SINAPI LAW ASSOCIATES, LTD.

Richard A. Sinapi, Esq.
Stephanie P. McConkey, Esq.*
Danilo A. Borgas, Esq.*
Joshua D. Xavier, Esq.

Anthony E. Sinapi, Esq.**
Gregory A. Mancini, Esq., of counsel*
*admitted in MA
**only admitted in MA

September 1, 2017

VIA HAND DELIVERY AND ELECTRONIC MAIL
Mr. Todd A. Bianco
Coordinator
State of Rhode Island Energy Facilities Siting Board
89 Jefferson Blvd.
Warwick, RI 02886

Re: SB 2015-06, Invenergy Thermal Development LLC's Application to Construction the Clear River Energy Center Power Plant in Burrillville, RI

Dear Mr. Bianco:

Please find enclosed an original and three (3) copies of rebuttal testimony of Marc Vatter.

Please let me know if you have any questions. Thank you.

Very truly yours,

Gregory A. Mancini

cc: SB 2015-06 Invenergy CREC Service List as of 9/1/2017 via email

2374 Post Road • Suite 201 • Warwick, RI 02886 • Phone: (401) 739-9690 • Fax: (401) 739-9040 • www.sinapilaw.com

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
ENERGY FACILITY SITING BOARD

RE: SB 2015-06, INVENERGY THERMAL DEVELOPMENT, LLC APPLICATION TO CONSTRUCT AND OPERATE THE CLEAR RIVER ENERGY CENTER IN BURRILLVILLE, RHODE ISLAND

MOTION TO PROVIDE WITNESS REBUTTAL TESTIMONY

On January 12, 2016, the State of Rhode Island Energy Facility Siting Board issued an Order granting the Rhode Island Building and Construction Trades Council's ("RIBCTC") Motion to Intervene subject to conditions outlined in the Order. See, State of Rhode Island Energy Facility Siting Board, SB 2015-06, Order No. 80. Specifically, the Order stated that the "intervention shall be limited to issues affecting employment opportunities." Id. It also said that "[s]should the RIBCTC wish to present witnesses or evidence related to any issues other than those related to employment opportunities, it must seek Board permission to do so. Permission will be **liberally granted** when, in the opinion of the Board, such evidence will assist the Board in its decision." Id. [Emphasis added.]

RIBCTC expert witnesses Mr. Marc Vatter drafted testimony that rebuts direct testimony submitted that the RIBCTC believes is related to employment opportunities. Mr. Vatter's testimony is attached hereto as Exhibit 1. Moreover, Mr. Vatter's testimony would also assist the Board in making an informed decision about whether or not to permit this project. Therefore, out of an abundance of caution the RIBCTC is filing this Motion to request permission to submit this evidence because some may construe it outside the scope of Order No. 80's limits.

WHEREFORE, for all the reasons set forth above, RIBCTC respectfully prays that this Motion be granted and that this evidence that will assist the Board in its decision be put into the record.

Rhode Island Building and Construction Trades Council,
By its attorneys,
SINAPI LAW ASSOCIATES, LTD.

Dated: September 1, 2017

Gregory A. Mancini (RI Bar No. 5740)
Sinapi Law Associates, Ltd.
2374 Post Road, suite 201
Warwick, RI 02886
P: (401)-739-9690; F: (401)-739-9040
gmancinilaw@gmail.com

CERTIFICATION

I hereby certify that on the 1st **day of September, 2017** a copy of the foregoing document was caused to be served upon the individuals on the Board's service list as of this date.

EXHIBIT 1

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
ENERGY FACILITY SITING BOARD

RE: SB 2015-06, INVENERGY THERMAL DEVELOPMENT, LLC APPLICATION TO CONSTRUCT AND OPERATE THE CLEAR RIVER ENERGY CENTER IN BURRILLVILLE, RHODE ISLAND
Rebuttal testimony of Marc H. Vatter

Executive Summary

Q. What is the purpose of your testimony?

I comment on some aspects of the testimonies of Robert M. Fagan, a witness for the Conservation Law Foundation, and Glenn C. Walker, a witness for the town of Burrillville.

Q. Please summarize your comments on Mr. Fagan's testimony.

I comment on his direct testimony and focus on two issues:

1) Mr. Fagan plays down the effects of economic growth on load growth, especially the role of the Great Recession in the slowdown in load growth since 2006. He emphasizes the roles of energy efficiency and behind-the-meter solar photovoltaic generation (BtM PV) in lowering net loads since 2006. I argue that energy efficiency is important, but that the macroeconomy is more important to the accuracy of predictions of load. Neither the ISO nor any other observer expects the Great Recession to be repeated in the near future, and load growth will be correspondingly more rapid, contributing to the anticipated need for CREC. I also suggest that the ISO's assumptions regarding economic growth going forward may still be on the pessimistic side, so the need for CREC may be greater than anticipated.

2) In assessing the need for CREC, Mr. Fagan focuses on annual peak and energy loads, to the exclusion of the need for dispatchable generation, other than, by implication, Canadian hydropower, to fill the gaps between intermittent solar and wind generation and load. I argue that a combination of gas-fired generation and Canadian hydropower is the least expensive complement to intermittent renewables in New England.

Q. Please summarize your comments on Mr. Walker's testimony.

I comment on Mr. Walker's initial and supplemental testimonies. Regarding his initial testimony, I question two points:

1) I question his forecast for the "next several" ISO forward capacity auctions (FCAs). He forecasts capacity prices of $5.00-$6.00/kw-mo, and that CREC will not be awarded a capacity supply obligation (CSO). His forecast is partly based on prices and supply and demand conditions in FCAs 10 and 11, but ignores the much higher prices that obtained in FCAs 8 and 9, and any trend in capacity prices since the auctions began. I argue that CREC will be a competitive source of capacity at prices below trend.

2) I challenge his argument that "CREC's fast start, ramping, and flexibility characteristics" will be supplanted by energy storage technologies during the 2020s. I argue that gas-fired generation will remain a less expensive way to integrate intermittent solar and wind generation into the generating fleet.

Regarding his supplemental testimony, I criticize a fallacious argument that a resource must clear a capacity auction to be needed, and challenge his assumption that the capacity factor for clean generation is 90%. A typical capacity factor for solar generation is a little over 20%, and below 50% for wind.

1. INTRODUCTION

Q. Please state your name, business title and business address.

My name is Marc H. Vatter, Ph.D., Consulting Economist. My address is 9 Underhill Street, Nashua, NH 03060.

Q. On whose behalf are you testifying?

My testimony is on behalf of the Rhode Island Building and Construction Trades Council (RIBCTC) in support of the Invenergy Thermal Development LLC (Invenergy) application for a license from the Rhode Island Energy Facilities Siting Board (RIEFSB) to construct the Clear River Energy Center (CREC) project in Burrillville, Rhode Island.

Q. Please describe your educational background and your professional experience.

I am a consulting economist with extensive experience in the electric utility industry. My most recent work includes production cost modeling of the electric power grid in Mexico using AURORAxmp® and testimony before the Michigan Public Service Commission. I have sponsored testimony before several regulatory commissions on rates, plant additions, etc. (My curriculum vitae is included as Exhibit 1.)

