STATE OF VERMONT
PUBLIC SERVICE BOARD

Petition of Champlain VT, LLC d/b/a TDI New England for a Certificate of Public Good, pursuant to 30 V.S.A. §248, authorizing the installation and operation of a high voltage direct current (HVDC) underwater and underground electric transmission line with a capacity of 1,000 MW, a converter station, and other associated facilities, to be located in Lake Champlain and in the Counties of Grand Isle, Chittenden, Addison, Rutland, and Windsor, Vermont, and to be known as the New England Clean Power Link Project ("NECPL")	)	Docket No. _____

DIRECT TESTIMONY OF SETH G. PARKER

ON BEHALF OF CHAMPLAIN VT, LLC

December 8, 2014

Summary:

Mr. Parker's testimony addresses the NECPL's compliance with the Section 248 criteria regarding Need, Economic Benefits, Greenhouse Gas Emissions, and Compliance with Vermont's 2011 Comprehensive Energy Plan. Mr. Parker generally concludes that the NECPL will facilitate the delivery of renewable, low-carbon energy, which will lessen New England's reliance on natural gas for power generation, increase fuel diversity, reduce wholesale power costs, and lower power plant emissions. Mr. Parker specifically concludes (i) there is a need for the NECPL in New England, including Vermont; (ii) the NECPL is expected to lower wholesale energy and capacity prices in New England; including Vermont, (iii) such lower wholesale prices will lower electric rates for retail customers in New England, including Vermont; (iv) the NECPL is expected to lower power plant emissions in New England; including Vermont; and (v) the NECPL complies with Vermont's 2011 Comprehensive Energy Plan.

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Introduction

Q1. Please state your name and occupation, and describe your company.

A1. Response: I am Seth G. Parker, a Vice President and Principal of Levitan & Associates, Inc. ("LAI"), a management consulting firm specializing in power market design, pipeline infrastructure, and competitive energy economics. I joined LAI in 1998. LAI is located at 100 Summer Street, Suite 3200, Boston, MA, 02110.

Since its founding in 1989, LAI has conducted numerous assignments in New England and other markets throughout the U.S. and Canada. These assignments have encompassed diverse matters pertaining to generation and transmission project evaluations, wholesale energy and capacity price forecasts, retail price impacts, competitive power market design, power plant valuation, bulk power security, power and fuel procurements, contract structures, gas/electric interdependencies, natural gas infrastructure, and risk management. LAI's clients include utilities, generators, Independent System Operators ("ISOs"), Regional Transmission Organizations ("RTOs"), end-users, state regulatory commissions, and financial institutions.

Q2. Please describe your professional experience and qualifications.

A2. Response: I am an economic and financial manager with 36 years of international experience in power and fuel project development, evaluation, financing, and transactions. I have been responsible for modeling and analyses of independent and utility-owned generation and transmission projects, as well as market design, regulatory policy, contract restructuring, power economics, and asset valuation assignments. My power market experience includes diverse engagements in New England and neighboring markets. These assignments have included establishing competitive market parameters that determine load payments and generator revenues, forecasting wholesale energy and capacity prices, projecting power plant revenues and costs, and calculating the impact of generation and transmission projects in competitive markets.

Q3. What were your previous positions and your educational background?

A3. Response: Before joining LAI, I worked as a consultant and officer of Stone & Webster Management Consultants, Inc., an advisory firm that provided business, technical, strategic management, economic, financial, and regulatory consulting services in the power, fuels, process, and infrastructure industries. While at Stone & Webster, I was responsible for due diligence and market reviews of many proposed power, fuel, and infrastructure projects in the U.S. and abroad for commercial banks, investment banks, multilateral lending agencies, and other financial institutions. I have also worked in the Treasurer's Office at Pacific Gas & Electric, and have been involved in project development and financing activities at ThermoElectron Energy Systems and J. Makowski Associates, Inc.

My educational background includes an Sc.B. in Applied Mathematics/Economics from Brown University and an M.B.A. in Finance / Operation Research from the Wharton Graduate School at the University of Pennsylvania. I have taught undergraduate-level finance courses, lectured at two Swiss universities, and have taken additional course work in Basic Gas Turbine Technology and International Political Economics. My resume, provided as ***Exhibit (Exh.) TDI-SGP-1,*** contains additional details as well as a list of my expert reports and testimony.

Q4. On whose behalf are you offering this testimony?

A4. Response: This testimony is offered on behalf of Champlain VT, LLC d/b/a TDI New England ("TDI-NE"), the developer of the proposed New England Clean Power Link Project ("NECPL").

Q5. Do you have particular knowledge about the New England wholesale power market, and Vermont in particular?

A5. Response: Yes. Vermont is part of the ISO-New England ("ISO-NE") wholesale power market with which I am very familiar. I have conducted and participated in numerous studies for ISO-NE participants in my career. These economic and power market studies included: (i) converting the Salem Harbor station to natural gas; (ii) evaluating the economics of the Deepwater Block Island offshore wind project; (iii) supporting the purchase of the Holyoke hydroelectric station; and (iv) expanding a university power plant. Moreover, I am familiar with the Vermont power market due to my previous work for the Public Service Department ("VTPSD") regarding Vermont Yankee.

Q6. What is ISO-NE and what are its responsibilities?

A6. Response: ISO-NE is an independent, not-for-profit company authorized by the Federal Energy Regulatory Commission ("FERC"). In general, ISO-NE is responsible for the safe and reliable operation of the bulk power system that is comprised of generating plants and the high voltage transmission network in New England. In particular, ISO-NE: (i) administers the wholesale markets for energy, ancillary services, and capacity, under rules and regulations established through a regional stakeholder process and approved by FERC; (ii) coordinates energy flows across the transmission network; and (iii) conducts planning studies to ensure long-term system reliability.

Q7. Have you previously testified before the Vermont Public Service Board ("Board") or in other judicial or administrative proceedings in Vermont?

A7. Response: Yes, I have submitted expert witness reports and/or testified before the Board (as well as other state regulatory commissions) and in the U.S. District Court for the District of Vermont (as well as in other state and federal courts). *First*, I testified before the Board on behalf of the VTPSD in Docket No. 7404 concerning Entergy Corporation's proposed restructuring of its merchant nuclear generating assets, including Vermont Yankee. *Second*, I submitted a declaration and expert report on behalf of the State of Vermont to the U.S. District Court for the District of Vermont in Civil Action No. 11-cv-99 concerning the request of Entergy Nuclear Vermont Yankee and Entergy Nuclear Operations, Inc. for an injunction of certain Vermont laws. *Third*, I testified before the Board on behalf of the VTPSD in Docket No. 7862 on the potential impacts of Vermont Yankee's retirement on system reliability, market energy and capacity prices, air emissions, and in-state customer rates.

Q8. What is the purpose of your testimony?

A8. Response: My testimony addresses the proposed NECPL's compliance with the Section 248 criteria regarding Need, Economic Benefits, Greenhouse Gas Emissions, and Compliance with the 2011 Comprehensive Energy Plan.

Q9. Have you relied on the work of any persons outside of LAI concerning the NECPL?

A9. Response: Yes. I relied on TDI-NE for the expected capacity factor and other pertinent information about the NECPL. I also relied on various assumptions concerning loads, resources, and transmission, GHG emission rates, and other data from studies and reports prepared by other parties, all as described and attributed in my testimony.

Q10. Have you provided Project information to other experts in support of their section 248 testimony, and if so, what?

A10. Response: Yes, I provided my forecast of the reduction in wholesale energy and capacity prices and the resulting ratepayer savings to Thomas Kavet, President of Kavet, Rockler, and Associates, LLC, who was retained by TDI-NE to estimate the socio-economic benefits of the NECPL.

Summary of Conclusions

Q11. What were your conclusions in general?

A11. Response: Based upon my analyses, I conclude the NECPL will facilitate the delivery of renewable, low-carbon energy from Canada, which will lessen New England's reliance on natural gas for power generation, increase fuel diversity, lower wholesale energy and capacity prices, and lower power plant emissions.

Q12. Did you conclude that the NECP satisfies the requirements of 30 V.S.A. § 248(b)(2) regarding Need, (b)(4) regarding Economic Benefit to Vermont, (b)(5) regarding Greenhouse Gas Emissions, and (b)(7) regarding Vermont's Comprehensive Electric Energy Plan)?

A12. Response: Yes. Based on the analyses that are described herein, I conclude (i) there is a need for the NECPL in New England, including in Vermont; (ii) the NECPL is expected to lower wholesale energy and capacity prices in New England, including Vermont; (iii) such lower wholesale prices will lower electric rates for retail customers in New England, including Vermont; (iv) the NECPL will lower power plant emissions in New England, including Vermont; and (v) the NECPL complies with Vermont's 2011 Comprehensive Energy Plan.

Q13. What were your specific conclusions?

A13. Response: Based on the analysis I performed, I specifically forecast the following benefits over the first ten years of the NECPL's expected operations, from April 2019 through March 2029 ("Study Period"):

(i) Wholesale energy prices (expressed in 2014 $ using a 2% long-term inflation rate) are forecasted to decline by a load-weighted average of $2.48/MWh, or 6.0%, in Vermont and by an average of $1.04/MWh, or 2.5% in New England at large due to the NECPL. Ancillary service prices may decline as well, but I did not attempt to calculate that decline.

