VVO/CVR
5 optimization,¹ for an annual total of 0.52 MW and 2,340 MWh.
- 6 • Identification of multiple device synergies from using AMF to expand VVO.²
- 7 • Training for Rhode Island personnel related to Field Area Network deployment.³
- 8 • Additional customer voltage information to identify power quality issues not captured
9 currently.⁴

10 **4. THE ROLE OF AMF IN RHODE ISLAND**

11 **Q. The Company's states that its proposal would improve the Company's**
12 **understanding of advanced metering functionality. How does this fit into the**
13 **broader context of AMF in Rhode Island?**

14 A. AMF has been identified as a key enabling technology for a modernized grid. For
15 example, the role of AMF in Rhode Island was addressed before the Commission in
16 Docket No. 4600, Investigation into the Changing Electric Distribution System. The
17 Commission opened Docket 4600 to “determine how rate modernization could

¹ Proposed FY 2019 Electric Infrastructure, Safety, and Reliability Plan, Docket 4783, December 21, 2017, page 42

² Response to PUC 2-24

³ Response to PUC 2-25

⁴ Response to PUC 2-23

1 accommodate and enhance an efficient modernization of the electric distribution
2 system.”⁵ In particular, the Commission sought to “develop a set of rate design principles
3 and a benefit-cost framework to inform how rates could be set in a way to properly incent
4 National Grid to meet state policies.”⁶

5 Docket 4600 was designed as a stakeholder process, which included a Working Group
6 composed of twelve stakeholders. The stakeholder process was managed by a facilitator,
7 in an attempt to develop consensus positions. On April 5, 2017 the Working Group
8 submitted to the Commission a Stakeholder Report describing the process, the areas
9 where stakeholders reached consensus, and several areas where consensus was not
10 reached. Synapse was actively engaged in the Docket 4600 Working Group on behalf of
11 the Division.

12 **Q. Please describe the 4600 Working Group’s findings as they relate to AMF.**

13 A. The Working Group addressed AMF because of its relationship to distribution system
14 planning and time-varying rates. The Working Group found that AMF would be
15 necessary to provide the system visibility for circuit-specific DER and distribution
16 system plans.⁷ In terms of time-varying rates, the Stakeholder report is clear that “TVR
17 offers an opportunity to provide efficient price signals across all resources,”⁸ and that the
18 “members of the Working Group all agree with the application of TVR over the long-

⁵ Rhode Island Public Utilities Commission, Investigation into the Changing Electric Distribution System and the Modernization of Rates in Light of the Changing Distribution System, Docket No. 4600, *PUC Report and Order No. 22851 Accepting the Stakeholder Report*, July 31, 2017, page 4.

⁶ *Ibid.*, pages 4-5.

⁷ Docket 4600 Stakeholder Working Group Report, submitted to the Rhode Island Public Utilities Commission, April 5, 2017, Appendix B.

⁸ *Ibid.*, page 15.

1 term.”⁹ That report is also clear that “until some form of advanced metering functionality
2 that provides data on time-specific usage is in place, TVR is not practical in Rhode
3 Island.”¹⁰

4 **Q. Please describe how AMF was addressed by the Commission in Docket 4600.**

5 A. In October 2017 the Commission issued its Goals, Principles, and Values for Matters
6 Involving the Narragansett Electric Company in Docket 4600 (the Guidance Document).
7 This document does not address AMF directly, as it was primarily focused on rate design
8 and cost-effectiveness issues.

9 Regarding rate design, the Guidance Document sets out several principles that should be
10 used by any party that seeks approval for new rate designs. Those principles do not
11 address any one rate design in particular. However, time-varying rates would be
12 consistent with several of the Commission’s rate design principles, including:¹¹

- 13 • Provides efficient price signals that reflect long-run marginal cost;
- 14 • Empowers customers to manage their costs;
- 15 • Ensure consistency with policy goals; and
- 16 • Encourage or discourage appropriate investments that enable the evolution of the
17 future energy system.

⁹ Ibid., page 16.

¹⁰ Ibid., page 16.

¹¹ Rhode Island Public Utilities Commission, Docket 4600, *Guidance on Goals, Principles, and Values for Matters Involving the Narragansett Electric Company*, October, 27, 2017, pages 4-5.

1 Time-varying rates could significantly advance these principles adopted by the
2 Commission. However, without advanced metering functionality, TVR cannot be
3 implemented company-wide.

4 **Q. Has AMF been addressed in other forums in Rhode Island?**

5 A. Yes, AMF has been addressed in the Power Sector Transformation (PST) Initiative. This
6 was an inter-agency collaborative effort of the Division, the Commission, and the Office
7 of Energy Resources (OER) to build on the consensus achieved in Docket 4600 to
8 advance four related topics: 1) utility business models; 2) grid connectivity and
9 functionality; 3) distribution system planning; and 4) beneficial electrification. The PST
10 initiative occurred between February and September 2017, and included significant
11 stakeholder engagement. The PST initiative concluded with a report to Governor
12 Raimondo in November 2017 (the PST Report).

13 **Q. Please describe what the PST Report said about the role of AMF in Rhode Island.**

14 A. The PST Report finds that “AMF is vital to accomplish many of the goals expressed in
15 the Power Sector Transformation Initiative.”¹² It lists the following advantages to
16 customers of AMF: “outage protection, faster outage restoration, access to various
17 pricing options that can save them money, access to energy efficiency and renewable
18 services tailored to their usage, and more efficient use of the distribution system that
19 creates consumer savings.”¹³

¹² Division of Public Utilities and Carriers, Office of Energy Resources, and Public Utilities Commission, *Rhode Island Power Sector Transformation*, Phase One Report to Governor Raimondo, November 2017, page 32.

¹³ *Ibid.*, page 32.

1 Further, the PST Report states that the “time for Rhode Island to invest in advanced
2 meters is now.”¹⁴ Many of the meters installed in Rhode Island are now reaching the end
3 of the useful life,¹⁵ and are currently being replaced at a rate of roughly 10,000-17,000
4 traditional meters per year.¹⁶ This means that for each passing year the Company may be
5 installing outdated meters that could soon become obsolete, while forgoing the
6 opportunity to achieve many potential customer benefits.

7 **Q. How should these previous discussions of AMF in Rhode Island inform the**
8 **evaluation of the Company’s proposed AMI/VVO pilot?**

9 A. These discussions demonstrate that AMF clearly has a vital role to play in Rhode Island
10 to help achieve state goals, facilitate the evolution towards a more efficient distribution
11 system, and provide benefits to customers. The Company’s proposed AMF pilot will help
12 to illuminate and quantify these benefits. Although the pilot maintains the conventional
13 utility-ownership approach, it uses the meter as a form of distributed intelligence to
14 provide service-level voltage data, enabling efficiency improvements beyond what could
15 be achieved under a conventional VVO approach.

¹⁴ Ibid., page 33.

¹⁵ According to the Company’s response to PUC 2-39, the Company forecasts needing to replace 66.4% of its existing meters over FY 2022 and 2023 as they reach the end of their useful lives.

¹⁶ *Rhode Island Power Sector Transformation*, Phase One Report, to Governor Raimondo, page 33.

1 **5. NATIONAL GRID'S PROPOSED COMPANY-WIDE AMF**

2 **Q. Please provide a brief description of the company-wide AMF proposal included in**
3 **National Grid's filing in Docket 4780.**

4 A. As part of Docket 4780, the Company is requesting approval to perform AMF design
5 work in FY 2019, with a complete proposal for AMF deployment to be filed by
6 December 1, 2018. Currently, the Company estimates that it will install back-office
7 systems in FY 2020, with electric meter and communication deployment commencing in
8 FY 2021.

9 **Q. Has the Company estimated the expected benefits and costs of full AMF deployment**
10 **in Rhode Island?**

11 A. Yes. In its testimony in Docket 4780, the Company presented the expected 20-year net
12 present value of a full roll-out of AMF in Rhode Island, either implemented jointly with
13 the Company's New York affiliate, or implemented only in Rhode Island. The Company
14 also estimated the net present value of the deployment with high and low savings from
15 customer price response under both opt-in and opt-out scenarios.