Q. What is the purpose of your testimony?

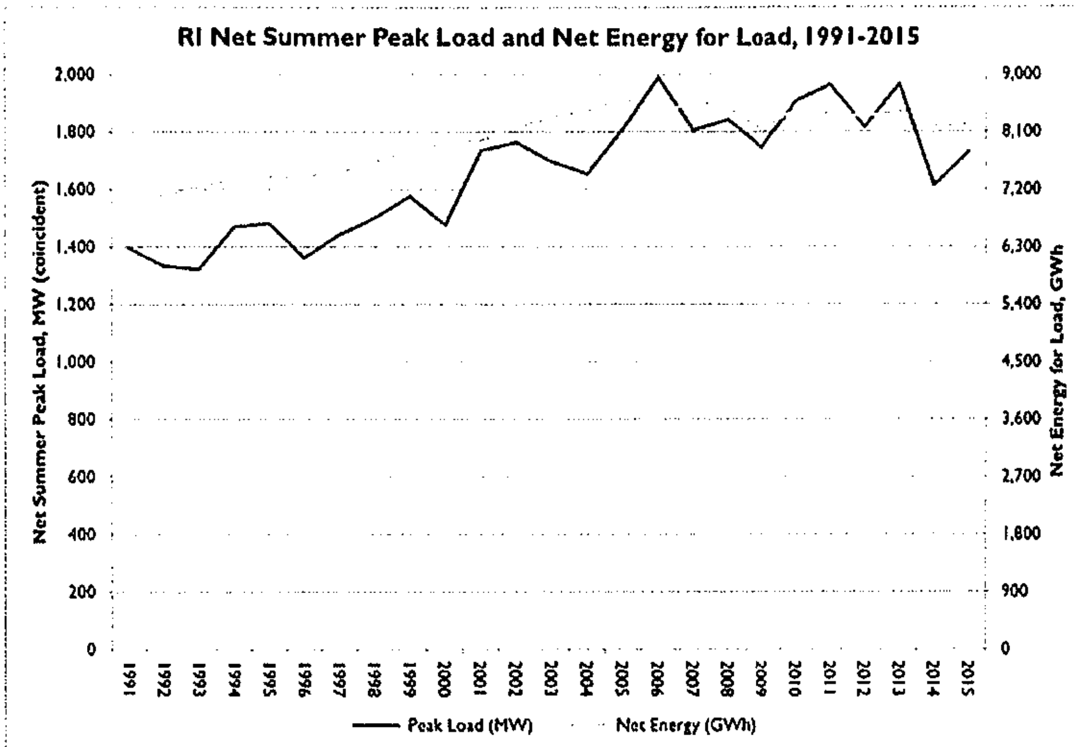
I comment on some aspects of the testimonies of Robert M. Fagan, a witness for the Conservation Law Foundation, and Glenn C. Walker, a witness for the town of Burrillville.

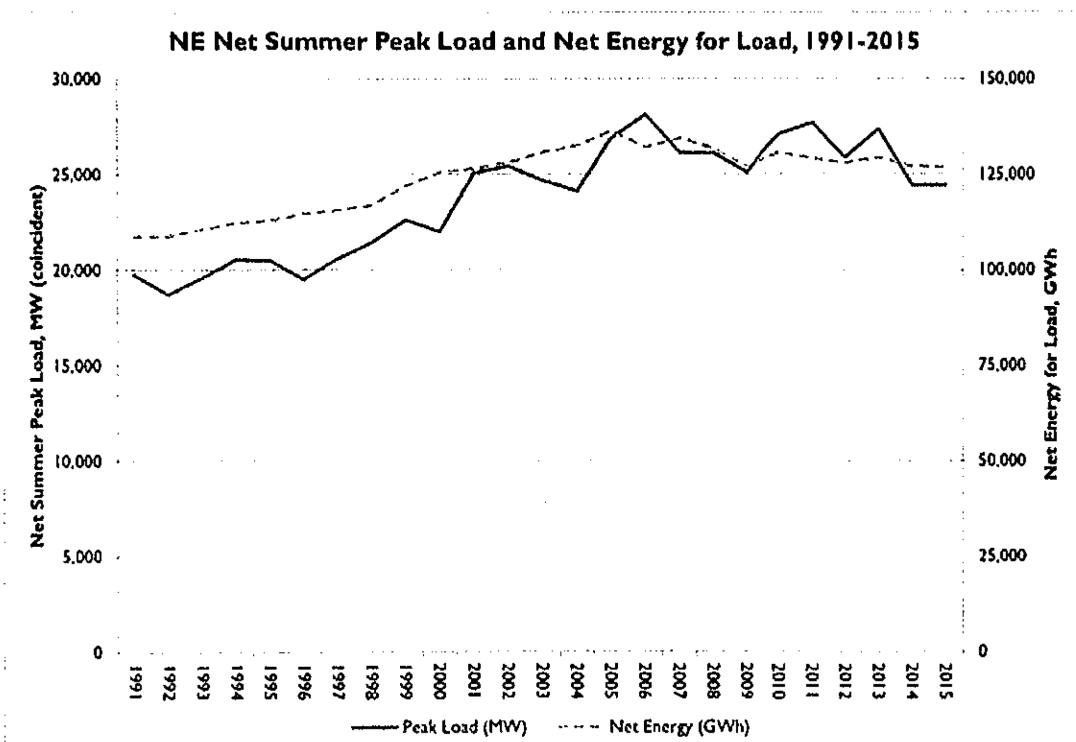
2. COMMENTS ON THE TESTIMONY OF ROBERT M. FAGAN

Q. Please comment on Mr. Fagan's lack of attention to the effects of economic growth on load growth.

Mr. Fagan testifies that CREC will not be needed because load growth in New England and Rhode Island have leveled off and begun to trend down. He includes the following graphs on pages 14 and 15, reprinted here as Figure 1.

Figure 1: Graphs reprinted from direct testimony of Robert Fagan





Note: Net energy for load is energy net of energy efficiency and behind-the-meter (BTM) solar PV resources. Net summer peak load is summer coincident peak load, net of the effects of energy efficiency and BTM solar PV. Source: ISO NE, 2016 CELT.