(ii) Wholesale capacity prices are forecasted to decline by an average of $0.64/kW-month in New England at large over the Study Period, conservatively assuming that the NECPL provides 500 MW of capacity to account for potential market responses and other uncertainties.[1]

(iii) I estimate that Vermont ratepayers would save a total of $150.8 million in energy costs plus $90.8 million (all in 2014 $) in capacity costs over the Study Period. I estimate that New England ratepayers overall would save $1,540.5 million in energy costs plus $2,692.8 million (all in 2014 $) in wholesale capacity costs over the Study Period. These results assume that Vermont ratepayers, and not other New England ratepayers, are partially insulated from swings in wholesale energy and capacity prices due to existing and future power purchase contracts, owned generation, and generation entitlements that hedge against swings in wholesale energy and capacity prices. I estimate that Vermont ratepayers are 25% hedged against swings in wholesale energy and capacity prices.

(iv) New England power plant emissions of carbon dioxide ("CO_2"), the primary constituent of Greenhouse Gases ("GHGs"), would decline by 32.9 million tons, equivalent to an 8.6% reduction, over the ten year Study Period. Very little of that reduction would occur in Vermont, reflecting the limited in-state fossil-fueled

[1] A market response, as discussed on pages 39-40 below, would dilute the magnitude of the forecasted reductions in wholesale capacity prices.

generation compared to the rest of ISO-NE. New England power plant emissions of nitrogen oxides ("NO_x") and sulfur dioxide ("SO_2") would also decline. The decline in GHG emissions could be partially offset by GHG emissions from hydroelectric projects in Quebec or the Canadian Maritimes that could be a source of power for the NECPL.

30 V.S.A. § 248(b)(2) – Need for the NECPL

Q14. Which aspects of "Need" under 30 V.S.A § 248(b) are you addressing?

A14. Response: I address need for the NECPL in New England and in Vermont, in terms of meeting load growth, providing low-carbon, renewable energy to meet policy goals, and lessening New England's dependence upon natural gas for power generation.

New England Has a Need for the NECPL to Meet Load Growth and Replace Retiring Plants

Q15. Is there a regional need for the NECPL in terms of increasing load in New England?

A15. Response: Yes, ISO-NE forecasts increasing energy use and peak demand in New England. ISO-NE's forecast is in its annual Regional System Plan ("RSP"), prepared in accordance with its Open Access Transmission Tariff and approved by the FERC. The RSP: (i) forecasts future annual energy use and peak loads and the need for resources, (ii) provides information about the resources that can meet the identified needs, and (iii) describes transmission projects for the region that could meet the identified needs. I utilized the 2013 Regional System Plan ("2013 RSP") issued November 7, 2013 and provided as ***Exh. TDI-***

SGP-2 for my modeling of the New England energy market.[2] According to ISO-NE's forecast for 2013-2022 contained in section 3 of the 2013 RSP:

- New England's load is expected to increase from 137,045 GWh in 2013 to 151,005 GWh by 2022, a compound annual growth rate ("CAGR") of 1.1%.
- New England's summer peak load (50/50 projection) is expected to increase from 27,840 MW in 2013 to 31,520 MW by 2022, a CAGR of 1.4%.
- New England's winter peak load (50/50 projection) is expected to grow from 22,445 MW in 2013 to 23,700 MW by 2022, a CAGR of 0.6%.

Q16. Is there a regional need for the NECPL in terms of facilitating the delivery of new energy sources into New England?

A16. Response: Yes. Over the past few years, a number of large power plants in New England have retired or announced their intention to retire. These plants include Salem Harbor (749 MW, retired on June 1, 2014), Vermont Yankee (604 MW, due to shut down year-end 2014), Norwalk Harbor (342 MW, shut down in 2013 and due to retire June 1, 2017) and Brayton Point (1535 MW, due to retire on June 1, 2017). In addition, there are many other plants that are at risk of retiring by the end of the decade.

According to an April 21, 2014 presentation by Gordon van Welie, ISO-NE President and CEO, Infrastructure Needs: Electricity-Natural Gas Interdependencies, "ISO estimates **up to 8,300 MW of non-gas-fired generation is "at risk" for retirement by**

[2] The 2014 RSP was not available at the time I commenced my modeling work.

2020 (28 older oil and coal units). If all retire, ISO estimates 6,300 MW of new or repowered capacity will be needed in the region." The relevant pages of that presentation are provided as ***Exh.TDI-SGP-3***.

Vermont Has a Need for the NECPL to Meet Load Growth

Q17. Is the NECPL needed by Vermont "…to meet the present and future demand for service which could not otherwise be provided in a more cost-effective manner through energy conservation programs and measures and energy efficiency and load management measures[s]…?"

A17. Response: Yes, Vermont has a growing demand for electricity that will require new electricity sources in addition to past and expected future conservation, energy efficiency, and load management measures. According to ISO-NE's 2013-2022 forecast for Vermont in Section 3 of the 2013 RSP which I used for my wholesale energy market modeling:

- Vermont load is expected to increase from 6,695 GWh in 2013 to 7,110 GWh by 2022, a CAGR of 0.7%.
- Vermont's summer peak load (50/50 projection) is expected to increase from 1,090 MW in 2013 to 1,175 MW by 2022, a CAGR of 0.9%.
- Vermont's winter peak load (50/50 projection) is expected to grow from 1,070 MW in 2013 to 1,130 MW by 2022, a CAGR of 0.6%.

Q18. Do the forecasted increases in Vermont's and New England's load from the 2013 RSP incorporate conservation, energy efficiency, and load management programs?

A18. Response: According to Section 3 of the 2013 RSP, the load forecast "…fully accounts for historical energy efficiency, passive demand resources, and future federal appliance standards. The forecast does not expressly reflect the future reduction in peak demand and energy use that will result from the passive demand resources that clear the Forward Capacity Auctions and the energy-efficiency forecast…"

There is some uncertainty about future reductions in peak demand and energy use from passive demand resources and increasing energy efficiency. ISO-NE has an "…ongoing effort to analyze the long-term impacts of state-sponsored energy efficiency programs on future demand." My understanding is that there are uncertainties concerning operational reliability, measurement, funding, and implementation. If the full amount of passive demand and future energy efficiency was included, ISO-NE anticipates that long-term load growth would essentially be flat and the summer peak load growth rate would be reduced by about one-half.

Q19. What is your opinion on ISO-NE's forecasts of load growth?

A19. Response: I would not second guess ISO-NE's approach to forecasting load growth. ISO-NE is responsible for the safe and reliable operation of the bulk power system in New England, which includes conducting comprehensive and detailed planning studies. Since Vermont's and New England's actual load growths are uncertain, some conservatism is warranted to ensure the "lights stay on" especially in light of recent and future power plant retirements that I discussed on pages 9-10. Moreover, I note that the 2013 RSP forecasts load growth only through 2022, and the NECPL expects to operate long beyond that date. I would not be surprised if Vermont's load, net of future conservation, energy efficiency, and load management programs, continue to grow beyond 2022.

Q20. Are the forecasted increases in Vermont's and New England's loads from the 2013 RSP supported by the 2014 RSP that was recently issued?

A20. Response: Yes. The 2014 RSP, issued November 6, 2014, ***Exh. TDI-SGP-8***, indicates that Vermont's and New England's loads will continue to grow over time. A summary of the load forecasts from the 2013 RSP and 2014 RSP is provided in Table 1 below.

Table 1. ISO-NE Forecast of Vermont and New England Load Growth

	2013 RSP			2014 RSP		
Vermont	2013	2022	CAGR	2014	2023	CAGR
Net Energy (MWh)	6,695	7,110	0.7%	6,730	7,175	0.7%
Summer Peak Load (MW)	1,090	1,175	0.9%	1,100	1,190	0.9%
Winter Peak Load (MW)	1,070	1,130	0.6%	1,080	1,145	0.6%
New England						
Net Energy (MWh)	137,045	151,005	1.1%	138,390	151,525	1.0%
Summer Peak Load (MW)	27,840	31,520	1.4%	28,165	31,620	1.3%
Winter Peak Load (MW)	22,445	23,700	0.6%	22,575	23,735	0.6%

Q21. Is the ISO-NE load forecast for Vermont consistent with the load forecast in the 2011 Comprehensive Energy Plan?

A21. Response: The forecasts appear to be consistent. Pages 40-41 of Volume 2 the 2011 Comprehensive Energy Plan indicate that Vermont's annual electricity requirements are projected to increase under Base Case assumption holding demand-side management investments at 2011 levels. Under the High Efficiency Case assumption in which energy efficiency funding approved by the Board for 2012-2014 continues through 2031, the state's load is forecasted to decline slightly through about 2020 and then increase to 2031.

Q22. Can the need that the NECPL would fulfill be met in a more cost-effective manner through conservation, energy efficiency, and load management options?

A22. Response: It is very difficult to compare the cost-effectiveness of the NECPL with those options because the NECPL is an entirely different type of resource. Market participants who obtain rights to utilize the NECPL, whom I refer to a "shippers", will be able to offer and deliver electric energy whenever the ISO-NE system demand is high enough to economically justify electric imports, any time of day or night. TDI-NE expects the NECPL to have a 95% capacity factor over the Study Period and provide the full 1,000 MWh of wholesale electrical energy in each peak hour (except for forced outages of the NECPL equipment or the Canadian generating source) and close to the full 1,000 MWh during off-peak hours.

To the extent the NECPL energy is deliverable, *i.e.* the energy can be injected into the bulk power system reliably and safely without violating security constraints, the NECPL will also facilitate the provision of wholesale capacity that will be counted in the ISO-NE capacity market. This type of round-the-clock delivery of wholesale electric energy and capacity to Vermont and the rest of New England is qualitatively different from conservation, energy efficiency, and load management programs that reduce or shift customer loads behind-the-meter and provide varying amounts of capacity benefit. To the extent load is forecast to grow even with these behind-the-meter programs, the NECPL would help meet that load growth.