16 **Q. Is a full roll-out of AMF expected to be cost-effective?**

17 A. The Company's initial analysis, as presented in Docket 4780, shows AMF to be cost-
18 effective under most scenarios. The benefit-cost ratio ranges from a low of 0.79 under the
19 Rhode Island-Only Opt-In/Low Savings scenario to a high of 1.72 under the Joint

1 Implementation Opt-Out/High Savings scenario. Notably, all scenarios in which AMF is
 2 implemented jointly with New York have a benefit-cost ratio greater than one.¹⁷

3 **6. THE VALUE OF THE AMF PILOT**

4 **Q. Did the Company evaluate the cost-effectiveness of the AMF pilot?**

5 A. Yes. The Company provided both the combined net benefits of the AMF pilot with
 6 VVO/CVR expansion at the Washington substation, as well as the incremental benefit
 7 attributable to the AMF functionality itself. These benefits and costs are shown in the
 8 table below.¹⁸

Rhode Island Cost Test			
	Category	VVO + AMI	AMI Incremental
Benefits	Forward Commitment: Capacity Value	\$4,603,260	\$1,134,453
	Energy Supply & Tx Operating Value of Energy	\$7,990,336	\$1,997,583
	Greenhouse Gas Externality Costs	\$4,969,591	\$1,242,390
	Subtotal: Benefits	\$17,563,187	\$4,374,426
Costs	Utility Costs	\$10,029,624	\$8,028,382
	Subtotal: Costs	\$10,029,624	\$8,028,382
	Net Benefits	\$7,533,563	-\$3,653,955
	Benefit-Cost Ratio	1.75	0.54

¹⁷ Testimony of the Power Sector Transformation Panel, RIPUC Docket No. 4780, January 12, 2018, pages 40-41.

¹⁸ Derived from response to PUC 12-16

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2 **Q. Is the pilot cost-effective?**

3 A. According to the Company's analysis, when considered with the VVO expansion as a
4 whole the pilot has a benefit-cost ratio of 1.75. Taken alone, however, the incremental
5 energy and capacity savings attributable to AMF do not outweigh the costs..

6 **Q. Do you have any comments regarding the Company's cost-effectiveness analysis?**

7 A. Yes. The Company used the weighted-average cost of capital to evaluate the pilot. If
8 instead a societal discount rate of 3% were used, the benefit-cost ratio is significantly
9 higher. A societal discount rate is more consistent with the Rhode Island cost-
10 effectiveness test. The table below shows that the benefit-cost ratio increases to 0.84
11 when the societal discount rate is used.

Rhode Island Cost-Effectiveness Test			
AMI Incremental			
		Weighted Avg Cost of Capital	Societal Discount Rate
Benefits	Forward Commitment: Capacity Value	\$1,134	\$2,189
	Energy Savings	\$1,997	\$3,624
	Greenhouse Gas Externality Costs	\$1,242	\$2,094
	Subtotal: Benefits	\$4,374	\$7,907
Costs	Capital Expenditures	\$5,604	\$5,849
	OpEx	\$2,424	\$3,580
	Subtotal: Costs	\$8,028	\$9,429
	Net Benefits	-\$3,654	-\$1,522
	Benefit-Cost Ratio	0.54	0.84

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2 **Q. Would the costs and benefits of the pilot scale linearly to a full roll-out?**

3 A. No. The Company expects that a full deployment of AMF would be expected to produce
4 some economies of scale, which improve the benefit-cost ratio associated with combining
5 AMF and VVO/CVR.¹⁹

¹⁹ Response to PUC 2-18

1 **Q. Should the Commission reject the pilot on the grounds that the AMF portion of the**
2 **pilot is not cost-effective?**

3 A. No. While the Docket 4600 Guidelines require that the Rhode Island benefit-cost analysis
4 framework be applied to pilot projects, they also clearly state that a pilot does not need to
5 yield net benefits if it provides value that is not included in the benefit-cost analysis.

6 **Q. Are there benefits attributable to the pilot that are not included in the benefit-cost**
7 **analysis?**

8 A. Yes. The pilot will provide valuable information that will support Rhode Island's
9 transition to a modern grid. As described above, some form of advanced metering
10 functionality will be required in order to achieve many of the Commission's goals. This
11 includes optimizing the grid for maximum efficiency (such as through VVO and CVR),
12 providing more efficient price signals to customers (such as through time-varying rates),
13 empowering customers to manage their costs (such as through integrating distributed
14 energy resources and time-varying rates).

15 As shown in

16 , deployment of AMF has the potential to be cost-effective if executed well. The AMI/VVO pilot
17 will support the Company in testing implementation strategies and training its workforce
18 in order to fully evaluate the benefits of AMF and to address barriers to full AMF
19 deployment. For example:

- 20 • The quantification and verification of additional capacity and energy savings
21 associated with joint AMI/VVO will help to quantify the benefits that a full roll-out
22 of AMF would provide to the customers of Rhode Island.

- 1 • If full AMF deployment is approved, the lessons learned from integration of AMF
2 with VVO/CVR should enable the Company to more quickly achieve these
3 incremental energy and capacity savings across the Company’s service territory, since
4 any problems will presumably have been addressed in the pilot phase.
- 5 • Training of the Rhode Island workforce should enable full deployment of AMF to
6 proceed more easily.

7 **Q. Do the additional lessons learned justify the Company’s proposed AMF pilot?**

8 A. Yes. While in the short-term it would be more cost-effective to simply expand
9 VVO/CVR without AMI, doing so would forego significant unquantified benefits
10 associated with pilot deployment of AMI. When considered in this broader context, the
11 pilot is clearly justified. The pilot will provide important information that will facilitate
12 the deployment of AMF in a manner that captures maximum benefits for customers and
13 avoids pitfalls that may be illuminated in the pilot phase.

14 **Q. Would the costs associated with the pilot investments be stranded if statewide**
15 **deployment of AMF is not approved?**

16 A. No. The Company states that the meters deployed in this pilot would continue to be used
17 to process monthly billing information and inform the VVO /CVR system.²⁰ Thus the
18 assets would continue to be used and provide useful information for billing and voltage
19 optimization. Because of this, the downside risk of the pilot is limited.

²⁰ Response to PUC 2-36

1 **Q. What do you recommend?**

2 A. We recommend that the Commission approve National Grid's AMF pilot proposal.

3 **Q. Does this conclude your direct testimony?**

4 A. Yes, it does.

Tim Woolf, Vice President

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PROFESSIONAL EXPERIENCE

Synapse Energy Economics Inc., Cambridge, MA. *Vice President*, 2011 – present.

Provides expert consulting on the economic, regulatory, consumer, environmental, and public policy implications of the electricity and gas industries. The primary focus of work includes technical and economic analyses, electric power system planning, climate change strategies, energy efficiency programs and policies, renewable resources and related policies, power plant performance and economics, air quality, and many related aspects of consumer and environmental protection.

Massachusetts Department of Public Utilities, Boston, MA. *Commissioner*, 2007 – 2011.

Oversaw a significant expansion of clean energy policies as a consequence of the Massachusetts Green Communities Act, including an aggressive expansion of ratepayer-funded energy efficiency programs; the implementation of decoupled rates for electric and gas companies; an update of the DPU energy efficiency guidelines; the promulgation of net metering regulations; review of smart grid pilot programs; and review of long-term contracts for renewable power. Oversaw six rate case proceedings for Massachusetts electric and gas companies. Played an influential role in the development of price responsive demand proposals for the New England wholesale energy market. Served as President of the New England Conference of Public Utility Commissioners from 2009-2010. Served as board member on the Energy Facilities Siting Board from 2007-2010. Served as co-chair of the Steering Committee for the Northeast Energy Efficiency Partnership's Regional Evaluation, Measurement and Verification Forum.

Synapse Energy Economics Inc., Cambridge, MA. *Vice President*, 1997 – 2007.

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Association for the Conservation of Energy, London, England. *Research Director*, 1991 – 1992.

Massachusetts Department of Public Utilities, Boston, MA. *Staff Economist*, 1989 – 1990.

Massachusetts Office of Energy Resources, Boston, MA. *Policy Analyst*, 1987 – 1989.

Energy Systems Research Group, Boston, MA. *Research Associate*, 1983 – 1987.