The graphs show loads rising from 1991 until 2006 and leveling off and turning down from 2006 to 2015. According to Mr. Fagan, "The figures show that for both Rhode Island, and New England as a whole, net electricity load has flattened (both summer net peak load, and annual net energy), and has begun to trend downward over the past decade, contrary to the assertion made by Invenergy." (page 14, lines 3-5) He attributes this primarily to rising acquisition of energy efficiency resources and BtM PV:

> Q. What is the cause of the change to the often-heard conventional wisdom that electric load is growing?
>
> A. There are multiple factors, but two dominating factors are Rhode Island's increasing investment in energy efficiency resources, and its investment in behind-the-meter solar PV resources. Rhode Island also has significant levels of utility-scale solar PV resources, in addition to its behind-the-meter solar PV resources. (page 15, lines 7-12)

Q. Do you agree that energy efficiency and BtM PV were the "dominating factors" in the slowdown in load growth?

No, I do not. Among the "multiple factors" that Mr. Fagan does not specify is slower economic growth associated with the Great Recession. Using the data used in the New England ISO's CELT model[1], real gross state product (GSP) in Rhode Island grew at an average annual rate of 2.75% from 1991 to 2006, but only 0.02% from 2006 to 2015. Total GSP for New England grew at an average annual rate of 2.91% from 1991 to 2006, but only 0.57% from 2006 to 2015. When I analyze CELT data statistically, I find that both energy efficiency and real GSP are highly statistically significant factors influencing annual energy and peak load, but that information on real GSP adds more to the accuracy of predictions of

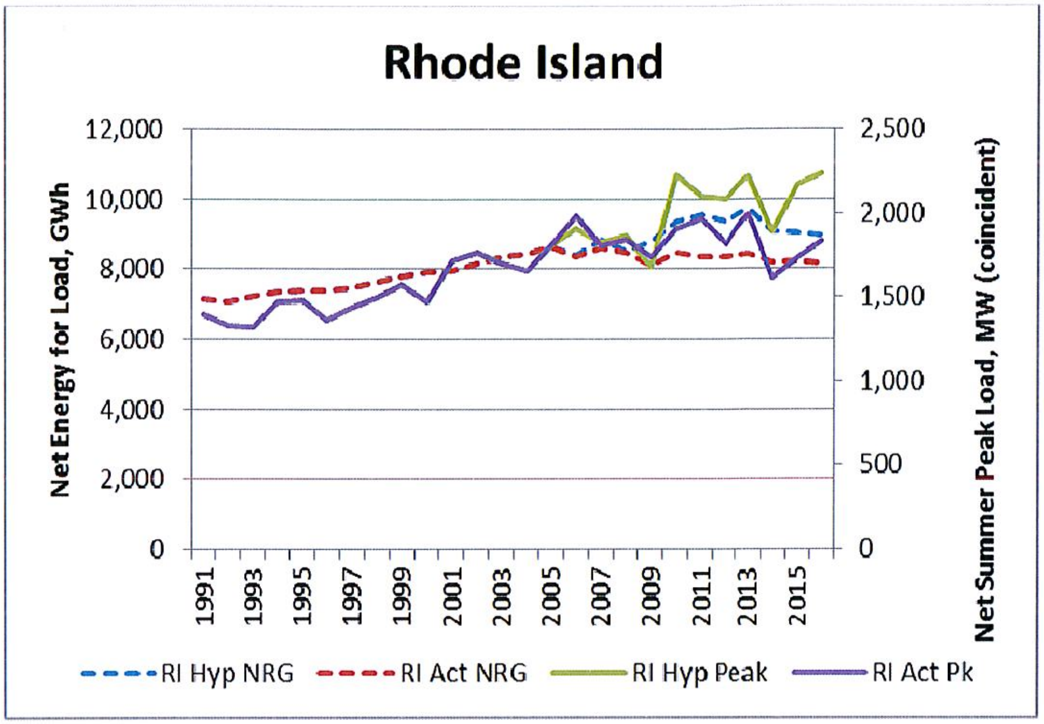
---

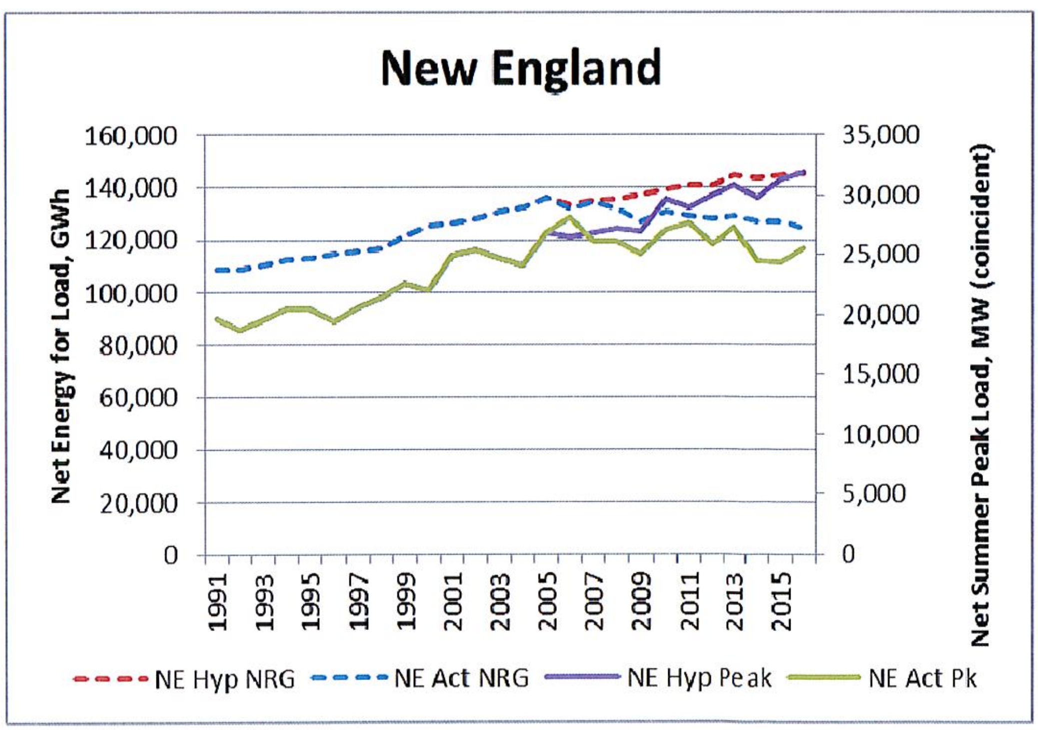
[1] See data for New England Independent System Operator's Capacity, Energy, Load, and Transmission forecast model, 2017, "2017-05-01 Forecast Data 2017", available at https://www.iso-ne.com/system-planning/system-forecasting/load-forecast, accessed August 5, 2017.

load than does information on energy efficiency and BtM PV. See the technical appendix for a discussion of the analysis.

Figure 2 shows the load trajectories depicted in Figure 1, along with loads in both Rhode Island and New England as a whole if the Great Recession had not occurred. I derive the loads for this hypothetical case using the statistical model discussed in the appendix, and I assume that economic growth from 2006 to 2016 would have continued at the same rate as it did from 1991 to 2005. Without the recession, loads grow more rapidly in every case. The downturn in energy loads in Rhode Island comes much later, and peak loads in Rhode Island never turn down. Moreover, neither energy loads nor peak loads in New England as a whole ever turn down. The slowing of load growth that actually occurred resulted substantially from a slowing of the regional economy, and I submit that this was also a, if not the, "dominating factor".