Finally, TDI-NE is a merchant developer, not a regulated distribution utility with retail customers, and the NECPL is a merchant transmission project. As such, TDI-NE is not in a position to provide conservation, energy efficiency, or load management services.

New England Has a Need for the NECPL to Deliver Low-Carbon Renewable Energy

Q23. Is there a regional need for the NECPL in terms of facilitating the delivery of low-carbon, renewable energy resources into New England?

A23. Response: Yes. There is an expressed desire for low-carbon, renewable energy resources in New England. Each of the New England states has some form of a Renewable Portfolio Standard ("RPS") or an equivalent (Vermont has the Sustainably Priced Energy Development ("SPEED") program) that requires their electric utilities or their load-serving entities ("LSEs") to procure a percentage of their energy supplies from qualified renewable resources. These RPS requirements have led to the development of wind, solar photovoltaic, hydroelectric, biomass, and other renewable energy projects in New England. Whether or not energy deliveries via the NECPL would count towards these RPS requirements, the NECPL would facilitate the delivery of low-carbon, renewable energy into New England.

Moreover, the New England Governors have expressed their collective perspective on increasing transmission investments to deliver renewable generation into the region. Working through the New England States Committee on Electricity ("NESCOE") that represents the interests of the six New England States on regional electricity matters, the Governors issued the New England Governor's Commitment to Regional Cooperation on Energy Infrastructure Issues, dated December 2013 and provided as ***Exh. TDI-SGP-4***, which includes the following:

> As the region's electric and natural gas systems have become increasingly interdependent, ensuring that we are efficiently using existing resources and securing additional clean energy supplies will be critical to New England's economic future. To ensure a reliable, affordable and diverse energy system, we need investments in additional energy efficiency, renewable generation, natural gas pipelines, and electric transmission.

Q24. Have the New England Governors proposed a mechanism to achieve the delivery of low-carbon or renewable energy resources into New England?

A24. Response: Yes. In its presentation of September 25, 2014 to the U.S. DOE Electricity Advisory Committee titled Regulatory Mechanisms to Ensure Fuel Adequacy, and provided as ***Exh.TDI-SGP-5***, NESCOE stated its goal to "**Expand electric transmission** to facilitate utility-scale development and delivery of no-to-low carbon energy resources." NESCOE proposed to conduct one or more "…coordinated RFPs to advance the development of transmission and delivery of at least 1000+ MWs of clean energy into New England." NESCOE believes that costs could be allocated through the ISO-NE tariff or through merchant projects, and states or utilities could procure energy and capacity from these projects to ensure delivery into the region.

Q25. Is it likely that NECPL shippers will obtain their energy and capacity from Canadian renewable energy resources?

A25. Response: Yes. According to TDI-NE, the NECPL will be utilized to import low-carbon and cost-competitive renewable energy, which could include hydroelectric and/or wind energy, from Canada. There are significant hydroelectric and wind resources in Quebec and the Maritime Provinces that have been and continue to be developed.[3]

Q26. What is Vermont's position on large-scale hydroelectric resources or other Canadian renewable resources that would likely provide the energy to be imported over the NECPL?

A26. Response: Vermont is supportive of large-scale hydroelectric generation because it is renewable (as defined under Vermont law), its price would not be volatile, and it would lower GHG emissions from power plants. Vermont's 2011 Comprehensive Energy Plan, developed by the VTPSD with support from other State agencies, highlights the important

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[3] According to information on its website, Hydro Quebec recently completed the Eastmain-1-A and Sarcelle hydroelectric projects with a combined installed capacity of 918 MW. In addition, Hydro Quebec is currently constructing the Romaine Complex to be comprised of four hydropower generating stations with a total installed capacity of 1,550 MW. According to its 2013 Annual Report, Hydro Quebec now owns 35,364 MW of hydroelectric capacity and has purchase rights to 5,428 MW of Churchill Falls (Labrador) hydroelectric capacity and 2,399 MW of wind farm capacity. In addition, Hydro Quebec issued a tender call for an additional 450 MW of wind capacity in December 2013.

According to section 5.8.2.1.4 of the 2011 Comprehensive Energy Plan, Volume 2, Vermont views Canadian hydropower favorably: "In addition to the approximately 10% of its power coming from in-state hydro, Vermont currently receives a significant portion of its electricity from out-of-state hydro, principally from Hydro-Quebec (HQ). … Further, since the power is supplied from many generators, its reliability is based on HQ's total system reliability, rather than the performance of a single dam or plant. The Vermont Legislature has recognized this resource as renewable."

Renewable energy resources have been, and continue to be developed in the Canadian Maritimes as well. Nalcor, a provincial energy corporation, generates significant amounts of hydroelectric energy and is developing an additional 3,000 MW of hydroelectric capacity on the lower Churchill River at Muskrat Falls and Gull Island in Labrador.

role that large-scale hydro has played in the past and how it could continue to play an important role in the future (underlining added for emphasis). According to page 7 of the Vermont 2011 Comprehensive Energy Plan, Volume 1, provided as ***Exh. TDI-SGP-6***:

> Vermont policies and utility choices have already put us in a very good position. While maintaining a regionally competitive electricity rate for Vermonters, we have attained nearly half of our present electricity needs from renewable resources, including large-scale hydro. At the core of our energy strategy in the next two decades and beyond must be an effort to continue our progress on renewable electricity, not only to meet our present electricity needs but also to allow our other energy needs to transition to electricity to the maximum extent possible—largely trading volatile, high-cost, and environmentally harmful petroleum-based fuels for renewable electricity.

Q27. Could significant amounts of hydroelectric or wind energy and capacity be developed in-state instead of imported from Canada?

A27. Response: No. It is not realistic to believe that significantly more hydro resources can be developed in Vermont. Most in-state hydro resources were developed decades ago, and most good sites have long since been developed in accord with FERC hydroelectric licensing requirements. Volume 2, page 102 of the 2011 Comprehensive Energy Plan makes this very point (underlining added for emphasis):

> Under any assessment, it is clear that the best hydropower sites have already been developed. There are very few undeveloped sites that could support capacity greater than 1 MW, and a relatively low number in the 500 kW to 1 MW range. There are many potential smaller community and residential sites sized at less than 200 kW.

Wind power could play a larger role in meeting Vermont's energy and capacity requirements, but is unlikely to come close to the energy and capacity of the NECPL in the next few years. Wind power presents specific challenges: (i) wind energy is variable and intermittent, (ii) the capacity value of wind for reliability purposes is much less than its nameplate capacity, and (iii) the potential in-state sites are limited by visual concerns, access to transmission, land ownership, and other factors. According to the 2011 Comprehensive Energy Plan, if all the projects currently proposed or under construction in Vermont became operational, the combined capacity would be 161.6 MW. However, it is my understanding that there are no in-state commercial-scale wind projects currently under construction or going through permitting at the PSB.

New England Has a Need for the NECPL to Lessen the Dependence on Natural Gas and Increase Fuel Diversity

Q28. Is there a regional need for the NECPL to lessen New England's dependence upon natural gas for power generation?

A28. Response: Yes. According to ISO-NE's January 10, 2014 data request response to FERC regarding the polar vortex period, temperature conditions in early January 2014 were "among the coldest 5% of days in the last 20 years, with daily average temperatures between 5-12 degrees F." ISO-NE had a winter peak load of 21,320 MW on January 7, 2014, faced 1,500 MW of forced outages, and lost 1,280 MW of gas capability over the course of the day due to "difficulty in arranging for gas during tight pipeline conditions." ISO-NE reviewed the generation operating by fuel type in the summer and winter peak, and found that natural gas- and oil-fired generation performed at less than half of their Capacity Supply Obligations set through ISO-NE's Forward Capacity Auctions ("FCAs"), the mechanism used to establish capacity obligations and wholesale capacity prices three years in advance of the delivery year.

Q29. Why did gas-fired resources underperform during the winter peak?

A29. Response: Gas pipeline scheduling restrictions and service curtailments limited the performance of gas-fired generation. *First*, interstate gas pipelines serving New England must serve firm transportation customers, typically gas utilities, before they serve interruptible customers, such as gas-fired generators. Most of these pipelines had very little delivery capacity available on that day due to high demand from those firm service customers. *Second,* ISO-NE reviewed the amount of generation that was online from each interstate pipeline serving gas-fired generation and found operational problems, including a compressor station failure and Operational Flow Order ("OFO") restricting customer deliveries on Texas Eastern/Algonquin, a critical day OFO on Tennessee Gas Pipeline, and a Critical Capacity Constraint on the Iroquois Gas Transmission. The Texas Eastern/Algonquin and Maritimes & Northeast pipelines were fully scheduled and Algonquin restricted interruptible deliveries at several points on their system. *Third*, most gas-fired power plants in New England were not designed with liquid oil storage and were thus unable to switch to a backup fuel and continue operating when interruptible gas supplies could not be delivered.

Q30. Will the gas pipelines expand their delivery capacity into New England?

A30. Response: There have been a number of proposed pipeline projects to alleviate congestion in New England, but thus far only one project, Spectra Energy's Algonquin Incremental Market ("AIM") Project, is moving forward based on firm delivery commitments by gas utilities. Other projects are being developed as well, but are not expected to provide sufficient capacity to alleviate all deliverability constraints, especially during "tight" pipeline conditions, *e.g.* during extended periods of very cold weather, for the foreseeable future.

Q31. Will the NECPL lessen New England's dependence upon natural gas?

A31. Response: Yes, energy flows over the NECPL would be sourced entirely from renewable energy resources, which would lessen New England's dependence on natural gas.

Q32. What measures has ISO-NE taken to ensure cold weather reliability?