Union of Concerned Scientists, Cambridge, MA. *Energy Analyst*, 1982-1983.

EDUCATION

Boston University, Boston, MA

Master of Business Administration, 1993

London School of Economics, London, England
Diploma, Economics, 1991

Tufts University, Medford, MA
Bachelor of Science in Mechanical Engineering,
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TESTIMONY

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New York Public Service Commission (Case 17-E-0238): Direct and rebuttal testimony of Tim Woolf and Melissa Whited regarding Earnings Adjustment Mechanisms proposed by National Grid. On behalf of Advanced Energy Economy Institute. August 25 and September 15, 2017.

Utah Public Service Commission (Docket No. 14-035-114): Direct and rebuttal testimony of Tim Woolf regarding the PacifiCorp's analysis of the benefits and costs associated with distributed generation resources. On behalf of Utah Clean Energy. June 8, 2017 and July 25, 2017.

Massachusetts Department of Public Utilities (D.P.U. 17-05): Direct and surrebuttal testimony of Tim Woolf and Melissa Whited regarding performance-based regulation, the monthly minimum reliability contribution, storage pilots, and rate design in Eversource's petition for approval of rate increases and a performance-based ratemaking mechanism. On behalf of Sunrun and the Energy Freedom Coalition of America, LLC. April 28, 2017 and May 26, 2017.

Massachusetts Department of Public Utilities (D.P.U. 15-120, D.P.U. 15-121, D.P.U. 15-122/15-123): Direct testimony of Tim Woolf and Ariel Horowitz, PhD, regarding the petitions by National Grid, Unitil,

NSTAR, and Eversource Energy for approval of their grid modernization plans. On behalf of Conservation Law Foundation. March 10, 2017.

Massachusetts Department of Public (D.P.U. 16-169): Direct testimony of Tim Woolf and Erin Malone regarding Nation Grid's petition for ruling regarding the provision of gas energy efficiency services. On behalf of the Cape Light Compact. November 2, 2016.

New Jersey Board of Public Utilities (Docket No. ER16060524): Direct testimony regarding Rockland Electric Company's proposed advanced metering program. On behalf of the New Jersey Division of Rate Counsel. September 9, 2016.

Colorado Public Utilities Commission (Proceeding No. 16AL-0048E): Answer testimony regarding Public Service Company of Colorado's rate design proposal. On behalf of Energy Outreach Colorado. June 6, 2016.

Georgia Public Service Commission (Docket No. 40161 and Docket No. 40162): Direct testimony regarding the demand-side management programs proposed by Georgia Power Company in its Certification, Decertification, and Amended Demand-Side Management Plan and its 2016 Integrated Resource Plan. On behalf of Sierra Club. May 3, 2016.

Massachusetts Department of Public Utilities (Docket No. 15-155): Joint direct and rebuttal testimony with M. Whited regarding National Grid's rate design proposal. On behalf of Energy Freedom Coalition of America, LLC. March 18, 2016 and April 28, 2016.

Maine Public Utilities Commission (Docket No. 2015-00175): Direct testimony on Efficiency Maine Trust's petition for approval of the Triennial Plan for Fiscal Years 2017-2019. On behalf of the Natural Resources Council of Maine and the Conservation Law Foundation. February 17, 2016.

Nevada Public Utilities Commission (Docket Nos. 15-07041 and 15-07042): Direct testimony on NV Energy's application for approval of a cost of service study and net metering tariffs. On behalf of The Alliance for Solar Choice. October 27, 2015.

New Jersey Board of Public Utilities (Docket No. ER14030250): Direct testimony on Rockland Electric Company's petition for investments in advanced metering infrastructure. On behalf of the New Jersey Division of Rate Counsel. September 4, 2015.

Utah Public Service Commission (Docket No. 14-035-114): Direct, rebuttal, and surrebuttal testimony on the benefit-cost framework for net energy metering. On behalf of Utah Clean Energy, the Alliance for Solar Choice, and Sierra Club. July 30, 2015, September 9, 2015, and September 29, 2015.

Nova Scotia Utility and Review Board (Matter No. M06733): Direct testimony on EfficiencyOne's 2016-2018 demand-side management plan. On behalf of the Nova Scotia Utility and Review Board. June 2, 2015.

Missouri Public Service Commission (Case No. ER-2014-0370): Direct and surrebuttal testimony on the topic of Kansas City Power and Light's rate design proposal. On behalf of Sierra Club. April 16, 2015 and June 5, 2015.

Missouri Public Service Commission (File No. EO-2015-0055): Rebuttal and surrebuttal testimony on the topic of Ameren Missouri's 2016-2018 Energy Efficiency Plan. On behalf of Sierra Club. March 20, 2015 and April 27, 2015.

Florida Public Service Commission (Dockets No. 130199-EI et al.): Direct testimony on the topic of setting goals for increasing the efficiency of energy consumption and increasing the development of demand-side renewable energy systems. On behalf of the Sierra Club. May 19, 2014.

Massachusetts Department of Public Utilities (Docket No. DPU 14-86): Direct and rebuttal Testimony regarding the cost of compliance with the Global Warming Solution Act. On behalf of the Massachusetts Department of Energy Resources and the Department of Environmental Protection. May 16, 2014.

Kentucky Public Service Commission (Case No. 2014-00003): Direct testimony regarding Louisville Gas and Electric Company and Kentucky Utilities Company's proposed 2015-2018 demand-side management and energy efficiency program plan. On behalf of Wallace McMullen and the Sierra Club. April 14, 2014.

Maine Public Utilities Commission (Docket No. 2013-168): Direct and surrebuttal testimony regarding policy issues raised by Central Maine Power's 2014 Alternative Rate Plan, including recovery of capital costs, a Revenue Index Mechanism proposal, and decoupling. On behalf of the Maine Public Advocate Office. December 12, 2013 and March 21, 2014.

Colorado Public Utilities Commission (Docket No. 13A-0686EG): Answer and surrebuttal testimony regarding Public Service Company of Colorado's proposed energy savings goals. On behalf of the Sierra Club. October 16, 2013 and January 21, 2014.

Kentucky Public Service Commission (Case No. 2012-00578): Direct testimony regarding Kentucky Power Company's economic analysis of the Mitchell Generating Station purchase. On behalf of the Sierra Club. April 1, 2013.

Nova Scotia Utility and Review Board (Matter No. M04819): Direct testimony regarding Efficiency Nova Scotia Corporation's Electricity Demand Side Management Plan for 2013 – 2015. On behalf of the Counsel to Nova Scotia Utility and Review Board. May 22, 2012.

Missouri Office of Public Counsel (Docket No. EO-2011-0271): Rebuttal testimony regarding IRP rule compliance. On behalf of the Missouri Office of the Public Counsel. October 28, 2011.

Nova Scotia Utility and Review Board (Matter No. M03669): Direct testimony regarding Efficiency Nova Scotia Corporation's Electricity Demand Side Management Plan for 2012. On behalf of the Counsel to Nova Scotia Utility and Review Board. April 8, 2011.

Rhode Island Public Utilities Commission (Docket No. 3790): Direct testimony regarding National Grid's Gas Energy Efficiency Programs. On behalf of the Division of Public Utilities and Carriers. April 2, 2007.

North Carolina Utilities Commission (Docket E-100, Sub 110): Filed comments with Anna Sommer regarding the Potential for Energy Efficiency Resources to Meet the Demand for Electricity in North Carolina. Synapse Energy Economics on behalf of the Southern Alliance for Clean Energy. February 2007.

Rhode Island Public Utilities Commission (Docket No. 3765): Direct and Surrebuttal testimony regarding National Grid's Renewable Energy Standard Procurement Plan. On behalf of the Division of Public Utilities and Carriers. January 17, 2007 and February 20, 2007.

Minnesota Public Utilities Commission (Docket Nos. CN-05-619 and TR-05-1275): Direct testimony regarding the potential for energy efficiency as an alternative to the proposed Big Stone II coal project. On behalf of the Minnesota Center for Environmental Advocacy, Fresh Energy, Izaak Walton League of America, Wind on the Wires and the Union of Concerned Scientists. November 29, 2006.