Figure 2: Actual and hypothetical loads in Rhode Island and New England if the Great Recession had not occurred

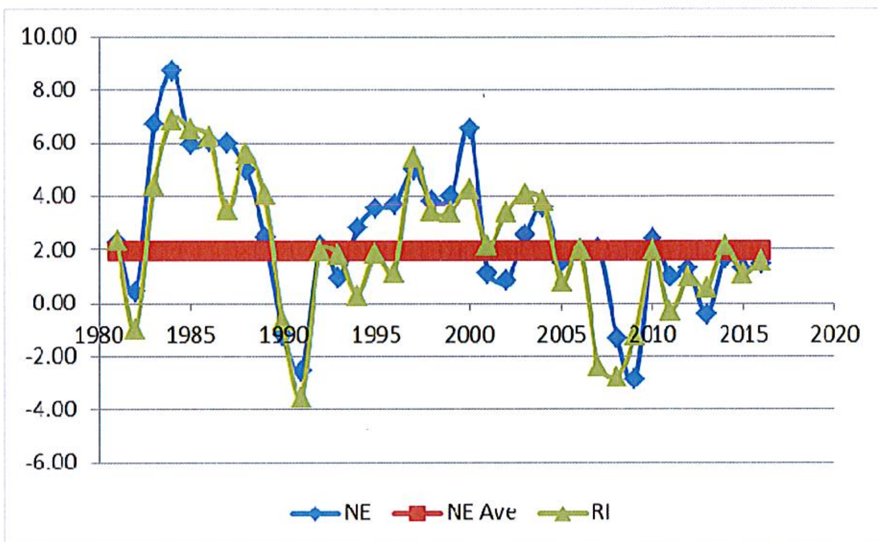




Q. Do you expect economic growth to be as slow going forward as it has been since 2006?

No, I do not. Figure 3 shows how annual economic growth in New England was largely below its 1981-2016 average of 1.98%[2] during 2006-2016.

Figure 3: Annual percentage growth in gross state product in New England and Rhode Island; 1981-2016



It is not expected that economic growth going forward will be as slow as it was from 2006 to 2016. In its 2017 CELT Report[3], the ISO forecasts annual economic growth in New England as a whole to be 1.92% to 2027, and 1.73% in Rhode Island. Both numbers are close to the average for 1981-2016, and well above annual growth from 2006 to 2016. Slow load growth between 2006 and 2016 resulted substantially from slow economic growth, and, other things being the same, load growth should be more rapid going forward, increasing the anticipated need for CREC.

The ISO forecasts economic growth in New England to 2027 slightly below the 1981-2016 average, an average that was brought down by the Great Recession. Not all forecasts are

[2] The Rhode Island average over 1981-2016 was 1.72%.

[3] Ibid.

below such a historical average. U.S. economic growth averaged 2.35% annually from 1981 to 2016, and the Organization for Economic Cooperation and Development forecasts U.S. growth of 2.51% annually from 2016 to 2027.[4] If the ISO's forecast of below average economic growth for New England is too pessimistic, then its load forecast will be too low, and the need for CREC will be greater than anticipated.

Q. Please comment on the role of gas-fired generation in integrating intermittent renewable resources.

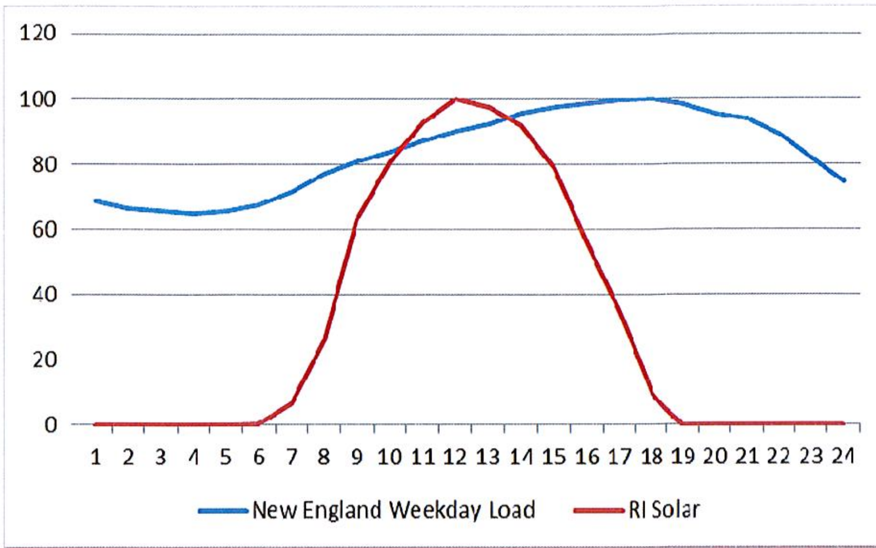
Mr. Fagan measures the need for resources in terms of annual peak and energy loads, such as those depicted in Figure 1. He argues that future load can be served using solar, wind, energy efficiency, and hydroelectric resources, without additional gas-fired generation like CREC. He does not comment on the intermittency of solar and wind. It is well understood in electric resource planning that solar and wind generators cannot be dispatched so that their generation coincides with load in real time. Consequently, integration of these resources into the generating fleet requires some complementary storage or generating technology capable of "shaping" output to meet load.

Figure 4 shows hourly shapes for load in New England and solar generation in Rhode Island for a weekday in early August.[5] The surge in solar output is much sharper than that in load, and it occurs considerably earlier in the day. The two hardly coincide. Actual load and solar output in any given hour are less certain than these shapes, which further increases the need for complementary storage or generation.

---

[4] See https://data.oecd.org/gdp/gdp-long-term-forecast.htm#indicator-chart, accessed August 12, 2017.
[5] Loads come from the NE ISO and are for early August, 2017; https://www.iso-ne.com/isoexpress/web/reports/load-and-demand, accessed August 14, 2017. Rhode Island solar output comes from the NREL; https://www.nrel.gov/grid/solar-power-data.html, accessed August 14, 2017.

Figure 4: Weekday hourly load and solar generation shapes; % of maximum



Estimates of the technical potential for demand-side flexibility vary widely[6], and economic potential is generally less. The Canadian hydropower Mr. Fagan mentions is ideal for shaping solar and wind output, but the transmission needed to import it has been contentious. The New Hampshire Site Evaluation Committee's approval process for the Northern Pass transmission project has been long and involved.[7] Figure 5 shows coal- and oil-fired generation in New England being displaced over time with a combination of Canadian hydropower and additions of gas-fired generation.[8]