A32. Response: ISO-NE has implemented short-term and long-term solutions to promote winter reliability. The short-term Winter Reliability Program solution procured additional demand response resources, provided incentives to oil-fired generators to increase fuel oil inventory, made payments to dual-fuel units for testing their switching capacity, and instituted market monitoring changes aimed at increasing the flexibility of dual-fuel units. The Winter Reliability Program resulted in the procurement of over three million barrels of oil last winter and generators burned 88% of it. The Winter Reliability Program will continue during the 2014/2015 winter with some changes, notably the addition of compensation for unused LNG contract volumes and incentives to commission or re-commission additional dual-fuel capability.[4]

The long-term solutions include market-based reforms, most notably the Pay-for-Performance changes to the FCM. The purpose is to incent better performance by capacity resources by linking their capacity revenues to performance during Capacity Scarcity Conditions when there are inadequate reserves in a zone. ISO-NE will implement a two-settlement system with (i) the Capacity Base Payment tied to the FCM clearing prices and (ii) the Capacity Performance Payment tied to the unit's performance during Capacity Scarcity Conditions. The Capacity Performance Payment could be positive or negative. The Pay-for-Performance initiative, which was largely approved by FERC in a May 30 2014 order, will provide further incentive for generators to make the needed investments in weatherization, fuel assurance, and backup fuel capability to ensure adequate cold weather performance.

Q33. Is NESCOE also addressing this issue of generators' dependence on natural gas?

A33. Response: Yes. In its September 25, 2014 presentation, Regulatory Mechanisms to Ensure Fuel Adequacy, the New England Governors through NESCOE also advocated ways to "**Expand pipeline capacity** to increase natural gas supply into New England, reducing supply constraints and associated energy price volatility." NESCOE also indicated that

[4] FERC Order Accepting Tariff Revisions, September 9, 2014, docket ER14-2407.

generators' dependence on natural gas, coupled with delivery limits into the regions will have the following consequences:

- New England's power system will be increasingly vulnerable to electric service disruptions;
- Consumers will needlessly pay more for energy than consumers in nearby states and elsewhere;
- Our region will remain at an unacceptable economic and competitive disadvantage to neighboring states and regions

Q34. How much of ISO-NE generation is provided by natural gas?

A34. Response: According to section 6.1 of the 2013 RSP, natural gas provided more than one-half of the region's energy generation in 2012. The 2014 RSP indicates natural gas provided 45.1% of the region's energy generation in 2013 and goes on to state, "The future fuel mix of the region will show continued dependence on natural-gas-fired generation and the addition of intermittent renewable resources." ISO-NE explains this continued dependence is due to non-gas-fired plant retirements and is supported by the Generator Interconnection Queue being primarily comprised of gas-fired and wind plants.

According to Section 1.3.4.1 Resource Performance and Natural Gas Dependency of the 2013 RSP, provided as ***Exh. TDI-SGP-2*** (underlining added for emphasis):

> New England is increasingly dependent on natural gas as a primary fuel for generating electric energy.... In 2000, 17.7% of the region's capacity was natural-gas-fired generation, which produced 14.7% of the region's electric energy, whereas in 2012, natural gas plants represented 43.0% of the region's capacity and 51.8% of the system's electric energy production.
>
> Accompanying the increased use of natural gas are concerns regarding the adequacy of the region's natural gas pipeline capacity and gas supply in the

> pipelines to serve electric power generation reliably; at any time of the year, natural and geopolitical events of all types could interrupt supplies of gas….

Q35. Is ISO-NE concerned about the region's lack of fuel diversity?

A35. Response: Yes. According to section 6.1 of the 2014 RSP (underlining added for emphasis), "New England's capacity and electric energy production in 2013 indicates that the region is highly dependent on natural gas-fired generation and lacks a more balanced mix of oil, coal, nuclear, and hydro and other renewable resources."

Q36. Would the NECPL increase the region's fuel diversity?

A36. Response: Yes. My wholesale energy market modeling results (more fully discussed below) indicate that average annual gas-fired generation would decline from approximately 72.9 TWh to 65.9 TWh during the Study Period. This decline (7.0 TWh/year) implies that 84% of the displaced energy due to the NECPL's deliveries (8.3 TWh/year) would be gas-fired generation, which would increase the region's fuel diversity.

Q37. If the NECPL did lessen generators' dependence on natural gas and increase fuel diversity, would that help ISO-NE meet reliability objectives?

A37. Response: Yes. By facilitating the import of renewable energy from hydroelectric and wind resources, the NECPL will lessen the region's dependence on natural gas and increase fuel diversity. These results would improve system reliability, especially during cold weather periods when gas pipelines have difficulty delivering interruptible gas supplies.

Q38. Would the NECPL also make energy prices more stable?

A38. Response: Yes. As I mentioned earlier, the 2011 Comprehensive Energy Plan, states that hydroelectric energy "…is stably priced, immune to escalating fossil fuel prices…" Hydroelectric and wind energy via NECPL would likely be bid into the ISO-NE energy market at prices that reflect their low marginal cost and would not be based on natural gas prices.

30 V.S.A. § 248(b)(4) – Economic Benefit to the State

Q39. Will the NECPL "…result in an economic benefit to the State and its residents…" per 30 V.S.A. § 248(b)(4)?

A39. Response: Yes, energy imports via the NECPL are expected to lower wholesale energy and capacity prices in Vermont and throughout the rest of the ISO-NE market, and thus lower ratepayer bills.

Q40. Please summarize the analyses you performed to calculate the power market impacts of the NECPL.

A40. Response: I conducted a set of integrated analyses to estimate the NECPL's power market impacts on Vermont and New England by: (i) forecasting the reduction in wholesale energy prices using a dispatch simulation model; (ii) estimating the reduction in wholesale capacity prices; (iii) addressing possible market responses to the NECPL; and (iv) calculating the consequential reduced bills for typical Vermont and New England residential ratepayers.

<u>The NECPL Will Reduce Wholesale Energy Prices in New England and Vermont</u>

Q41. How are wholesale energy prices determined in ISO-NE?

A41. <u>Response</u>: Generators (including external resources) submit offers to sell wholesale electric energy in the ISO-NE Day-Ahead Market one day before the operating day.[5] ISO-NE evaluates those bids and commits generators in the Day-Ahead Market to meet the system demand as well as to provide reserves and other products required to keep the bulk power system reliable.[6] ISO-NE utilizes a least-cost methodology to commit the resources that will operate in specific hours during the operating day. The highest-priced bid offer accepted in each hour sets the ISO-NE wholesale market energy price that is paid to all generators providing electrical energy in that hour. If transmission constraints prevent energy from reaching any zone within the region, ISO-NE may commit higher-priced resources within the constrained zone to meet load and reliability requirements, raising wholesale energy prices within the constrained zone relative to the rest of the ISO-NE system.

Q42. How would the NECPL affect ISO-NE wholesale energy prices?

A42. <u>Response</u>: TDI-NE is expected to sell transmission rights at negotiated rates through an open solicitation process that would allow shippers to utilize NECPL's line capacity to offer

[5] There is also a Real-Time Market for energy, also referred to as the Spot Market, that (i) allows market participants to buy and sell wholesale electricity during the operating day and (ii) balances the differences between actual real-time demand for and production of electricity. While energy prices in the Real-Time Market can deviate from the Day-Ahead Market, the overwhelming majority of ISO-NE wholesale energy is priced in the Day-Ahead Market.

[6] Those other products include regulation to maintain system frequency, voltage support to maintain energy deliveries over long distances, and blackstart capability to restore the system in the event of a blackout.

and deliver electrical energy into the ISO-NE wholesale energy market.[7] These shippers are expected to utilize hydroelectric or other renewable generation in Canada in order to offer and bid energy into ISO-NE's Day-Ahead Market for energy, consistent with ISO-NE rules.

Q43. How did you forecast NECPL's operation and its effect on ISO-NE wholesale energy prices?

A43. Response: Working with my colleagues at LAI, I utilized a standard industry dispatch simulation model (also referred to as a production cost model), AURORAxmp, to simulate the operation of the ISO-NE bulk power system on a zonal basis and to forecast day-ahead wholesale energy prices. LAI licenses the AURORAxmp model and database from EPIS Inc. AURORAxmp simulates ISO-NE's Day-Ahead Market security-constrained scheduling of resources on an hourly basis that: (i) utilizes a least-cost commitment and dispatch algorithm; (ii) accounts for reserves and other products required for the safe and reliable operation of the power system (referred to as "security constraints"); (iii) accounts for transmission limitations within ISO-NE zones ("interface limits") to capture key congestion that gives rise to zonal energy price differentials; and (iv) accounts for interface limits between ISO-NE and surrounding markets to capture price-sensitive energy imports and exports.

I modeled the NECPL as a 950 MW scheduled round-the-clock delivery into the Vermont zone to reflect the expected injection of 1,000 MW at a 95% availability factor. In order to estimate the NECPL's effect on wholesale energy prices, I prepared two wholesale

[7] I address deliveries of capacity and impacts on wholesale capacity prices in the next section of my testimony.

energy price forecasts, one without the NECPL and one with the NECPL, and calculated the price differentials between the two forecasts for the Vermont load zone and for the other load zones in New England.

Q44. What other key assumptions did you utilize in running AURORAxmp?

A44. Response: In general, my colleagues and I used the latest load, resource, and transmission data in the public domain to establish the key AURORAxmp assumptions for the ten year Study Period beginning with NECPL's expected commercial operating date ("COD") of April 1, 2019. In cases where assumptions did not extend for the full ten years, I extrapolated the trends based on the last few years of data. Briefly stated, the assumptions I used are generally as follows; assumption details are in my Technical Report, provided as *Exh.TDI-SGP-9*.