Rhode Island Public Utilities Commission (Docket No. 3779): Oral testimony regarding the settlement of Narragansett Electric Company's 2007 Demand-Side Management Programs. On behalf of the Division of Public Utilities and Carriers. November 24, 2006.

Nevada Public Utilities Commission (Docket Nos. 06-04002 & 06-04005): Direct testimony regarding Nevada Power Company's and Sierra Pacific Power Company's Renewable Portfolio Standard Annual Report. On behalf of the Nevada Bureau of Consumer Protection. October 26, 2006

Nevada Public Utilities Commission (Docket No. 06-06051): Direct testimony regarding Nevada Power Company's Demand-Side Management Plan in the 2006 Integrated Resource Plan. On behalf of the Nevada Bureau of Consumer Protection. September 13, 2006.

Nevada Public Utilities Commission (Docket Nos. 06-03038 & 06-04018): Direct testimony regarding the Nevada Power Company's and Sierra Pacific Power Company's Demand-Side Management Plans. On behalf of the Nevada Bureau of Consumer Protection. June 20, 2006.

Nevada Public Utilities Commission (Docket No. 05-10021): Direct testimony regarding the Sierra Pacific Power Company's Gas Demand-Side Management Plan. On behalf of the Nevada Bureau of Consumer Protection. February 22, 2006.

South Dakota Public Utilities Commission (Docket No. EL04-016): Direct testimony regarding the avoided costs of the Java Wind Project. On behalf of the South Dakota Public Utilities Commission Staff. February 18, 2005.

Rhode Island Public Utilities Commission (Docket No. 3635): Oral testimony regarding the settlement of Narragansett Electric Company's 2005 Demand-Side Management Programs. On behalf of the Division of Public Utilities and Carriers. November 29, 2004.

British Columbia Utilities Commission. Direct testimony regarding the Power Smart programs contained in BC Hydro's Revenue Requirement Application 2004/05 and 2005/06. On behalf of the Sierra Club of Canada, BC Chapter. April 20, 2004.

Maryland Public Utilities Commission (Case No. 8973): Oral testimony regarding proposals for the PJM Generation Attributes Tracking System. On behalf of the Maryland Office of People's Counsel. December 3, 2003.

Rhode Island Public Utilities Commission (Docket No. 3463): Oral testimony regarding the settlement of Narragansett Electric Company's 2004 Demand-Side Management Programs. On behalf of the Division of Public Utilities and Carriers. November 21, 2003.

California Public Utilities Commission (Rulemaking 01-10-024): Direct testimony regarding the market price benchmark for the California renewable portfolio standard. On behalf of the Union of Concerned Scientists. April 1, 2003.

Québec Régie de l'énergie (Docket R-3473-01): Direct testimony with Philp Raphals regarding Hydro-Québec's Energy Efficiency Plan: 2003-2006. On behalf of Regroupement national des Conseils régionaux de l'environnement du Québec. February 5, 2003.

Connecticut Department of Public Utility Control (Docket No. 01-10-10): Direct testimony regarding the United Illuminating Company's service quality performance standards in their performance-based ratemaking mechanism. On behalf of the Connecticut Office of Consumer Counsel. April 2, 2002.

Nevada Public Utilities Commission (Docket No. 01-7016): Direct testimony regarding the Nevada Power Company's Demand-Side Management Plan. On behalf of the Bureau of Consumer Protection, Office of the Attorney General. September 26, 2001.

United States Department of Energy (Docket Number-EE-RM-500): Comments with Bruce Biewald, Daniel Allen, David White, and Lucy Johnston of Synapse Energy Economics regarding the Department of Energy's proposed rules for efficiency standards for central air conditioners and heat pumps. On behalf of the Appliance Standards Awareness Project. December 2000.

US Department of Energy (Docket EE-RM-500): Oral testimony at a public hearing on marginal price assumptions for assessing new appliance efficiency standards. On behalf of the Appliance Standards Awareness Project. November 2000.

Connecticut Department of Public Utility Control (Docket No. 99-09-03 Phase II): Direct testimony regarding Connecticut Natural Gas Company's proposed performance-based ratemaking mechanism. On behalf of the Connecticut Office of Consumer Counsel. September 25, 2000.

Mississippi Public Service Commission (Docket No. 96-UA-389): Oral testimony regarding generation pricing and performance-based ratemaking. On behalf of the Mississippi Attorney General. February 16, 2000.

Delaware Public Service Commission (Docket No. 99-328): Direct testimony regarding maintaining electric system reliability. On behalf of Delaware Public Service Commission Staff. February 2, 2000.

Delaware Public Service Commission (Docket No. 99-328): Filed expert report ("Investigation into the July 1999 Outages and General Service Reliability of Delmarva Power & Light Company," jointly authored

with J. Duncan Glover and Alexander Kusko). Synapse Energy Economics and Exponent Failure Analysis Associates on behalf the Delaware Public Service Commission Staff. February 1, 2000.

New Hampshire Public Service Commission (Docket No. 99-099 Phase II): Oral testimony regarding standard offer services. On behalf of the Campaign for Ratepayers Rights. January 14, 2000.

West Virginia Public Service Commission (Case No. 98-0452-E-GI): Rebuttal testimony regarding codes of conduct. On behalf of the West Virginia Consumer Advocate Division. July 15, 1999.

West Virginia Public Service Commission (Case No. 98-0452-E-GI): Direct testimony regarding codes of conduct and other measures to protect consumers in a restructured electricity industry. On behalf of the West Virginia Consumer Advocate Division. June 15, 1999.

Public Service Commission of West Virginia (Case No. 98-0452-E-GI): Filed expert report (“Measures to Ensure Fair Competition and Protect Consumers in a Restructured Electricity Industry in West Virginia,” jointly authored with Jean Ann Ramey and Theo MacGregor) in the matter of the General Investigation to determine whether West Virginia should adopt a plan for open access to the electric power supply market and for the development of a deregulation plan. Synapse Energy Economics and MacGregor Energy Consultancy on behalf of the West Virginia Consumer Advocate Division. June 1999.

Massachusetts Department of Telecommunications and Energy (DPU/DTE 97-111): Direct testimony regarding Commonwealth Electric Company’s energy efficiency plan, and the role of municipal aggregators in delivering demand-side management programs. On behalf of Cape and Islands Self-Reliance Corporation. January 1998.

Delaware Public Service Commission (DPSC 97-58): Direct testimony regarding Delmarva Power and Light’s request to merge with Atlantic City Electric. On behalf of Delaware Public Service Commission Staff. May 1997.

Delaware Public Service Commission (DPSC 95-172): Oral testimony regarding Delmarva’s integrated resource plan and DSM programs. On behalf of the Delaware Public Service Commission Staff. May 1996.

Colorado Public Utilities Commission (5A-531EG): Direct testimony regarding the impact of proposed merger on DSM, renewable resources and low-income DSM. On behalf of the Colorado Office of Energy Conservation. April 1996.

Colorado Public Utilities Commission (3I-199EG): Direct testimony regarding the impacts of increased competition on DSM, and recommendations for how to provide utilities with incentives to implement DSM. On behalf of the Colorado Office of Energy Conservation. June 1995.

Colorado Public Utilities Commission (5R-071E): Oral testimony on the Commission's integrated resource planning rules. On behalf of the Colorado Office of Energy Conservation. July 1995.

Colorado Public Utilities Commission (31-098E): Direct testimony on the Public Service Company of Colorado's DSM programs and integrated resource plans. On behalf of the Colorado Office of Energy Conservation. April 1994.

Delaware Public Service Commission (Docket No. 96-83): Filed comments regarding the Investigation of Restructuring the Electricity Industry in Delaware (Tellus Institute Study No. 96-99). On behalf of the Staff of the Delaware Public Service Commission. November 1996.

Colorado Public Utilities Commission (Docket No. 96Q-313E): Filed comments in response to the Questionnaire on Electricity Industry Restructuring (Tellus Institute Study No. 96-130-A3). On behalf of the Colorado Governor's Office of Energy Conservation. October 1996.

State of Vermont Public Service Board (Docket No. 5854): Filed expert report (Tellus Institute Study No. 95-308) regarding the Investigation into the Restructuring of the Electric Utility Industry in Vermont. On behalf of the Vermont Department of Public Service. March 1996.