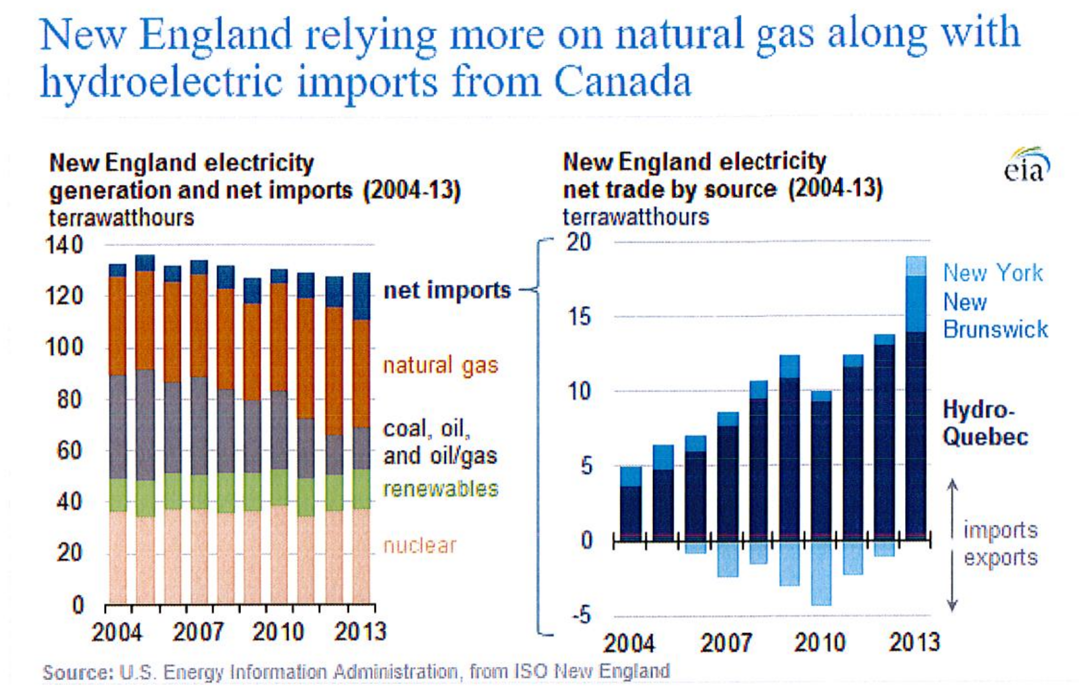
---

[6] See Pacific Gas & Electric, "Demand side resources for renewables integration", September 2014, available at https://static1.squarespace.com/static/573ca4db22482e9a6e805853/t/5750a95601dbae39a9a572e3/1464904025929/DSM+for+Renewables+Integration.pdf, accessed August 5, 2017.

[7] See https://www.nhsec.nh.gov/projects/2015-06/2015-06.htm, accessed August 5, 2017.

[8] See https://www.eia.gov/todayinenergy/detail.php?id=17671, accessed August 9, 2017.

Figure 5: Reprinted from Energy Information Administration



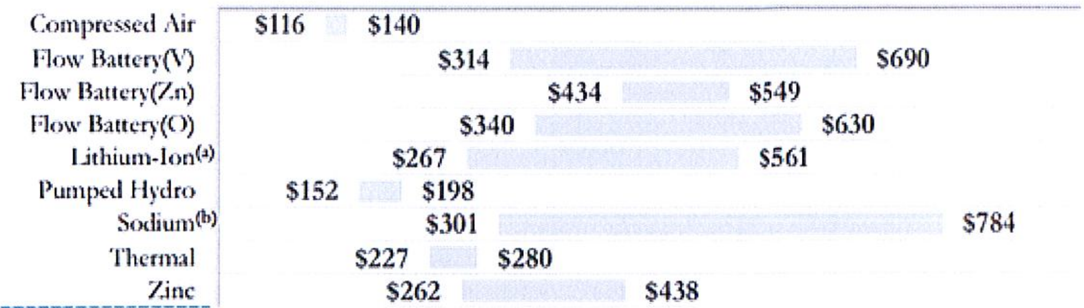
As yet, battery storage, flywheels, and compressed air remain expensive means for shaping solar and wind output. According to Lazard, the levelized cost of lithium-ion battery storage to "...assist in the integration of largescale variable energy resource generation (e.g., utility-scale wind, solar, etc.)" is now between \$267/MWh and \$561/MWh. Figure 6 shows the ranges of costs for that and other technologies.[9] All of them are considerably higher than the cost of a resource like CREC. Based on capital cost data from the Energy Information Administration (EIA), and assuming amortization over 20 years at 6.33%, a fuel cost of \$6.50/MMBtu, a heat rate of 6,300 Btu/kwh, and a capacity factor of 65%, the levelized total cost of an advanced combined-cycle natural gas plant is around \$55/MWh.[10]

---

[9] See Lazard's Levelized Cost of Storage – Version 2, December 2016, pages 6 and 11, available at https://www.lazard.com/media/438042/lazard-levelized-cost-of-storage-v20.pdf, accessed August 9, 2017.

[10] Overnight capital costs are \$1,094/kw . See EIA Table 8.2 from Cost and Performance Characteristics of New Generating Technologies, *Annual Energy Outlook 2017*, available at https://www.eia.gov/outlooks/aeo/assumptions/pdf/table_8.2.pdf, accessed August 9, 2017. I assume fixed O&M of \$15/kw-yr and variable O&M of \$3/MWh. See National Renewable Energy Laboratory, "Cost and

Figure 6: Reprinted from Lazard; $/MWh costs for energy storage technologies



Gas-fired generation like CREC, therefore, is an important tool for integrating intermittent solar and wind. A study at the National Bureau of Economic Research[11] finds that "…a 1% increase in the share of fast-reacting fossil generation capacity is associated with a 0.88% increase in renewables in the long run…Our analysis points to the substantial indirect costs of renewable energy integration and highlights the complementarity of investments in different generation technologies for a successful decarbonization process."(abstract)

3. COMMENTS ON THE TESTIMONY OF GLENN C. WALKER

Q. How much confidence do you have in Mr. Walker's forecast of capacity prices?

It could easily be low, given the history of capacity prices. On page 8, lines 5-8 of his initial testimony, Mr. Walker forecasts prices of $5.00-6.00/kw-mo in "the next several auctions", with reference to some qualitative factors. In the subsequent question, he states that "Given the surplus of capacity that was procured in FCA 11" he also does not "anticipate that Unit 2 will receive a CSO in the next several auctions". Again on page 10, lines 1-3, he only discusses FCAs 10 and 11.

He does not mention that capacity prices in FCAs 8 and 9 were much higher, that prices have exhibited considerable variability. In FCA 9, "Even before the auction started, there were not

Performance Assumptions for Modeling Electricity Generation Technologies", pp. 55-57; available at https://www.nrel.gov/docs/fy11osti/48595.pdf, accessed August 25, 2017.
[11] See http://www.nber.org/papers/w22454?utm_campaign=ntw&utm_medium=email&utm_source=ntw, accessed August 5, 2017.

enough new and existing resources, combined, to provide the capacity needed in the SEMA/RI zone in 2018-2019....Administrative pricing rules were triggered because of SEMA/RI's inadequate supply. Under these rules, the 353 MW of new resources in the zone will receive the auction starting price of $17.73/kW-month, while the 6,888 MW of existing resources in the zone will receive $11.08/kW-month, which is based on the net cost to build a new resource."[12]