- Load growth, planned resource additions, expected resource retirements, and approved transmission projects were utilized from ISO/RTO planning documents.
- Renewable resources were added to gradually satisfy state Renewable Portfolio Standard ("RPS") requirements, and gas-fired resources were added throughout the ISO-NE and other markets as needed to ensure system reliability.
- Two new proposed import projects were included: Northern Pass (1,200 MW HVDC projected to start in 2019) and Champlain Hudson Power Express (1,000 MW HVDC projected to start in 2019).
- ISO-NE was divided into eight zones to reflect existing and known changes to transfer limits: Vermont, New Hampshire, Maine, West-Central Massachusetts

("WCMA"), Boston (which includes Northeastern Massachusetts), Southeastern Massachusetts ("SEMA"), Connecticut, and Rhode Island.

- The New York ISO ("NYISO") and the Mid-Atlantic Coordination Council ("MAAC") portion of the Pennsylvania-New Jersey-Maryland RTO ("PJM") were also divided into zones to reflect existing and known changes to transfer limits within and among those markets, as well as between those markets and ISO-NE.
- The Ontario and New Brunswick markets were modeled, and energy imports from Quebec into ISO-NE and NYISO were modeled as scheduled imports based on historical data.

Q45. What would be the impact of the NECPL on ISO-NE wholesale energy prices?

A45. Response: The largest wholesale energy price impact is forecasted to occur in Vermont, in which the average load-weighted wholesale energy price (2014 $) is forecasted to decline from $41.15/MWh to $38.67/MWh over the Study Period, a decline of $2.48/MWh (6.03%).[8] The decline in the other northern-tier states of New Hampshire and Maine were similar, while the decline in Massachusetts, Connecticut, and Rhode Island were about one-third of that in Vermont, as shown in Table 2 below. For New England as a whole, the NECPL is forecasted to reduce the average load-weighted wholesale energy price from $41.11/MWh to $40.07/MWh (2.52%).

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[8] In order to combine dollar prices and impacts across multiple years, I converted annual prices and savings into mid-year 2014 $ using a 2% annual inflation rate from 2014 through the end of the Study Period.

Table 2. Forecasted Impact of the NECPL on ISO-NE Wholesale Energy Prices[9]
(2014 $/MWh; ten year Study Period)

ISO-NE Zone	Without NECPL	With NECPL	Savings	Savings (%)
Vermont	41.15	38.67	2.48	*6.03%*
New Hampshire	40.56	38.32	2.24	*5.51%*
Maine	40.35	38.20	2.15	*5.34%*
WCMA	41.20	40.47	0.73	*1.78%*
Boston	41.31	40.59	0.72	*1.74%*
SEMA	41.17	40.50	0.67	*1.63%*
Connecticut	41.28	40.60	0.68	*1.65%*
Rhode Island	41.08	40.40	0.68	*1.65%*

Q46. What would be total dollar savings over the Study Period due to the NECPL and the reduction in ISO-NE wholesale energy prices?

A46. Response: The total dollar savings by ISO-NE load zone is provided in Table 3 below. The savings for the Vermont load zone ignores any hedge that would insulate ratepayers from the reduction in wholesale energy prices due to the NECPL. The total wholesale savings for all of New England would be $1,590.7 million (2014 $) over the Study Period.

Table 3. Forecasted ISO-NE Wholesale Energy Price Savings
(2014 $; ten year Study Period; without hedges)

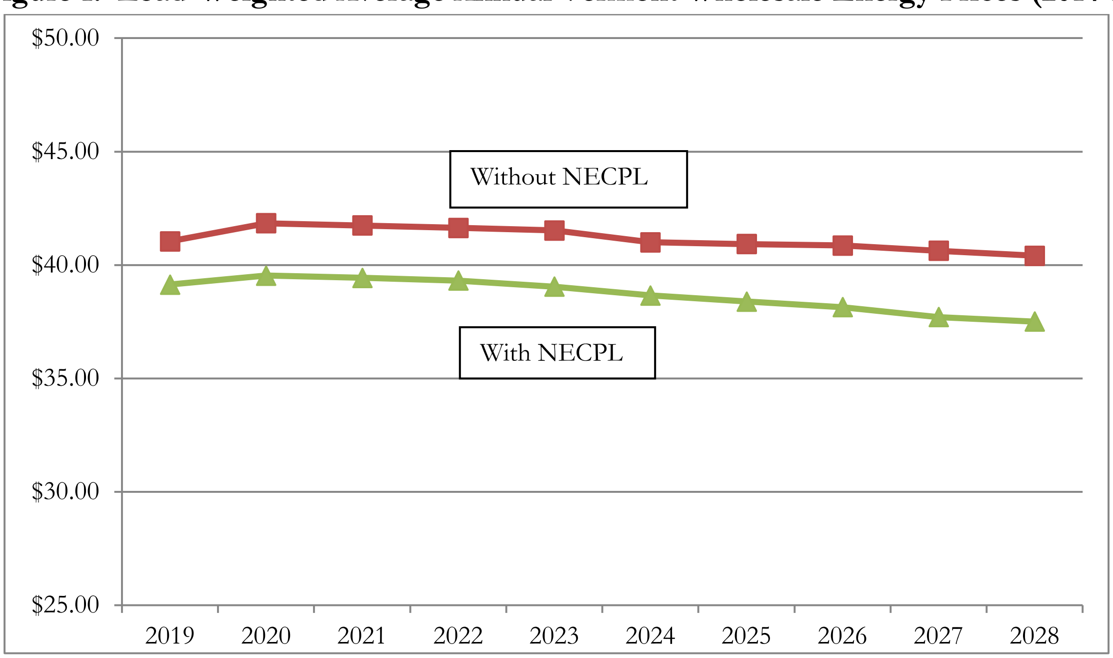
ISO-NE Zone	Savings ($/MWh)	Load (TWh)	Savings ($ million)
Vermont	2.48	81.0	201.0
New Hampshire	2.24	121.8	272.4
Maine	2.15	129.1	278.2
WCMA	0.73	216.2	158.4
Boston	0.72	317.4	228.3
SEMA	0.67	160.6	107.7
Connecticut	0.68	374.4	254.4
Rhode Island	0.68	133.4	90.3
Average / Totals	1.04	1,533.9	1,590.7

[9] Note Massachusetts is divided into three zones as previously described.

Q47. What would be the year-by-year impact of NECPL on Vermont wholesale energy prices?

A47. Response: The NECPL is expected to reduce the load-weighted average annual wholesale energy prices in the Vermont load zone on a consistent basis over the Study Period. The NECPL will facilitate the delivery of renewable Canadian energy that will displace an equivalent quantity of energy in Vermont and throughout ISO-NE, allowing generators with lower bid prices to set lower hourly wholesale energy prices. My forecast of load-weighted average annual wholesale energy prices for the Vermont zone, expressed in 2014 $ using a 2.0% inflation rate for 12-month periods April-March, is illustrated in Figure 1 below. These results are also provided in table format as ***Exh. TDI-SGP-10***, along with results expressed in nominal (in current $) terms.

Figure 1. Load-Weighted Average Annual Vermont Wholesale Energy Prices (2014 $)



Q48. What would be the total savings in Vermont wholesale energy prices due to the NECPL?

A48. Response: I estimate that NECPL will reduce wholesale energy prices in the Vermont zone by a total of $201.0 million (2014 $) over the Study Period. I estimate that Vermont ratepayers will obtain about 75% of this savings in wholesale energy prices because long-term power purchase contracts, owned generation, and generation entitlements partially insulate ratepayers from swings in wholesale energy prices.

Q49. How would the forecasted reduction in wholesale energy prices change if the NECPL utilization were less than 95%?

A49. Response: I expect the forecasted reduction in wholesale energy prices would be lower if the NECPL's utilization were less than 95%. However, I expect that the NECPL's impact on wholesale energy prices is not a linear function of its utilization, *i.e.* a lower NECPL utilization factor would likely mean fewer imports during off-peak periods, while imports during on-peak periods would likely not be significantly affected. In this case, the NECPL would still significantly reduce wholesale energy prices even at a utilization level below 95%.

Q50. In addition to the wholesale energy market benefits you have estimated, would the NECPL provide any benefits in the ISO-NE ancillary services market?

A50. Response: Yes, there would likely be additional benefits for certain ancillary services, including black start, reserves, reactive power (generally referred to as VAR) support, and regulation. I did not try to estimate which ancillary services the NECPL would provide, and since the size of the ancillary services market is quite small relative to the wholesale energy market, I did not estimate these potential benefits. Based on ISO-NE's 2013 Annual Markets Report, annual energy market costs amounted to $7.49 billion whereas annual ancillary services market costs amounted to only $0.27 billion, equivalent to just 3.6% of the energy market costs.[10] Nonetheless, I believe the Board can consider the potential ancillary service benefits of the NECPL as an additional small but unquantified economic benefit.

The NECPL Will Reduce Wholesale Capacity Prices in New England and Vermont

Q51. How are wholesale capacity prices determined in the ISO-NE market?

A51. Response: Locational wholesale capacity prices are determined through the Forward Capacity Market ("FCM") that was developed through an ISO-NE stakeholder process. FCM is intended to send appropriate price signals to attract new investment and maintain existing resources where they will be needed. Under FCM, capacity resources, predominantly generators plus some demand-side resources, submit bids in annual FCAs. ISO-NE conducts a descending clock auction that effectively matches supply bids against the Net Installed Capacity Requirement to set the capacity quantity and wholesale price. ISO-NE transmission constraints that lead to congestion and locational price differences in the wholesale energy market can also lead to locational price differences in wholesale capacity prices.

[10] Table 1-2 of ISO-NE's 2013 Annual Markets Report.

Q52. Will FCM change between now and the end of your Study Period, and have you incorporated those changes?