Pennsylvania Public Utility Commission (Docket No. I-00940032): Filed comments (Tellus Institute Study No. 95-260) regarding an Investigation into Electric Power Competition. On behalf of The Pennsylvania Office of Consumer Advocate. November 1995.

New Jersey Board of Public Utilities (Docket No. EX94120585Y): Initial and reply comments ("Achieving Efficiency and Equity in the Electricity Industry Through Unbundling and Customer Choice," Tellus Institute Study No. 95-029-A3) regarding an investigation into the future structure of the electric power industry. On behalf of the New Jersey Division of Ratepayer Advocate. September 1995.

ARTICLES

Woolf, T., E. Malone, C. Neme, R. LeBaron. 2014. "Unleashing Energy Efficiency." *Public Utilities Fortnightly*, October, 30-38.

Woolf, T., A. Sommer, J. Nielson, D. Berry, R. Lehr. 2005. "Managing Electricity Industry Risk with Clean and Efficient Resources." *The Electricity Journal* 18 (2): 78-84.

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Woolf T., B. Biewald. 2000. "Electricity Market Distortions Associated With Inconsistent Air Quality Regulations." *The Electricity Journal* 13 (3): 42-49.

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Woolf, T., B. Biewald. 1998. "Efficiency, Renewables and Gas: Restructuring As if Climate Mattered." *The Electricity Journal* 11 (1): 64–72.

Woolf, T., J. Michals. 1996. "Flexible Pricing and PBR: Making Rate Discounts Fair for Core Customers." *Public Utilities Fortnightly*, July 1996.

Woolf, T., J. Michals. 1995. "Performance-Based Ratemaking: Opportunities and Risks in a Competitive Electricity Industry." *The Electricity Journal* 8 (8): 64–72.

Woolf, T. 1994. "Retail Competition in the Electricity Industry: Lessons from the United Kingdom." *The Electricity Journal* 7 (5): 56–63.

Woolf, T. 1994. "A Dialogue About the Industry's Future." *The Electricity Journal* 7 (5).

Woolf, T., E. D. Lutz. 1993. "Energy Efficiency in Britain: Creating Profitable Alternatives." *Utilities Policy* 3 (3): 233–242.

Woolf, T. 1993. "It is Time to Account for the Environmental Costs of Energy Resources." *Energy and Environment* 4 (1): 1–29.

Woolf, T. 1992. "Developing Integrated Resource Planning Policies in the European Community." *Review of European Community & International Environmental Law* 1 (2) 118–125.

PRESENTATIONS

Woolf, T., M. Whited. 2016. "Show Me the Numbers: A Framework for Balanced Distributed Solar Policies." Presentation for Consumers Union Webinar, December 2016.

Woolf, T. 2016. "Show Me the Numbers: Balancing Solar DG with Consumer Protection." Public workshop on solar distributed generation for the Federal Trade Commission, June 2016.

Woolf, T. 2016. "Rate Designs for Distributed Generation: State Activities & A New Framework." Presentation at the NASUCA 2016 Mid-Year Meeting, June 2016.

Woolf, T., M. Whited. 2016. "3rd Annual 21st Century Electricity System Workshop – Implications of Different Rate Designs." Presentation at the Advanced Energy Economy Institute, April 2016.

Woolf, T., M. Whited. 2016. "Decoupling in Pennsylvania: Advantages, Disadvantages, and Design Issues." Presentation to Pennsylvania Decoupling Stakeholders, February 2016.

Woolf, T. 2016. "Earnings Impact Mechanisms: Energy Efficiency." Presentation at the New York REV Technical Conference, January 2016.

Lowry, M. N., T. Woolf. 2015. "Performance-Based Regulation in a High Distributed Energy Resources Future." Webinar on January 2016.

Woolf, T. 2015. "Performance Incentive Mechanisms: A Catalyst for Change." Webinar for Power Sector Transformation Group, December 2015.

Woolf, T. 2015. "Energy Efficiency Valuation: Boogie Men, Time Warps, and other Terrifying Pitfalls." Presentation at ACEEE Conference on Energy Efficiency as a Resource, September 2015.

Woolf, T., M. Whited, A. Napoleon. 2015. "Thoughts on How to Design Clean Energy Performance Incentive Mechanisms." Webinar for the Western Clean Energy Advocates, April 2015.

Woolf, T. 2015. "Properly Valuing the Benefits and Costs of Energy Efficiency." Presentation at the 2015 National Efficiency Advocates Meeting, April 2015.

Woolf, T. 2015. "Non-Energy Benefits & Efficiency Program Screening." Presentation for Georgia DSM Work Group, March 2015.

Woolf, T. 2014. "Performance Incentive Mechanisms And Their Role in New Regulatory Models." Presentation at Acadia Center Conference, Envisioning Our Energy Future, December 2014.

Woolf, T., M. Whited., A. Napoleon. 2014. "Guiding Utility Performance: A Handbook for Regulators." Webinar for the Western Interstate Energy Board, December 2014.

Woolf, T. 2014. "Planning for Distributed Energy Resources." Presentation for Advanced Energy Economy Webinar, November 2014.

Woolf, T. 2014. "Benefit-Cost Analysis for Distributed Energy Resources in New York: A Framework for Accounting for All Relevant Costs and Benefits." Presentation to NARUC ERE Committee, November 2014.

Woolf, T. 2014. "Presenting the Full Value of Energy Efficiency: Creating a Better Message." Presentation at Sierra Club Beyond Coal Conference, October 2014.

Woolf, T., C. Neme. 2014. "Regulatory Policies to Support Energy Efficiency in Virginia." Presentation for the 2014 Virginia Energy Efficiency Workshop, October 2014.

Woolf, T. 2014. "Benefit-Cost Analysis for Distributed Energy Resources in New York: A Framework for Accounting for All Relevant Costs and Benefits." Presentation for Advanced Energy Economy Institute, October 2014.

Woolf, T. 2014. "Performance Incentive Mechanisms: Digging Deeper Into Performance-Based Regulation." Presentation for National Governor's Association Conference: Utility Business Models That Align with State Clean Energy Goals, September 2014.

Woolf, T. 2014. "The Resource Value Framework: Reforming Energy Efficiency Cost-Effectiveness Screening." Presentation at the ACEEE Summer Study, August 2014.

Woolf, T. 2014. "Cost-Effectiveness of Demand Response." Presentation at MADRI Working Group Meeting #34, July 2014.

Woolf, T. 2014. "Time to Overhaul Our Energy Efficiency Screening Practices." Presentation for U.S. Environmental Protection Agency Energy Efficiency Cost-Effectiveness Webinar, January 2014.

Woolf, T. 2013. "Survey of Energy Efficiency Screening Practices in the Northeast and Mid-Atlantic." Presentation for Northeast Energy Efficiency Partnerships EM&V Forum Annual Public Meeting, December 2013.

Woolf, T. 2013. "Recommendations for Reforming Energy Efficiency Cost-Effectiveness Screening in the United States." Presentation at the National Association of Regulatory Commissioners Annual Meeting, November 2013.

Woolf, T. 2013. "Energy Efficiency Program Screening: Let's Get Beyond the TRC Test." Presentation for 7th Annual ENERGY STAR Certified Homes Utility Sponsor Meeting, October 2013.

Woolf, T. 2013. "Decoupling in Maine: Why Decoupling is in Consumers' Interest." Presentation for Office of Public Advocate- Decoupling Debate, October 2013.

Woolf, T. 2013. "NHPC Efficiency Screening Initiative: Unleashing the Potential for Energy Efficiency." Presentation for Advocates Meeting, September 2013.

Woolf, T. 2013. "Energy Efficiency: Rate, Bill and Participation Impacts." Presentation for ACEEE's Energy Efficiency as a Resource Conference, September 2013.

Woolf, T. 2013. "Energy Efficiency Screening: Challenges and Opportunities." Presentation for NARUC Summer Meeting Consumer Affairs Panel, July 2013.

Woolf, T., R. Sedano. 2013. "Decoupling Overview." Presentation for Finding Common Ground Meeting, July 2013.