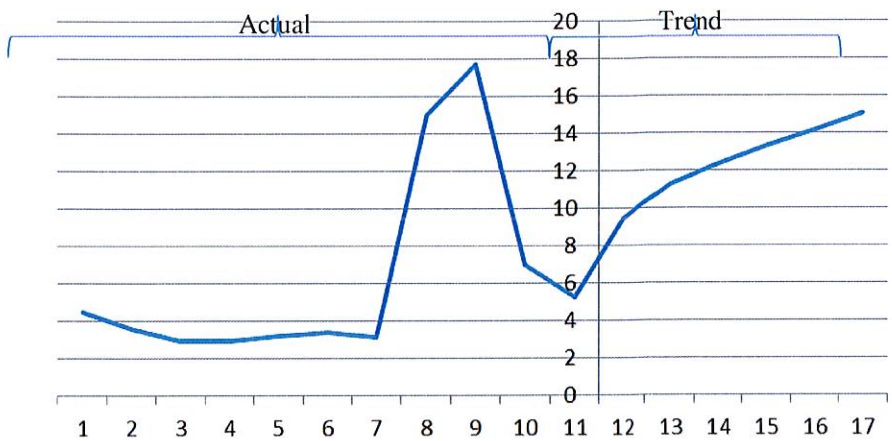
If there is a trend in capacity prices in Rhode Island, based on *all* the past FCAs, it is higher than $5.00-6.00/kw-mo going forward. Figure 7 shows the trend in capacity prices for new generation in Rhode Island going forward to FCA 17. In FCA 12, the trend starts out at $9.45/kw-mo, and rises to $15.06/kw-mo by FCA 17. Using cost data from the EIA and NREL, the levelized fixed cost of an advanced combined cycle gas plant is $9.41/kw-mo[13], and CREC Unit 1 cleared FCA 10 at a price of $7.03/kw-mo. Actual prices may not reach the trend, but at prices below the trend, CREC Unit 2 would be a competitive source of capacity.

---

[12] ISO press release "Annual Forward Capacity Market Auction Acquires Major New Generation Resources for 2018-2019", p. 2; available at https://www.iso-ne.com/static-assets/documents/2015/02/fca9_initialresults_final_02042015.pdf, accessed August 21, 2017.

[13] Overnight capital costs are $1,094/kw, amortization is over 30 years at 6.33%, and fixed O&M is $9.94/kw-mo. See EIA Table 8.2 from Cost and Performance Characteristics of New Generating Technologies, *Annual Energy Outlook 2017*, available at https://www.eia.gov/outlooks/aeo/assumptions/pdf/table_8.2.pdf, accessed August 9, 2017.

Figure 7: $/kw-mo for new generation in Rhode Island in NE-ISO forward capacity auctions



Forward Capacity Auction

Mr. Walker claims that his forecasted prices are high enough to prevent older units from retiring, but low enough that CREC Unit 2 will not obtain a CSO. His $5.00-$6.00/kw-mo range is below the historic average price of $6.26/kw-mo. Given the upward direction of any trend in prices, it is more likely that prices will be higher than lower than $6.26/kw-mo. The standard deviation of historic prices is $5.18/kw-mo, so a price one standard deviation above average is $11.44/kw-mo, which, like the trend, is more than high enough for CREC Unit 2 to obtain a CSO.

Q. Do you agree with Mr. Walker that CREC will not be a resource of choice for backing up intermittent renewable generation?

No, I do not. On page 11, lines 10-20 of his initial testimony, Mr. Walker argues that "CREC's fast start, ramping, and flexibility characteristics" will be supplanted by energy storage technologies during the 2020s. Most storage technology is still far from being competitive with natural gas as a way to shape the output of intermittent renewables. As noted in my comments on Mr. Fagan's testimony, the levelized cost of storage technologies used to "…assist in the integration of largescale variable energy resource generation (e.g., utility-scale wind, solar, etc.)" are in the hundreds of dollars per MWh (See Figure 6.), while the levelized total cost of an advanced combined-cycle natural gas plant is around $55/MWh.

Q. Please clarify the purpose of a CSO.

Mr. Walker's statements on page 6, lines 12-16 of his supplemental testimony are a misuse of conventional terminology.

> Clearly the second unit is not needed. If the RIEFSB granted approval for the entire 1,000 MW facility, the RIEFSB would allow the construction of at least 500 MW that has failed to obtain a CSO and would be surplus to the existing resources. Therefore, the proposed 1,000 MW facility is not needed in the state and/or region for energy of the type to be produced by CREC.

A CSO is an obligation to provide capacity, which is priced in $/kw-mo in the FCAs and represents the ability to meet load during short, peaking periods, usually a single hour; not "energy", which is priced in $/MWh, and the need for which is often defined over longer periods of time, such as a year.

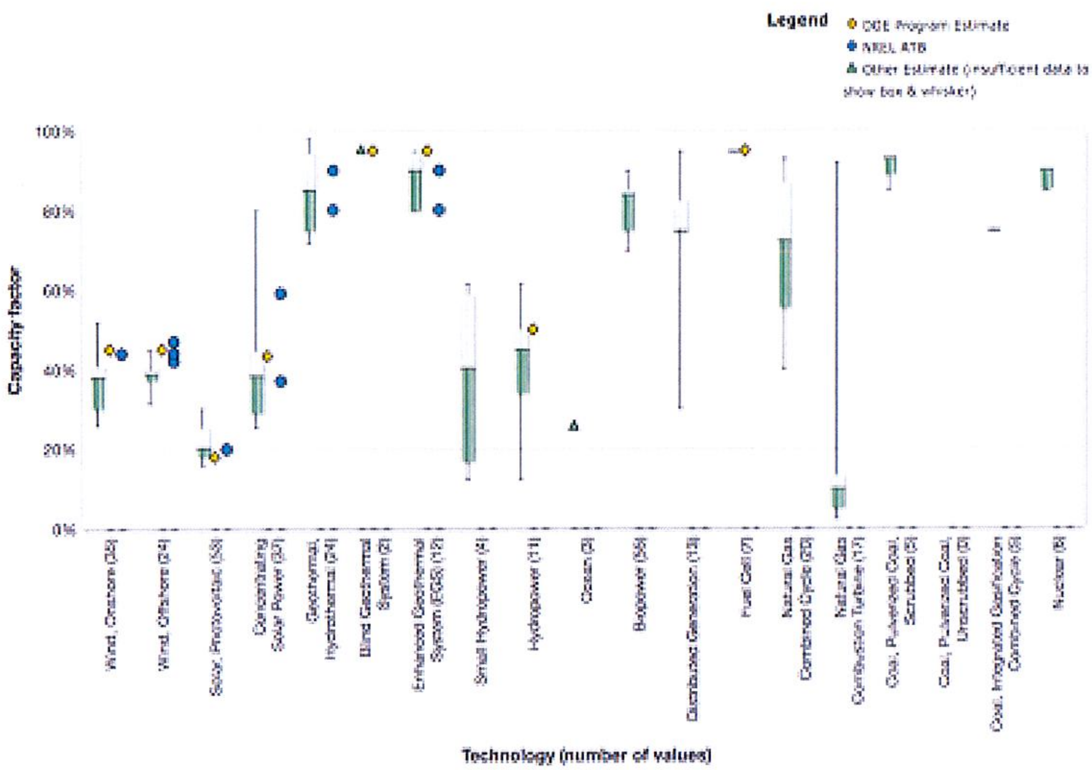
Q. In his testimony, did Ryan Hardy, a witness for Invenergy, imply that a resource must obtain a CSO in order to be needed?