A52. Response: There are three known changes that will affect the FCM. *First,* FERC approved a proposal to replace the vertical demand curve with a sloped curve starting with FCA #9.[11] This change is expected to moderate the volatility in capacity prices and eliminate the need for administrative corrections that were implemented in the past. The sloped demand curve parameters for the next FCA have been publicized and were incorporated in my wholesale capacity price forecast.

Second, a U.S. Court of Appeals ruling vacated FERC's Order 745 requiring ISOs and RTOs to include demand-side resources in wholesale markets.[12] However, there is considerable uncertainty about the transition of demand-side resources from wholesale markets to state-regulated retail markets. Moreover, there may be legal appeals that delay or could alter the ultimate outcome for demand-side resources. In light of these uncertainties, I have continued treating demand-side resources as a wholesale capacity resource for the purpose of my testimony in this matter.

Third, ISO-NE filed Pay-for-Performance changes to the FCM mechanism in response to FERC's Order of May 30, 2014 in Docket ER14-1050-000 to reward generators and other capacity resources that can operate, and penalize those that cannot, during Capacity Scarcity Conditions. I have not made any structural changes to our estimate of wholesale capacity prices because: (i) it is too soon to estimate what specific impact, if any,

[11] FERC Order issued May 30, 2014, Docket No. ER14-1639-000.

[12] Case No. 11-1484, May 23, 2014.

Pay-for-Performance will have on FCA results; and (ii) ISO-NE designed these changes to be revenue neutral, *i.e.* total capacity payments by load will be unaffected. Moreover, any impact on wholesale capacity prices would likely be similar with and without the NECPL in service, so that the estimated reduction in wholesale capacity prices would not be significantly different with Pay-for-Performance.

Q53. Have wholesale capacity prices for the Vermont zone been equal to the Rest-of-Pool price in the past few years?

A53. Response: Yes. The Vermont zone cleared with the Rest-of-Pool in every FCA.

Q54. Briefly describe how you estimated the reduction in capacity prices due to the NECPL.

A54. Response: The NECPL will enable up to 1,000 MW of capacity to be delivered into ISO-NE. This would effectively shift the capacity supply curve to the right and lower the point at which the supply curve intersects with the demand curve. In order to estimate the resulting reduction in wholesale capacity prices, I undertook the following steps:

First, I estimated the shape and slope of the relevant portion of the supply curves for FCA #4-7, *i.e.* where they intersect the demand curve, based on auction data provided by

ISO-NE.[13] The shape and slope of the supply curves for these four FCAs in the region where they would intersect sloped demand curves were fairly consistent.

Second, I generated FCA sloped demand curves based on the FERC-approved parameters had they been utilized for FCA #4-#7.

Third, I calculated the impact that 500 MW of new capacity would have had on the ISO-NE capacity clearing price for FCAs #4-#7 by shifting the supply curves by 500 MW to the right. I averaged the resulting decrease in wholesale capacity prices for those four FCAs and then escalated them over time to reflect the expected increase in net CONE over the Study Period.

Q55. Why did you assume a capacity value of 500 MW for the NECPL?

A55. Response: I conservatively assumed that the NECPL would allow shippers to qualify only 500 MW as capacity under ISO-NE rules for FCM, halfway between the NECPL's full 1,000 MW of line capacity and zero, due to uncertainty factors of: (i) uncertain transmission upgrades that will be required in order for NECPL energy to be considered deliverable and thus qualify as capacity; and (ii) potential market responses (discussed in the next section) that could dilute NECPL's capacity value.

[13] The shape and slope of the supply curves are revealed by the amount of capacity remaining in the auction with each round of the descending clock mechanism. Results for FCA #8 were not useful because that auction concluded after a single round.

Q56. Will transmission upgrades be required downstream of the NECPL's point of interconnection at the Coolidge Substation in Cavendish to ensure that energy delivered via the NECPL is deliverable throughout ISO-NE?

A56. Response: It is likely that some transmission upgrades will be required, particularly if NECPL shippers want to participate in ISO-NE's capacity market and receive wholesale capacity revenues. TDI-NE submitted an Elective Transmission Upgrade Interconnection Request to ISO-NE that is currently pending. If transmission upgrades are identified through the ISO-NE interconnection process and are constructed, then shippers should be able to participate in ISO-NE's wholesale energy and capacity markets and receive the associated revenues.

Q57. Did your model assume that such transmission upgrades are completed?

A57. Response: No, I did not try to estimate what transmission upgrades would be required and what the resulting increase on ISO-NE zonal transfer limits would be. The wholesale energy price impacts I have calculated indicate that energy flows over the NECPL are affecting wholesale energy prices throughout New England even without additional upgrades. If transmission upgrades were required and built, and the transfer limits from Vermont to surrounding ISO-NE zones were increased, then: (i) Vermont and the other northern tier New England states might have a lower reduction in wholesale energy prices; and (ii) the southern tier New England states might have a greater reduction in wholesale energy prices.

Q58. How would the NECPL affect ISO-NE wholesale capacity prices?

A58. Response: We expect shippers who contract for NECPL line capacity to either own Canadian generation or contract with Canadian generators. In either case, generators who dedicate their contracted capacity to the ISO-NE market would qualify as capacity resources, participate in the FCAs, and collect capacity revenues, provided that ISO-NE finds the NECPL energy satisfies system deliverability requirements.

Q59. When would the NECPL shippers bid into the FCAs?

A59. Response: Given the three-year forward capacity commitments that ISO-NE requires for FCAs and NECPL's expected COD of April 1, 2019, a shipper wanting to receive capacity revenues starting on that date would have to bid in FCA 10 that will take place in February, 2016. According to TDI-NE, (i) the NECPL should have received all permits and approvals by early 2016, (ii) major equipment and financing commitments will have been made, and (iii) construction would then commence shortly thereafter. Therefore, shippers should have sufficient confidence that the NECPL will achieve its COD to submit capacity bids into FCA #10 in early 2016.

Q60. What other capacity resources did you assume would be added in the ISO-NE market?

A60. Response: For the next few years through 2018, I assumed that 2,747 MW of capacity would be added to the ISO-NE resource mix based on resources in the ISO-NE interconnection queue and the anticipated growth of renewable resources. Over the Study

Period, I added 1,315 MW of wind and solar generation to satisfy New England RPS goals and 4,463 MW of gas-fired simple cycle and combined cycle plants to satisfy ISO-NE's net installed capacity requirement. Simple and combined cycle resources are the non-renewable plant technologies that have been developed in ISO-NE over the past few years and are expected to be developed for the foreseeable future. Together, these renewable and gas-fired resource additions would maintain system reliability over the Study Period.

Q61. What was the impact of your assumed 500 MW of additional capacity from the NECPL on ISO-NE wholesale capacity prices?

A61. Response: The 500 MW shift to the four FCAs I analyzed resulted in an average reduction in the ISO-NE Rest-of-Pool wholesale capacity clearing price of \$0.64/kW-month (2014 \$). The total regional savings over the Study Period, including hedges that would partially insulate Vermont ratepayers from changes in wholesale capacity prices, would total \$2,692.8 million (2014 \$) over the Study Period.

A Market Response Could Affect the Reduction in Energy and Capacity Prices

Q62. Would existing and proposed power plants and transmission projects respond to the addition of new energy and capacity delivered via NECPL?

A62. Response: It is likely there would be some type of market response, but it would be difficult to forecast a specific response to the addition of 8,322 GWh of annual energy deliveries and up to 1,000 MW of new capacity via the NECPL. Potential market responses to the resulting reduction in wholesale energy and market capacity prices include delays or cancellations of new resource additions. I did not conduct the requisite financial analyses in sufficient detail for each existing and proposed capacity resource in ISO-NE, including the expected change in operations, revenues, and expenses, along with the risk factors that investors and lenders would consider. These analyses were beyond the scope of this assignment. Moreover, any specific market response estimate would be highly uncertain and unnecessary as I explain below.

Q63. What is your opinion of the likely impact of such market responses on the decrease in wholesale energy costs that you estimated?

A63. Response: In my opinion, the reduction in wholesale energy prices due to the NECPL would not be significantly affected. According to page 20 of ISO-NE's 2013 Annual Markets Report, provided as ***Exh. TDI-SGP-11***, natural gas was the marginal fuel during 69% of all pricing intervals. As more gas-fired generation is developed in New England, gas-fired resources will be on the margin an even a greater percentage of time over the Study Period. Neither retirements of existing residual oil-fired and coal-fired generation in New England, nor delays or cancellations of gas-fired power plants, would significantly affect (i) the high percentage of the annual hours when gas-fired generation is at the margin or (ii) the energy bid prices those generators submit ISO-NE for scheduling in the day ahead energy market. Thus the forecasted reduction in wholesale energy prices would not be sensitive to such market responses, and it was not necessary to estimate a specific market response to the NECPL.

Q64. What is your opinion on the likely impact of such market responses on the decrease in wholesale capacity costs that you estimated?

A64. Response: On the one hand, the absolute value of wholesale capacity prices is sensitive to power plant retirements, delays, and cancellations. This is because relatively small changes in the quantity of capacity resources bidding into the FCA have the potential to shorten the supply curve, thereby raising wholesale capacity prices. On the other hand, a given change in capacity, *e.g.* 1,000 MW from the NECPL, will have a consistent price impact anywhere along the sloped demand curve. Therefore, I am confident that my estimated reduction in wholesale capacity prices due to the NECPL is reasonable because I was conservative in assuming only a 500 MW capacity value to reflect the uncertainties of deliverability and market response.

The NECPL Will Lower Costs for Vermont Ratepayers

Q65. Given the NECPL's expected impact on ISO-NE wholesale energy and capacity prices, how would the NECPL affect Vermont ratepayers?