Woolf, T. 2013. "Utility Incentives for Energy Efficiency." Presentation for Finding Common Ground Meeting, July 2013.

Woolf, T. 2013. "Energy Efficiency: Rate, Bill and Participation Impacts." Presentation for State Energy Efficiency Action Webinar, June 2013.

Woolf, T., B. Biewald, and J. Migden-Ostrander. 2013. "NARUC Risk Workshop for Regulators." Presentation at the Mid-Atlantic Conference of Regulatory Utility Commissioners, June 2013.

Woolf, T. 2013. "Energy Efficiency Screening: Accounting for 'Other Program Impacts' & Environmental Compliance Costs." Presentation for the Consortium for Energy Efficiency Summer Meeting, May 2013.

Woolf, T. 2013. "Best Practices in Energy Efficiency Program Screening." Presentation at ACI National Home Performance Conference, May 2013.

Woolf, T. 2013. "Utility Shareholder Incentives to Support Energy Efficiency Programs." Presentation to Common Ground, May 2013.

Woolf, T. 2013. "Energy Efficiency Screening: Accounting for 'Other Program Impacts' & Environmental Compliance Costs." Presentation for Regulatory Assistance Project Webinar, March 2013.

Woolf, T. 2013. "Energy Efficiency: Rates, Bills, Participants, Screening, and More." Presentation at Connecticut Energy Efficiency Workshop, March 2013.

Woolf T. 2013. "Best Practices in Energy Efficiency Program Screening." Presentation for SEE Action Webinar, March 2013.

Woolf, T. 2013. "Energy Efficiency: Rates, Bills and Participants." Presentation for Rhode Island Energy Efficiency Collaborative, February 2013.

Woolf, T. 2013. "Energy Efficiency Screening: Application of the TRC Test." Presentation for Energy Advocates Webinar, January 2013.

Woolf, T. 2012. "Best Practices in Energy Efficiency Program Screening." Presentation for American Council for an Energy-Efficient Economy Webinar, December 2012.

Woolf, T. 2012. Indian Point Replacement Analysis: A Clean Energy Roadmap. Presentation for Natural Resource Defenses Council and Environmental Entrepreneurs, November 2012.

Woolf, T. 2012. "In Pursuit of All Cost-Effective Energy Efficiency." Presentation at Sierra Club Boot Camp, October 2012.

Woolf, T. 2012. "Best Practices in Energy Efficiency Program Screening." Webinar for Northeast Energy Efficiency Partnerships, September 2012.

Woolf, T., L. Schwartz. "What Remains to be Done with Demand Response? A National Forum from the FERC National Action Plan on Demand Response Tries to Give an Answer." Presentation at NARUC National Town Meeting on Demand Response, July 2012.

Woolf, T. 2012. "Best Practices in Energy Efficiency Program Screening." Presentation at NARUC Summer Meetings – Energy Efficiency Cost-Effectiveness Breakfast, July 2012.

Woolf, T. 2012. "Avoided Cost of Complying with Environmental Regulations in MA." Presentation for Mass Energy Consumer's Alliance, January 2012.

Woolf, T. 2011. "Energy Efficiency Cost-Effectiveness Tests." Presentation at the Northeast Energy Efficiency Partnerships Annual Meeting, October 2011.

Woolf, T. 2011. "Why Consumer Advocates Should Support Decoupling." Presentation at the 2011 ACEEE National Conference on Energy Efficiency as a Resource, September 2011.

Woolf, T. 2011. "A Regulator's Perspective on Energy Efficiency." Presentation at the Efficiency Maine Symposium *In Pursuit of Maine's Least-Cost Energy*, September 2011.

Woolf, T. 2010. "Bill Impacts of Energy Efficiency Programs: The Importance of Analyzing and Managing Rate and Bill Impacts." Presentation at the Energy in the Northeast Conference, Law Seminar International, September 2010.

Woolf, T. 2010. "Bill Impacts of Energy Efficiency Programs: The Implications of Bill Impacts in Developing Policies to Motivate Utilities to Implement Energy Efficiency." Presentation to the State Energy Efficiency Action Network, Utility Motivation Work Group, November 2010.

Woolf, T. 2010. "Bill Impacts of Energy Efficiency Programs." Presentation to the Energy Resources and Environment Committee at the NARUC Winter Meetings, February 2010.

Woolf, T. 2009. "Price-Responsive Demand in the New England Wholesale Energy Market: Description of NECPUC's Limited Supply-Side Proposal." Presentation at the NEPOOL Markets Committee Meeting, November 2009.

Woolf, T. 2009. "Demand Response in the New England Wholesale Energy Market: How Much Should We Pay for Demand Resources?" Presentation at the New England Electricity Restructuring Roundtable, October 2009.

Woolf, T. 2008. "Promoting Demand Resources in Massachusetts: A Regulator's Perspective." Presentation at the Energy Bar Association, Northeast Chapter Meeting, June 2008.

Woolf, T. 2008. "Turbo-Charging Energy Efficiency in Massachusetts: A DPU Perspective." Presentation at the New England Electricity Restructuring Roundtable, April 2008.

Woolf T. 2002. "A Renewable Portfolio Standard for New Brunswick." Presentation to the New Brunswick Market Design Committee, January 10, 2002.

Woolf, T. 2001. "Potential for Wind and Renewable Resource Development in the Midwest." Presentation at WINDPOWER 2001 in Washington DC, June 7, 2001.

Woolf T. 1999. "Challenges Faced by Clean Generation Resources Under Electricity Restructuring." Presentation at the Symposium on the Changing Electric System in Florida and What it Means for the Environment in Tallahassee, FL, November 1999.

Woolf, T. 2000. "Generation Information Systems to Support Renewable Portfolio Standards, Generation Performance Standards and Environmental Disclosure." Presentation at the Massachusetts Restructuring Roundtable on behalf of the Union of Concerned Scientists, March 2000.

Woolf, T. 1998. "New England Tracking System Project: An Electricity Tracking System to Support a Wide Range of Restructuring-Related Policies." Presentation at the Ninth Annual Energy Services Conference and Exposition in Orlando, FL, December 1998.

Woolf, T. 2000. "Comments of the Citizens Action Coalition of Indiana." Presentation at Workshop on Alternatives to Traditional Generation Resources, June 2000.

Woolf, T. 1996. "Overview of IRP and Introduction to Electricity Industry Restructuring." Training session provided to the staff of the Delaware Public Service Commission, April 1996.

Woolf, T. 1995. "Competition and Regulation in the UK Electric Industry." Presentation at the Illinois Commerce Commission's workshop on Restructuring the Electric Industry, August 1995.

Woolf, T. 1995. "Competition and Regulation in the UK Electric Industry." Presentation at the British Columbia Utilities Commission Electricity Market Review, February 1995.

Resume dated January 2018

Melissa Whited, Principal Associate

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PROFESSIONAL EXPERIENCE

Synapse Energy Economics, Cambridge MA. *Principal Associate*, 2017 – present, *Senior Associate*, 2015 – 2017, *Associate*, 2012 – 2015

Conduct research, author reports, and assist in preparation of expert testimony. Consult on issues related to distributed energy resources, rate design, cost-benefit analysis, integrated resource planning, utility regulation, water use and conservation, and market power.

University of Wisconsin - Madison, Department of Agricultural and Applied Economics, Madison, WI. *Teaching Assistant – Environmental Economics*, 2011 – 2012

Developed teaching materials and led discussions on cost-benefit analysis, carbon taxes and cap-and-trade programs, management of renewable and non-renewable resources, and other topics.

Public Service Commission of Wisconsin, Water Division, Madison, WI. *Program and Policy Analyst - Intern*, Summer 2009

Researched water conservation programs nationwide to develop a proposal for Wisconsin's state conservation program. Developed spreadsheet model to calculate avoided costs of water conservation in terms of energy savings and avoided emissions.

Synapse Energy Economics, Cambridge, MA. *Communications Manager*, 2005 – 2008

Developed technical proposals for state and federal agencies, environmental and public interest groups, and businesses. Edited reports on energy efficiency, integrated resource planning, greenhouse gas regulations, renewable resources, and other topics.

EDUCATION

University of Wisconsin, Madison, WI

Master of Arts in Agricultural and Applied Economics, 2012.