No, he did not. Mr. Walker's argument on page 6, line 18 to page 7, line 7 of his supplemental testimony is fallacious. He takes Mr. Hardy's statement that if a resource clears an FCA, then it is needed, to imply the converse: that if it does not clear an FCA, then it is not needed. Mr. Hardy did not, however, assert the converse, and it does not follow from what he did assert.

Q. Please comment on Mr. Walker's assumed capacity factor for clean energy projects.

On page 14, line 9 of his supplemental testimony, Mr. Walker assumes a 90% capacity factor for clean energy projects. A typical capacity factor for solar PV is a little over 20%, and below 50% for wind, as shown in Figure 8.[14]

Figure 8: Reprinted from National Renewable Energy Laboratory; Capacity factors by generating technology



Q. Does this conclude your rebuttal testimony?

A. Yes, it does.

<u>Technical Appendix</u>

Q. Please describe your analysis of the factors driving electric loads during 1991-2016.

I use the "sureg" command in Stata® to simultaneously estimate the effects of the variables in the ISO's dataset on annual energy and peak load. In a seemingly unrelated regression, the errors in prediction of peak load may correlate with those in the prediction of energy load.

[14] See http://www.nrel.gov/analysis/tech_cap_factor.html, accessed August 9, 2017.

The ISO provides data for the six New England states from 1991 to 2016, for a panel of 156 observations. The variables in the dataset include actual net energy for load (GWh), passive demand resources (PDR or "energy efficiency"; GWh), behind-the-meter solar PV (BtM PV; GWh), real price of electricity (2016 cents/kwh), New England composite consumer price index (CPI; Base=2016), population (Ths.), personal income (Mil $), disposable income (Mil $), nonagricultural employment (Ths.), real gross state product (real GSP; Mil. 09$), unemployment rate (%), cooling degree days (base 65F), and heating degree days (base 65F). The difference between the, also included, gross and net coincident summer peak loads (MW) is the ISO's "reconstitution" of the sum of the contributions of PDR, BtM PV, and Operating Procedure 4 (OP4), invoked when capacity runs short, to meeting gross peak load. I begin by regressing net annual energy and coincident peak load on all of the variables, with the following exceptions: Heating degree days is not included in the equation for summer peak; reconstitution (MW) of PDR, BtM PV, and OP4 is only included in the equation for summer peak; and PDR (GWh) and BtM PV (GWh) are only included in the equation for annual energy. I also examine a deterministic trend variable (Year) and indicator variables for each of the states. I then eliminate regressors that are not statistically significant or whose coefficients do not have the expected sign. I also eliminate the CPI once all nominal dollar-denominated variables have been eliminated. Having done so, I arrive at the model shown in Table 1.

Table 1: Regression model of net annual energy (GWh) and summer peak (MW) load

	Net Annual Energy (GWh)		Net Coincident Summer Peak (MW)	
	Coefficient	Std. Err.	Coefficient	Std. Err.
PDR (GWh)	-1.026	0.055		
Reconstitution of PDR, BtM PV, & OP4 (MW)			-0.813	0.130
Real GSP	0.089	0.002	0.025	0.001
Real price of electricity	-171.516	35.167		
Heating degree days	0.390	0.119		
Cooling degree days	2.682	0.767	2.016	0.328
Maine	-7100.545	375.699	-332.605	161.621
Massachusetts	12229.250	323.298	1321.608	143.598
New Hampshire	-8084.595	348.755	-322.678	151.036
Rhode Island	-10003.770	352.390	-775.122	154.515
Vermont	-10367.880	409.052	-668.047	174.655
Constant	13746.870	1104.828	561.256	213.580

All of the variables in Table 1 are highly statistically significant, except the indicator variables for Maine and New Hampshire. Those indicator variables are significant at the 95% level. A lagged dependent variable added to either equation is not statistically significant. Notably, BtM PV is far from statistically significant if added to the energy equation. This may be due to difficulty in measurement. An email from Jonathan Black at the ISO, attached as Exhibit 2, explains that net load and PDR are observed, but that BtM PV and, therefore, gross load are estimated. Still, its lack of statistical significance casts doubt on the importance of BtM PV as a predictor of net energy load.

The largest *t*-statistics in both equations are those associated with real gross state product. Retail prices of electricity are set in rate filings and may not be sensitive to contemporaneous changes in load. However, if I treat price as endogenous, then instrument for it using its own lag, and follow the same procedure, I also come out with the model in Table 1, and very similar statistics, including root mean squared errors.

Root mean squared error (RMSE) is the square root of the average squared deviation of observations of the dependent variable from the values predicted by a regression equation. It is a widely used measure of the predictive accuracy of an equation. In order to compare the predictive accuracy of the variables Mr. Fagan refers to as "dominating", PDR and BtM PV, to that of real GSP, I compare the mean squared errors when those variables are alternately excluded from the model in Table 1. Table 2 shows the result.

Table 2: Root Mean Squared Errors of Alternative Regression Models

	Full Model	Model w/o PDR, BtM PV, & OP4	Model w/o Real GSP
Net annual energy for load	569.3	1034.0	2066.5
Net coincident summer peak	260.3	295.4	630.6

PDR, BtM PV, and OP4 lower RMSE in the energy equation by 60%, and by 13% in the peak load equation. However, including real GSP in the model cuts RMSE in the energy equation by 129%, and by 88% in the peak load equation. I conclude that, though they are all significant, the macroeconomy, as measured by real gross state product, is more important to the accuracy of predictions of electric load than are energy efficiency and behind-the-meter solar photovoltaics.

EDUCATION

Ph.D. in Economics, Brown University, Providence, RI, 2006

M.A. in Economics, Brown University, Providence, RI, 1999

B.A. in Economics with departmental honors, University of Oregon, Eugene, OR, 1986

CONSULTING EXPERIENCE

Consulting Economist, Nashua, NH and Portland, OR, January 2010 – present

- Affiliated with Birch Energy Economics, Post Falls, ID, July 2015 – present
- Affiliated with Economic Insight, Sisters, OR, January 2010 – January 2013
- Used AURORAxmp® (xmp) to forecast wholesale electric prices in Michigan and sponsored testimony on behalf of Michigan Public Service Commission staff
- Recent work in newly restructured wholesale power market in Mexico
    - Used xmp to model expansion and operation of wholesale power grid for independent generators
    - Estimated Herfindahl-Hirschman indices of market concentration
    - Forecasted hourly loads and prices for power
    - Developed methodology and forecasted prices for clean energy certificates,
    - Developed methodology and forecasted prices for ancillary services
    - Adapted methodology and forecasted costs of congestion in a "zonal" model
- Used xmp to model electric resource planning in the Pacific Northwest
- Used xmp to estimate trade benefits of Entergy and South Mississippi Electric Power Association joining regional transmission organizations, sponsored testimony before the Mississippi Public Service Commission (MPSC)
- Assessed application to install pollution controls on coal plant; testified before the MPSC
- Estimated dollars of spending per employee by generating technology
- Analyzed issues regarding pricing and royalties in geothermal and natural gas leases in California and Texas;