A65. Response: The NECPL's impact on Vermont ratepayers depends on their exposure to wholesale market energy and capacity prices. In the past, Vermont's electric distribution utilities have entered into contracts for most of their energy and capacity needs. Long-term contracts tend to insulate ratepayers from swings in wholesale prices; while short-term contracts tend to reflect known and anticipated wholesale market prices. Ratepayers would be further insulated from wholesale price swings to the extent Vermont's utilities have ownership in power plants.

Q66. How much of Vermont's energy and capacity requirements are obtained through contracts and power plant ownership?

A66. Response: A high percentage of Vermont's energy and capacity requirements is obtained through contracts and power plant ownership. According to section 5.1 of the 2011 Comprehensive Energy Plan, "…the aggregate supply of committed contracts or generation units (as opposed to open market purchases) has provided 85% to 90% of Vermont's energy needs over the last several years, of which 55% to 60% has been from Vermont-based resources."

Q67. Can you confirm that contracts alone provide a high percentage of Vermont's energy and capacity requirements?

A67. Response: Yes. *Exhibit 7-7 Load Subject to Marker Energy Prices by State, GWh* of the Avoided Energy Supply Costs in New England: 2013 Report dated July 12, 2013 ("AESC 2013 Report"), provided as ***Exh. TDI-SGP-12***, states that Vermont has energy contracts for 4135 GWh in 2014, equivalent to 68% of its energy requirements. *Exhibit 7-3 Load Subject to Market Capacity Prices by State (MW)* in the same AESC 2013 Report, states that Vermont has capacity contracts for 820 MW in 2014, equivalent to 82% of its peak demand. According to the 2011 Comprehensive Energy Plan, Vermont utilities have long-term contracts with Hydro Quebec and the Seabrook station (to replace power previously purchased from Vermont Yankee), as well as contracts with twenty hydroelectric and one biomass project.

Q68. Would all contracts hedge against swings in wholesale energy and capacity prices?

A68. Response: No. Long-term contracts would likely provide a hedge, while short-term contracts would not. Short-term contracts reflect known and anticipated structural changes in the wholesale energy and capacity markets, and thus reflect the reductions due to the NECPL.

Q69. Do Vermont's utilities own or have entitlements to power plants?

A69. Response: Yes, there are many utility-owned hydroelectric plants in Vermont, as well as a biomass-fueled plant and some gas turbines. According to the 2011 Comprehensive Energy Plan, "Utility-owned generators include the McNeil Generating Station (50 MW wood biomass), Burlington Electric's gas turbine (25 MW), Washington Electric Coop's Coventry Landfill methane plant (6 MW), Searsburg wind facility (6 MW), and a number of small hydroelectric facilities."[14] In addition, Vermont's utilities have entitlements to energy from power plants outside of Vermont, all of which would insulate ratepayers from swings in wholesale energy prices.

[14] I confirmed these plants are listed in ISO-NE's 2014-2023 Forecast Report of Capacity, Energy, Loads, and Transmission ("2014 CELT Report"). The 2014 CELT Report also lists three more recent wind projects in Vermont: Sheffield Wind (40 MW), Lowell/Kingdom Community Wind (63 MW), and Georgia Mountain Community Wind (10 MW).

Q70. In spite of these contracts and owned generation, will Vermont have a need for replacement energy and capacity by the NECPL's expected COD of April 1, 2019?

A70. Response: Yes. According to the 2011 Comprehensive Energy Plan, "…even with the new Hydro-Quebec contract and other contracts to replace power previously supplied by Vermont Yankee, a gap between contracted supply and expected demand still exists." Exhibit 5-3 of the 2011 Comprehensive Energy Plan lists eighteen hydroelectric projects that have contracts through the Vermont Electric Power Producers to allocate their energy and costs to Vermont utilities, and all but two of those contracts will expire prior to the NECPL's COD.

Q71. Would it be reasonable for Vermont utilities to purchase line capacity on the NECPL?

A71. Response: Yes. *First*, Volume 2, page 67 of the 2011 Comprehensive Energy Plan states "Vermont utilities should continue to diversify their portfolios with appropriate mixes of renewable energy, through contract procurement and ownership of generating supply via both in-state and out-of-state sources…" *Second,* the NECPL is expected to be in service starting 2019 and the AESC 2013 Report indicates that Vermont's energy and capacity contract hedges will decline from 68% and 82% in 2014, respectively, to 56% and 62% by 2019, absent new contracts. Thus it is reasonable for Vermont utilities to purchase line capacity on NECPL to bring hedged energy and capacity in Vermont back to 2014 levels.

Q72. If Vermont utilities entered into contracts for NECPL's line capacity, would that be consistent with Vermont's energy policy?

A72. Response: Yes. Not only did the 2011 Comprehensive Energy Plan recommend "…utilities should continue to diversify their portfolios with appropriate mixes of renewable energy, through contract procurement and ownership of generating supply…", but it identified transmission challenges that would be solved by the NECPL. According to page 3, volume 1 of the 2011 Comprehensive Energy Plan, "challenges remain to carry out transmission upgrades needed in the years ahead and to ensure that long-term electricity needs are met in a cost-effective and environmentally-sustainable manner." The NECPL would provide a direct transmission pathway to import renewable energy into Vermont.

Q73. Would NECPL benefit Vermont ratepayers regardless of any contracts with Vermont utilities?

A73. Response: Yes. My forecasts indicate that the NECPL will lower wholesale energy and capacity prices in the Vermont load zone. Contract parties, both buyers and sellers, understand that contract terms must provide a benefit relative to what could otherwise be obtained in the wholesale market. Thus power purchase contracts are affected by known and expected structural changes in the wholesale energy and capacity markets.

Once construction of the NECPL is assured, contract buyers and sellers in the wholesale energy and capacity markets will account for the expected price reductions. Thus Vermont's ratepayers will benefit directly (through contracts for NECPL line capacity) and indirectly (through other contracts that reflect the expected reduction in wholesale energy and capacity prices as well as through market purchases of wholesale energy and capacity) from the NECPL.

Q74. What is a reasonable assumption to reflect the hedging benefit of Vermont utility contracts and generation ownership?

A74. Response: I believe a 25% hedge factor is a reasonable estimate based on (i) long-term contracts, *e.g.* with Hydro Quebec, (ii) the large number of small hydro and other owned generation resources in Vermont, and (iii) generation entitlements in other generation resources that effectively charge ratepayers based on the cost of service, not market prices. A 25% hedge factor would insulate Vermont ratepayers from 25% of wholesale energy and capacity price swings and provide ratepayers with 75% of the wholesale energy and capacity price reductions due to the NECPL.

Q75. Can you provide an example how long-term contracts insulate Vermont's ratepayers from swings in wholesale energy prices?

A75. Response: Yes, the AESC 2013 Report stated in footnote 233: "The Vermont resources include a large purchase from HQ that is partially tied to market prices, with lags and fixed components. Since the pricing terms are not public, we assumed that 50 percent of the Vermont HQ contract price is tied to current market prices."

Q76. How much would ratepayers in Vermont and in New England overall save due to the NECPL's forecasted impact on wholesale energy prices?

A76. Response: I estimate that Vermont ratepayers would save a total of $201.0 million and New England ratepayers overall would save $1,590.7 million (all in 2014 $) in energy costs over the Study Period, ignoring hedges that insulate ratepayers from the estimated reduction in wholesale energy prices.

If I include a 25% hedge for Vermont ratepayers, they would save a total of $150.8 million and New England ratepayers overall would save $1,540.5 million in (all in 2014 $) in energy costs over the Study Period.

Q77. How much would a typical Vermont residential ratepayer save due to the NECPL's forecasted impact on wholesale energy and capacity prices?

A77. Response: *First*, I estimate that a typical Vermont residential ratepayer will save an average of $1.86/MWh, equivalent to a total of $133.63 in wholesale energy costs over the Study Period. *Second*, I estimate that a typical Vermont residential ratepayer will save an average of $0.48/kW-mo, equivalent to $69.40 (all in 2014 $) in wholesale capacity costs over the Study Period. Both of these values assume a 25% hedge factor and a typical consumption of 600 kWh/month (according to the VTPSD), an average demand of 0.82 kW, and a 1.21 kW peak load. The savings for typical Vermont residential ratepayers over the Study Period would total $203.80 (2014 $) over the Study Period. The annual savings for commercial, industrial, and other ratepayers would depend on their annual and peak energy consumption.

Q78. How much would typical residential ratepayers throughout New England save due to the NECPL's forecasted reduction in wholesale energy prices?

A78. Response: I estimate that a typical New England residential ratepayer (including Vermont) will save $72.31 (2014 $) in energy prices over the ten year Study Period. I assumed residential consumption of 600 kWh/month and no energy price hedges outside of Vermont because most utilities in the rest of New England have divested their generation assets and do not enter into long-term power purchase contracts. Consistent with Table 2 above, typical residential ratepayers in Vermont, New Hampshire, and Maine will have greater energy savings than those in Massachusetts, Connecticut, and Rhode Island.

30 V.S.A. § 248(b)(5) – Greenhouse Gas Impacts

The NECPL Will Lower Greenhouse Gas Emissions in New England

Q79. Please summarize the analyses you performed and the sources you relied on to calculate the impact of the NECPL on power plant GHG emissions in New England.