Certificate in Energy Analysis and Policy.

National Science Foundation Fellow.

University of Wisconsin, Madison, WI

Master of Science in Environment and Resources, 2010.

Certificate in Humans and the Global Environment (CHANGE).

Nelson Distinguished Fellowship.

Southwestern University, Georgetown, TX

Bachelor of Arts in International Studies, *Magna cum laude*, 2003.

ADDITIONAL SKILLS

- Econometric Modeling – Linear and nonlinear modeling including time-series, panel data, logit, probit, and discrete choice regression analysis
- Nonmarket Valuation Methods for Environmental Goods – Hedonic valuation, travel cost method, and contingent valuation
- Cost-Benefit Analysis
- Input-Output Modeling for Regional Economic Analysis

FELLOWSHIPS AND AWARDS

- Winner, M. Jarvin Emerson Student Paper Competition, Journal of Regional Analysis and Policy, 2010
- Fellowship, National Science Foundation Integrative Graduate Education and Research Traineeship (IGERT), University of Wisconsin – Madison, 2009
- Nelson Distinguished Fellowship, University of Wisconsin – Madison, 2008

PUBLICATIONS

Whited, M., T. Woolf. 2018. *Electricity Prices in the Tennessee Valley: Are customers being treated fairly?* Prepared by Synapse Energy Economics for the Southern Alliance for Clean Energy.

Woolf, T., A. Hopkins, M. Whited, K. Takahashi, A. Napoleon. 2018. *Review of New Brunswick Power's 2018/2019 Rate Case Application*. In the Matter of the New Brunswick Power Corporation and Section 103(1) of the Electricity Act Matter No. 375. Prepared by Synapse Energy Economics for the New Brunswick Energy and Utilities Board Staff.

Whited, M., T. Vitolo. 2017. Reply comments in District of Columbia Public Service Commission Formal Case No. 1130: *Reply Comments of the Office of the People's Counsel for the District of Columbia Regarding Pepco's Comments on the Office of the People's Counsel's Value of Solar Study*. Prepared by Synapse Energy Economics. July 24, 2017.

Whited, M., A. Horowitz, T. Vitolo, W. Ong, T. Woolf. 2017. *Distributed Solar in the District of Columbia: Policy Options, Potential, Value of Solar, and Cost-Shifting*. Synapse Energy Economics for the Office of the People's Counsel for the District of Columbia.

Whited, M., E. Malone, T. Vitolo. 2016. *Rate Impacts on Customers of Maryland's Electric Cooperatives: Impacts on SMECO and Choptank Customers*. Synapse Energy Economics for Maryland Public Service Commission.

Woolf, T., M. Whited, P. Knight, T. Vitolo, K. Takahashi. 2016. *Show Me the Numbers: A Framework for Balanced Distributed Solar Policies*. Synapse Energy Economics for Consumers Union.

Whited, M., T. Woolf, J. Daniel. 2016. *Caught in a Fix: The Problem with Fixed Charges for Electricity*. Synapse Energy Economics for Consumers Union.

Lowry, M. N., T. Woolf, M. Whited, M. Makos. 2016. *Performance-Based Regulation in a High Distributed Energy Resources Future*. Pacific Economics Group Research and Synapse Energy Economics for Lawrence Berkley National Laboratory.

Woolf, T., M. Whited, A. Napoleon. 2015-2016. *Comments and Reply Comments in the New York Public Service Commission Case 14-M-0101: Reforming the Energy Vision*. Comments related to Staff's (a) a benefit-costs analysis framework white paper, (b) ratemaking and utility business models white paper, and (c) Distributed System Implementation Plan guide. Prepared by Synapse Energy Economics on behalf of Natural Resources Defense Council and Pace Energy and Climate Center.

Luckow, P., B. Fagan, S. Fields, M. Whited. 2015. *Technical and Institutional Barriers to the Expansion of Wind and Solar Energy*. Synapse Energy Economics for Citizens' Climate Lobby.

Wilson, R., M. Whited, S. Jackson, B. Biewald, E. A. Stanton. 2015. *Best Practices in Planning for Clean Power Plan Compliance*. Synapse Energy Economics for the National Association of State Utility Consumer Advocates.

Whited, M., T. Woolf, A. Napoleon. 2015. *Utility Performance Incentive Mechanisms: A Handbook for Regulators*. Synapse Energy Economics for the Western Interstate Energy Board.

Stanton, E. A., S. Jackson, B. Biewald, M. Whited. 2014. *Final Report: Implications of EPA's Proposed "Clean Power Plan."* Synapse Energy Economics for the National Association of State Utility Consumer Advocates.

Peterson, P., S. Fields, M. Whited. 2014. *Balancing Market Opportunities in the West: How participation in an expanded balancing market could save customers hundreds of millions of dollars*. Synapse Energy Economics for the Western Grid Group.

Woolf, T., M. Whited, E. Malone, T. Vitolo, R. Hornby. 2014. *Benefit-Cost Analysis for Distributed Energy Resources: A Framework for Accounting for All Relevant Costs and Benefits*. Synapse Energy Economics for the Advanced Energy Economy Institute.

Peterson, P., M. Whited, S. Fields. 2014. *Synapse Comments on FAST Proposals in ERCOT*. Synapse Energy Economics for Sierra Club.

Hornby, R., N. Brockway, M. Whited, S. Fields. 2014. *Time-Varying Rates in the District of Columbia*. Synapse Energy Economics for the Office of the People's Counsel for the District of Columbia, submitted to Public Service Commission of the District of Columbia in Formal Case No. 1114.

Peterson, P., M. Whited, S. Fields. 2014. *Demonstrating Resource Adequacy in ERCOT: Revisiting the ERCOT Capacity, Demand and Reserves Forecasts*. Synapse Energy Economics for Sierra Club – Lone Star Chapter.

Stanton, E. A., M. Whited, F. Ackerman. 2014. *Estimating the Cost of Saved Energy in Utility Efficiency Programs*. Synapse Energy Economics for the U.S Environmental Protection Agency.

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- Ackerman, F., M. Whited, P. Knight. 2014. "Would banning atrazine benefit farmers?" *International Journal of Occupational and Environmental Health* 20 (1): 61–70.
- Ackerman, F., M. Whited, P. Knight. 2013. *Atrazine: Consider the Alternatives*. Synapse Energy Economics for Natural Resources Defense Council (NRDC).
- Whited, M., F. Ackerman, S. Jackson. 2013. *Water Constraints on Energy Production: Altering our Current Collision Course*. Synapse Energy Economics for Civil Society Institute.
- Whited, M. 2013. *Water Constraints on Energy Production: Altering our Current Collision Course – Policy Brief*. Synapse Energy Economics for Civil Society Institute.
- Hurley, D., P. Peterson, M. Whited. 2013. *Demand Response as a Power System Resource: Program Designs, Performance, and Lessons Learned in the United States*. Synapse Energy Economics for Regulatory Assistance Project.
- Whited, M., D. White, S. Jackson, P. Knight, E.A. Stanton. 2013. *Declining Markets for Montana Coal*. Synapse Energy Economics for Northern Plains Resource Council.
- Woolf, T., M. Whited, T. Vitolo, K. Takahashi, D. White. 2012. *Indian Point Energy Center Replacement Analysis: A Plan for Replacing the Nuclear Plant with Clean, Sustainable, Energy Resources*. Synapse Energy Economics for National Resources Defense Council and Riverkeeper.
- Whited, M., K. Charipar, G. Brown. *Demand Response Potential in Wisconsin*. Nelson Institute for Environmental Studies, Energy Analysis & Policy Capstone for the Wisconsin Public Service Commission.
- Whited, M. 2010. "Economic Impacts of Irrigation Water Transfers in Uvalde County, Texas." *Journal of Regional Analysis and Policy* 40 (2): 160–170.
- Grabow, M., M. Hahn and M. Whited. 2010. *Valuing Bicycling's Economic and Health Impacts in Wisconsin*. Nelson Institute for Environmental Studies, Center for Sustainability and the Global Environment (SAGE) for State Representative Spencer Black.
- Whited, M., D. Bernhardt, R. Deitchman, C. Fuchsteiner, M. Kirby, M. Krueger, S. Locke, M. Mcmillen, H. Moussavi, T. Robinson, E. Schmitz, Z. Schuster, R. Smail, E. Stone, S. Van Egeren, H. Yoshida, Z. Zopp. 2009. *Implementing the Great Lakes Compact: Wisconsin Conservation and Efficiency Measures Report*. Department of Urban and Regional Planning, University of Wisconsin-Madison, Extension Report 2009-01.
- Whited, M. 2009. *2009 Wisconsin Water Fact Sheet*. Public Service Commission of Wisconsin.
- Whited, M. 2003. *Gender, Water, and Trade*. International Gender and Trade Network Washington, DC.