9 Underhill Street, Nashua, New Hampshire 03060-4060, USA
603.402.3433 (land); 503.227.1994 (cell)
marc@appliedecon.net; appliedecon.net

- Analyzed pricing and alleged use of market power in California power crisis
- Edited several scholarly articles written by non-native speakers of English
- Estimated lost earnings in a wrongful death lawsuit and testified to report
- Edited scholarly research written by non-native speakers of English

Assistant consulting economist to personal injury and wrongful death litigants, Allan M. Feldman, Providence, RI, 2002-2003

- Worklife evaluation for litigation related to personal injury or wrongful death

Research Associate, Synapse Energy Economics, Cambridge, MA, July 1998 - February 1999

- Evaluated forecasts of electricity prices submitted in "stranded-cost" claim by four Maryland utilities

Associate Economist, Economic Insight, Portland, OR, May 1988 - September 1988

- Surveyed forecasts of electricity prices and estimates of demand elasticities related to litigation over Washington Public Power Supply System bond defaults

Technical Assistant, ECO Northwest, Eugene, OR, July 1986 - August 1987

- Worklife evaluation for litigation related to personal injury and wrongful death; wrote company training manual on the subject

TEACHING EXPERIENCE

Visiting Assistant Professor of Economics, Universidad del Pacifico, Jesús María, Lima, Peru, September 2014

- Taught topical graduate course in Energy Economics

Visiting Assistant Professor of Economics, Pacific University, Forest Grove, OR, August 2008 - May 2009

- Taught principles of microeconomics, environmental economics, and international trade

Lecturer in Economics, Eastern Connecticut State University, Willimantic, CT, August 2005 - May 2006

- Taught principles of microeconomics

Teaching Assistant to Harl Ryder and others, Brown University, Providence, RI, September 1999 - May 2002

- Teaching Assistant for Principles of Micro- and Macroeconomics
- **Teacher, English as a Second Language**, Changsha Normal University of Water Resources and Electric Power, Changsha, Hunan, PRC, August 1987 - January 1988, Brown University, Providence, RI, Summer 2001

GOVERNMENTAL EXPERIENCE

Associate Economist, New York Department of Public Service, Albany, NY, August 2006 - December 2007

- Projects in energy conservation and pollution control

Industry Economist, Bonneville Power Administration, Portland, OR, May 1994 - June 1997

- Authored and testified to marginal cost analysis in 1996 rate case
    - Helped prepare inputs to and interpreted and applied results of Power Marketing Decision Analysis Model (PMDAM) to rate design and to planning and evaluation of generation and conservation resources
    - Prepared and conducted public meetings on analysis and its implications for rate design
    - Fielded and incorporated comments from a variety of participants
    - Authored rate case study, documentation, and testimony

Public Utilities Specialist, Bonneville Power Administration, Portland, OR, September 1988 - May 1994

- Conducted research on marginal costs of generating and marketing hydropower on the West Coast
- Prepared workshop briefing material, rate case studies, and documentation supporting Marginal Cost Analysis and other rate-related issues as assigned
- Evaluated contracts for disposition of wholesale power

RESEARCH

Title	Status	Availability

9 Underhill Street, Nashua, New Hampshire 03060-4060, USA
603.402.3433 (land); 503.227.1994 (cell)
marc@appliedecon.net; appliedecon.net

OPEC's Kinked Demand Curve	(2017) *Energy Economics*, 63, pp. 272-287.	https://doi.org/10.1016/j.eneco.2017.02.010
Macroeconomic Risk and Residential Rate Design	International Association for Energy Economics (IAEE) Working Paper No. 15-208; under review	http://ssrn.com/abstract=2596258
Social Discounting with Diminishing Returns on Investment	Under review	http://ssrn.com/abstract=1078502
The Impact of International Trade on Electric Loads in Mexico	IAEE Working Paper No. 17-301; non-technical version published in IAEE Energy Forum	http://ssrn.com/abstract=2928817 https://www.iaee.org/en/publications/newsletterdl.aspx?id=406
Stockpiling to Contain OPEC	Dissertation chapter; IAEE Working Paper No. 17-136; presented at 12/08 IAEE conference in New Orleans	http://ssrn.com/abstract=912311
OPEC's Demand Curve	Dissertation chapter; reviewed at http://knowledgeproblem.com/2008/05/14/	http://ssrn.com/abstract=1127642
The Cause and Effect of Exclusionary Zoning in Central Cities	Dissertation chapter; under review	http://ssrn.com/abstract=636962

Research Assistant to Allan M. Feldman, valuation of individual earning capacity, Brown University, 2000

Research Assistant to J. Vernon Henderson, industrial location in Indonesia, Brown University, Summer 1999

AWARDS

- Twelve monetary awards for job performance at Bonneville Power Administration
- Award for best undergraduate research project in economics at University of Oregon; examined deregulation of U.S. airline industry

OTHER ACTIVITIES

Monitored the House Science, Technology, and Energy Committee in Concord, NH for the Northeast Energy and Commerce Association

Peer Reviewer for *Land Economics*: effects of endowments of petroleum resources on corruption, 2008; hedging in coal contracts under the acid rain program, 2010-11; suburban agriculture as an amenity, 2012; prorationing versus unitization in the U.S. petroleum industry in the 20th century

Founded and Managed "Micro Lunch" seminar, Brown University, 2001-2002

9 Underhill Street, Nashua, New Hampshire 03060-4060, USA
603.402.3433 (land); 503.227.1994 (cell)
marc@appliedecon.net; appliedecon.net

Role of Expert Witness in Lewis & Clark Law School's mock personal-injury litigation, 1996

Peer Advisor, Department of Economics, University of Oregon, 1984-1986

MEMBERSHIPS

American Economic Association; Association for Christian Economists; International and United States Associations for Energy Economics; Northeast Energy and Commerce Association; National Association of Forensic Economics; Editorial Freelancers Association

9 Underhill Street, Nashua, New Hampshire 03060-4060, USA
603.402.3433 (land); 503.227.1994 (cell)
marc@appliedecon.net; appliedecon.net

Exhibit 2
Email from Jonathan Black

Hi Marc,

Answers in red below. Let me know if you have further questions.

Jon

Jon Black, Manager – Load Forecasting
System Planning
ISO New England Inc.
Holyoke, MA 01040
Tel: (413) 540-4745
E-mail: jblack@iso-ne.com

ISO-NE PUBLIC

The information in this email and in any attachments is intended to be conveyed only to the designated recipient(s). If you are not an intended recipient of this message, please delete the message and notify the sender.

From: Marc Vatter
Sent: Monday, August 14, 2017 11:37 PM
To: jdblack@iso-ne.com
Subject: Observed Variables

Hi Jonathan,

I hope you would not mind answering a brief question. In the ISO's historic data, not its forecast, of the four variables listed below, which are observed, and which are estimated?

gross load Estimated (because it is based on estimates of BTM PV)

net load Observed

passive demand resources Observed

behind-the-meter solar generation Estimated

Thank you for your attention.

Best regards,

Marc Vatter

Exhibit 2
Email from Jonathan Black

603.402.3433 (land)

503.227.1994 (cell)