A79. Response: The AURORAxmp model calculates emissions for all fossil plants using emission rates based on Continuous Emissions Monitoring system data reported to the US Environmental Protection Agency and on other emission data.[15] I extracted AURORAxmp CO_2 and other emissions data by load zone to determine the net impact on CO_2 emissions for ISO-NE power plants over the Study Period as shown in Table 6 below. Very little,

[15] The emission rates in the AURORAxmp are based on 2011 Continuous Emission Monitoring system data and other sources and do not reflect (i) future improvements in emission control technology or (ii) additional emission control investments that have been made since then and may be made over the Study Period. Thus the forecasted levels of NO_x and SO_2 emissions, as well as the reduction due to the NECPL, may be less than reported above.

about 0.9 million tons of CO_2 emissions, will be abated in Vermont over the Study Period due to the NECPL. The majority of the Vermont CO_2 reductions are due to having added some in-state gas-fired capacity to maintain long-term ISO-NE system reliability, not from Vermont's existing fossil-fueled power plants.

Table 5. Forecast Reduction in ISO-NE Power Plant Emissions over the Study Period

	CO_2 (million tons)		NO_x (thousand tons)		SO_2 (thousand tons)	
Without NECPL	383.5		234.5		118.0	
With NECPL	350.6		220.9		111.6	
Reduction	32.9	*8.6%*	13.6	*5.8%*	6.4	*5.4%*

Q80. Is there a monetary value of such reductions in power plant air emissions?

A80. Response: There is considerable uncertainty about the economic value of health and environmental benefits due to reduced air emissions. One source is the AESC 2013 Report (Synapse Energy Economics) that "…provides projections of marginal energy supply costs that will be avoided due to reductions in the use of electricity, natural gas, and other fuels resulting from energy efficiency programs offered to customers throughout New England." The State of Vermont was one of the sponsors of this report. The AESC 2013 Report indicates that "…it is reasonable to use a CO_2 marginal abatement cost of $100 per short ton in 2013 dollars." I note that Synapse based this value on the cost of abatement, not on the health benefits associated with reduced air emissions. Nevertheless, applying this $100/ton value to my forecast of reduced air emissions would result in a gross New England-wide value of $3.3 billion (2014 $) over the ten year Study Period.

Q81. Do large-scale hydroelectric projects have a GHG footprint?

A81. Response: Yes. Hydroelectric projects do have a long term net GHG footprint. Studies have shown that there is a net increase in GHG emissions resulting from reservoir creation when accounting for CO_2 and methane (CH_4) produced or absorbed by the natural ecosystems within the watershed. Studies have shown that the net GHG emissions are highest in the first few years after flooding, then subside and levelize over time.

Q82. What studies and information did you review concerning net GHG emissions from hydroelectric projects?

A82. Response: We relied on two sources. For an overview of available data, we relied on a publication by the International Panel on Climate Change ("IPCC"), IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation, Chapter 5 Hydropower, by A. Kumar, *et al*, and Annex II, by W. Moomaw, *et al,* 2011. Scientists at the U.S. National Renewable Energy Laboratory ("NREL"), contributed to this study, which evaluated estimates of life cycle GHG emissions from hydropower projects through a comprehensive review and analysis of published literature. The study used a procedure called "harmonization" to adjust the published GHG emission estimates to a consistent set of methods and assumptions. For a recent empirical study relevant to boreal hydropower projects, we relied on an analysis of GHG emissions from a hydroelectric reservoir in northern Quebec by Christian R. Teodoru *et al*, The Net Carbon Footprint of a Newly Created Boreal Hydroelectric Reservoir, published in *Global Biochemical Cycles*, Volume 26,

2012. An overview of this literature can be found in the LAI Technical Memorandum attached as ***Exh. TDI-SGP-13***.

Q83. What did the existing literature tell you as it relates to the GHG footprint of hydropower projects?

A83. Response: The studies concur that, on a life-cycle basis, hydropower is not "carbon-free." However, the net hydropower GHG emissions are far lower that the GHG emissions from generation sources that combust fossil fuels, *e.g.* gas-fired combined cycle plants. Field measurements and other estimates of net GHG emissions associated with hydropower projects vary, depending on the location of the reservoir, the ecosystem of the watershed, the annual energy output of the hydropower plant, and other factors. Research is still evolving, and there is no standardized method for accounting for the GHG footprint of hydropower projects. For the specific northern Quebec reservoir examined in the Teodoru Study, the estimate of life-cycle net GHG emissions (expressed in terms of CO_2-equivalent, or CO_2eq) is 158 kg per MWh, which declines to 62 kg/MWh when the recent expansion of the hydropower project is factored in. Both of these values exceed the range compiled in the IPCC Special Report, which presents a maximum value of 43 kg CO_2eq/MWh. For comparison, an efficient, natural gas-fired combined cycle plant with an assumed heat rate of 7,200 Btu per kWh would emit approximately 380 kg CO_2eq/MWh.

Q84. Based on the existing literature, what is your assessment of the likely net GHG reductions due to the NECPL assuming the Canadian energy supply is derived largely from hydropower projects?

A84. Response: There is no single "correct" value that should be used to calculate the GHG contribution of the Canadian hydropower projects. For illustration purposes, I selected a life-cycle hydropower GHG emission rate of 62 kg CO_2eq / MWh for the reservoir footprint at the energy source in Quebec, which is higher than the upper end of the IPCC published range and the lower of the two values offered in the Teodoru Study. Assuming that the NECPL delivers that energy at a 95% capacity factor, then the annual average CO_2eq emissions displaced by the NECPL of approximately 3.3 million tons would be offset by 0.6 million tons of CO_2eq ascribable to the hydropower reservoir source in Canada. We emphasize that this illustration does not specifically calculate the emissions ascribable to the energy delivered via the NECPL, because the exact energy mix has not yet been determined. Moreover, there are site-specific factors in determining the specific GHG footprint of a hydroelectric project, as I discussed previously.

30 V.S.A. § 248(b)(7) – Compliance with the Vermont 2011 Comprehensive Energy Plan

The NECPL Complies with the 2011 Comprehensive Energy Plan

Q85. Would the NECPL "…be in compliance with the electric energy plan approved by the VTPSD under section 202 of this title…" as required by 30 V.S.A. § 248(b)(7)?

A85. Response: Yes, the NECPL would be in compliance with the electric energy plan approved by the VTPSD. According to the VTPSD's Addendum to the 2011 Electric Plan, "Sections

3, 4, and 5 of the *2011 Comprehensive Energy Plan* are the [VTPSD's] *2011 Vermont Electric Plan*." Therefore I have reviewed and address each of those three sections in Volume 2 of the 2011 Comprehensive Energy Plan.

Q86. How does the NECPL comply with section 3 of the 2011 Comprehensive Energy Plan?

A86. Response: According to the 2011 Comprehensive Energy Plan, "Section 3 contains an overview of electric usage and demand, explains the electric dispatch modeling scenarios compiled for the CEP, and summarizes the economic modeling that was completed on the basis of that forecast power modeling." The NECPL complies with Section 3, Vermont's Current and Future Electric Sector, because the base case forecast (Exhibit 3-9, page 41) shows Vermont's load increasing throughout the Study Period. Vermont will require new sources of energy and capacity, and the NECPL can facilitate deliveries of low carbon, renewable, and stably priced hydroelectric energy and capacity.

Q87. How does the NECPL comply with section 4 of the 2011 Comprehensive Energy Plan?

A87. Response: The NECPL complies with section 4, Electric Energy Efficiency, because it will further the following goals that were explicitly stated in section 4, pages 53-55, of the 2011 Comprehensive Energy Plan:

- Reducing Vermont's share of the Regional Network Service (RNS) charge.
- Reducing the overall cost of purchased electricity.

- Generating local jobs.
- Reducing the carbon emissions from electricity generation.
- Creating other, non-quantified benefits for participants, such as increased productivity, safety, and comfort.

Q88. How does the NECPL comply with section 5 of the <u>2011 Comprehensive Energy Plan</u>?

A88. <u>Response</u>: According to the <u>2011 Comprehensive Energy Plan</u>, "[T]his section describes the state's current electricity supply, the regional transmission network that delivers our power, and the potential for a number of technologies and resources to meet our supply needs in the future. The section concludes with a discussion of tools and recommended policies to improve the state's electric portfolio."

The NECPL complies with section 5, Vermont's Electric Supply, consistent with my earlier testimony, because (i) Vermont supports large-scale hydroelectric generation, (ii) Vermont supports renewable resources from both in-state and out-of state sources, (iii) the NECPL would take advantage of Vermont's strategic position being interconnected with Canada, (iv) energy flows over the NECPL would lower GHG emissions from power plants, and (v) the price of hydroelectric energy over the NECPL would be more stable compared to gas-fired generation.

<u>The NECPL Complies with the 2013 Total Energy Study</u>

Q89. Has the VTPSD produced more recent energy studies since the <u>2011 Comprehensive Energy Plan</u>?

A89. <u>Response</u>: Yes, the VTPSD published the <u>Total Energy Study</u> on December 15, 2013, provided as ***Exh. TDI-SGP-7***. The purpose of the <u>Total Energy Study</u> was to inform the Legislature and the public of progress to date in carrying out the state's energy and GHG goals of: (i) meeting 90% of Vermont's overall energy needs from renewable sources by 2050 and (ii) reducing Vermont's GHG emissions by 50% from the 1990 baseline level by 2028 and 75% from the 1990 level by 2050. These goals were established in Act 170 of 2012 and modified through Act 89 of 2013 by the Vermont General Assembly.

Q90. Would NECPL be consistent with the goals of the <u>Total Energy Study</u>?

A90. <u>Response</u>: Yes, NECPL would (i) create a delivery pathway for the import of renewable, low-carbon energy and capacity from Canada and (ii) deliver energy that would displace fossil-fueled energy and thus reduce GHG emissions from ISO-NE power plants.

Q91. Does this conclude your testimony at this time?

A91. <u>Response</u>: Yes.