TESTIMONY

Virginia State Corporation Commission (Case No. PUR-2017-00044): Direct testimony of Melissa Whited regarding Rappahannock Electric Cooperative's proposed increases to fixed charges for residential customers and small business customers. On behalf of Sierra Club. September 19, 2017.

California Public Utilities Commission (Application 17-01-020, 17-01-021, and 17-01-022): Joint opening testimony with Max Baumhefner and Katherine Stainken on fast charging infrastructure and rates; joint opening testimony with Max Baumhefner and Joel Espino on medium and heavy-duty and fleet charging infrastructure and commercial EV rates; joint opening testimony with Max Baumhefner and Chris King on residential charging infrastructure and rates. Rebuttal testimony on public fast charging rate design, commercial EV rate design, and residential EV rate design. On behalf of Natural Resources Defense Council, the Greenlining Institute, Plug In America, the Coalition of California Utility Employees, Sierra Club, and the Environmental Defense Fund. July 25, August 1, August 7, and September 5, 2017.

New York Public Service Commission (Case 17-E-0238): Direct and rebuttal testimony of Tim Woolf and Melissa Whited regarding Earnings Adjustment Mechanisms proposed by National Grid. On behalf of Advanced Energy Economy Institute. August 25 and September 15, 2017.

Utah Public Service Commission (Docket No. 14-035-114): Direct testimony of Melissa Whited regarding PacifiCorp's proposed rates for customers with distributed generation. On behalf of Utah Clean Energy. June 8, 2017.

Texas Public Utilities Commission (SOAH Docket No. 473-17-1764, PUC Docket No. 46449): Cross-rebuttal testimony evaluating Southwestern Electric Power Company's proposed revisions to its Distributed Renewable Generation tariff. On behalf of Sierra Club and Dr. Lawrence Brough. May 19, 2017.

Massachusetts Department of Public Utilities (Docket No. 17-05): Direct and surrebuttal testimony of Tim Woolf and Melissa Whited regarding performance-based regulation, the monthly minimum reliability contribution, storage pilots, and rate design in Eversource's petition for approval of rate increases and a performance-based ratemaking mechanism. On behalf of Sunrun and the Energy Freedom Coalition of America, LLC. April 28, 2017 and May 26, 2017.

Public Utilities Commission of Hawaii (Docket No. 2015-0170): Direct testimony regarding Hawaiian Electric Light Company's proposed performance incentive mechanisms. On behalf of the Division of Consumer Advocacy. April 28, 2017.

Massachusetts Department of Public Utilities (Docket No. 15-155): Joint direct and rebuttal testimony with T. Woolf regarding National Grid's rate design proposal. On behalf of Energy Freedom Coalition of America, LLC. March 18, 2016 and April 28, 2016.

Federal Energy Regulatory Commission (Docket No. EC13-93-000): Affidavit regarding potential market power resulting from the acquisition of Ameren generation by Dynegy. On behalf of Sierra Club. August 16, 2013.

Wisconsin Senate Committee on Clean Energy: Joint testimony with M. Grabow regarding the importance of clean transportation to Wisconsin's public health and economy. February 2010.

TESTIMONY ASSISTANCE

Colorado Public Utilities Commission (Proceeding No. 16AL-0048E): Answer testimony of Tim Woolf regarding Public Service Company of Colorado's rate design proposal. On behalf of Energy Outreach Colorado. June 6, 2016.

Nevada Public Utilities Commission (Docket Nos. 15-07041 and 15-07042): Direct testimony on NV Energy's application for approval of a cost of service study and net metering tariffs. On behalf of The Alliance for Solar Choice. October 27, 2015.

Missouri Public Service Commission (Case No. ER-2014-0370): Direct and surrebuttal testimony on the topic of Kansas City Power and Light's rate design proposal. On behalf of Sierra Club. April 16, 2015 and June 5, 2015.

Wisconsin Public Service Commission (Docket No. 05-UR-107): Direct and surrebuttal testimony of Rick Hornby regarding Wisconsin Electric Power Company rate case. On behalf of The Alliance for Solar Choice. August 28, 2014 and September 22, 2014.

Maine Public Utilities Commission (Docket No. 2013-00519): Direct testimony of Richard Hornby and Martin R. Cohen on GridSolar's smart grid coordinator petition. On behalf of the Maine Office of the Public Advocate. August 28, 2014.

Maine Public Utilities Commission (Docket No. 2013-00168): Direct and surrebuttal testimony of Tim Woolf regarding Central Maine Power's request for an alternative rate plan. December 12, 2013 and March 21, 2014.

Massachusetts Department of Public Utilities (Docket No. 14-04): Comments of Massachusetts Department of Energy Resources on investigation into time varying rates. On behalf of the Massachusetts Department of Energy Resources. March 10, 2014.

State of Nevada, Public Utilities Commission of Nevada (Docket No. 13-07021): Direct testimony of Frank Ackerman regarding the proposed merger of NV Energy, Inc. and MidAmerican Energy Holdings Company. On behalf of the Sierra Club. October 24, 2013.

PRESENTATIONS

Whited, M. 2016. "Energy Policy for the Future: Trends and Overview." Presentation to the National Conference of State Legislators' Capitol Forum, Washington, DC, December 8.

Whited, M. 2016. "Ratemaking for the Future: Trends and Considerations." Presentation to the Midwest Governors' Association, St. Paul, MN, July 14.

Whited, M. 2016. "Performance Based Regulation." Presentation to the NARUC Rate Design Subcommittee. September 12.

Whited, M. 2016. "Demand Charges: Impacts and Alternatives (A Skeptic's View)." EUCI 2nd Annual Residential Demand Charges Summit, Phoenix, AZ, June 7.

Whited, M. 2016. "Performance Incentive Mechanisms." Presentation to the National Governors Association, Wisconsin Workshop, Madison WI, March 29.

Whited, M., T. Woolf. 2016. "Caught in a Fix: The Problem with Fixed Charges for Electricity." Webinar presentation sponsored by Consumers Union, February.

Whited, M. 2015. "Performance Incentive Mechanisms." Presentation to the National Governors Association, Learning Lab on New Utility Business Models & the Electricity Market Structures of the Future, Boston, MA, July 28.

Whited, M. 2015. "Rate Design: Options for Addressing NEM Impacts." Presentation to the Utah Net Energy Metering Workgroup, Workshop 4, Salt Lake City, UT, July 8.

Whited, M. 2015. "Performance Incentive Mechanisms." Presentation to the e21 Initiative, St. Paul, MN, May 29.

Whited, M., F. Ackerman. 2013. "Water Constraints on Energy Production: Altering our Current Collision Course." Webinar presentation sponsored by Civil Society Institute, September 12.

Whited, M., G. Brown, K. Charipar. 2011. "Electricity Demand Response Programs and Potential in Wisconsin." Presentation to the Wisconsin Public Service Commission, April.

Whited, M. 2010. "Economic Impact of Irrigation Water Transfers in Uvalde County, Texas." Presentation at the Mid-Continent Regional Science Association's 41st Annual Conference/IMPLAN National User's 8th Biennial Conference in St. Louis, MO, June

Whited, M., M. Grabow, M. Hahn. 2009. "Valuing Bicycling's Economic and Health Impacts in Wisconsin." Presentation before the Governor's Coordinating Council on Bicycling, December.

Whited, M., D. Sheard. 2009. "Water Conservation Initiatives in Wisconsin." Presentation before the Waukesha County Water Conservation Coalition Municipal Water Conservation Subgroup, July.

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