STATE OF NEW HAMPSHIRE

BEFORE THE

NEW HAMPSHIRE PUBLIC UTILITIES COMMISSION

PREPARED TESTIMONY OF

David Harrison, Jr., Ph.D.

and

Noah Kaufman, Ph.D.

July 11, 2014

I. WITNESS INFORMATION

1. Q. DR. HARRISON PLEASE STATE YOUR NAME, OCCUPATION, JOB TITLE, EMPLOYER, BUSINESS ADDRESS AND THE PARTY FOR WHOM YOU ARE FILING TESTIMONY.

A. My name is David Harrison, Jr. I am an economist and Senior Vice President at NERA Economic Consulting ("NERA"), an international firm of economists specializing in microeconomics. Established in 1961, NERA has earned wide recognition for its work in energy, environmental economics and regulation, antitrust, public utilities regulation, transportation, securities, mass torts, health care, international trade and other areas. The work is performed by more than 500 professional staff members qualified in economics, statistics, mathematics, computer applications, and business administration. NERA operates in numerous offices across North America, Europe, Asia and Australia. My business address is 200 Clarendon Street, Boston, Massachusetts 02116. I am filing testimony on behalf of Public Service Company of New Hampshire ("PSNH").

2. Q. PLEASE DESCRIBE YOUR EDUCATIONAL BACKGROUND.

A. I received a Ph.D. in Economics from Harvard University, where I was a Graduate Prize Fellow. I also hold a B.A. magna cum laude in Economics from Harvard College, where I was a member of Phi Beta Kappa, and a M.Sc. in Economics from the London School of Economics, where I was the Rees Jeffreys Scholar.

3. Q. PLEASE SUMMARIZE YOUR RELEVANT WORK EXPERIENCE.

A. I am currently co-chair of NERA's global environmental practice. I have extensive experience over more than three decades evaluating energy and environmental policies and projects as an academic, government official and consulting economist.

Before joining NERA, I was an Associate Professor at the John F. Kennedy School of Government at Harvard University, where I taught economics, energy and environmental policy, benefit-cost analysis, and other subjects for more than a decade. I was a member of the Faculty Steering Committee of the Energy and Environmental Policy Center at Harvard University, and a member of the Advisory Board of the Interdisciplinary Program in Health at the Harvard School of Public Health.

I earlier served as a Senior Staff Economist on the President's Council of Economic Advisors, where my areas of responsibility included energy and environment policy, natural resources, occupational health and safety, and transportation. I also have worked at the U.S. Department of Transportation, the U.S. Department of Housing and Urban Development, and the National Bureau of Economic Research.

At NERA, I have directed projects in many environmental areas—including climate change, air quality, water quality, solid and hazardous waste, occupational health and safety, and others—as well as in many areas related to energy and macroeconomic modeling. I also have evaluated the employment and other impacts of numerous polices and projects on local, state and national economies using state-of-the-art economic models. My full curriculum vitae is provided in Attachment 1.

4. Q. HAVE YOU PREVIOUSLY TESTIFIED IN NEW HAMPSHIRE?

A. Yes. In 2007 I submitted an affidavit to the New Hampshire Air Resources Council in support of Public Service Company of New Hampshire's comments on the Department of Environmental Service's Preliminary Responses to requests for bonus carbon dioxide (CO_2) allowances Pursuant to RSA 125-O and Env-A.

5. Q. DR. KAUFMAN PLEASE STATE YOUR NAME, OCCUPATION, JOB TITLE, EMPLOYER, BUSINESS ADDRESS AND THE PARTY FOR WHOM YOU ARE FILING TESTIMONY.

A. My name is Noah Kaufman. I am an economist and a Senior Consultant at NERA, an international firm of economists described by Dr. Harrison above. My business address is 200 Clarendon Street, Boston, Massachusetts 02116. I am filing testimony on behalf of PSNH.

6. Q. PLEASE DESCRIBE YOUR EDUCATIONAL BACKGROUND.

A. I received a Ph.D. in Economics from the University of Texas at Austin, where my research focus was environmental and public economics, and I wrote my dissertation on the economics of climate change. I also hold a B.S. in Economics, cum laude, from Duke University.

7. Q. PLEASE SUMMARIZE YOUR RELEVANT WORK EXPERIENCE.

A. At NERA, I have worked on projects related to the economics of environmental and energy policies, including the regulation of climate change, air quality and water quality. I also have experience evaluating the impacts to the economy and to the electricity grid of infrastructure investments and energy policies. I have published peer-reviewed journal articles on the topics of the social cost of CO_2 emissions, the role of risk aversion in environmental policy evaluations, and the design of incentives to support green consumer products and energy-efficiency programs run by electric and gas utilities. Before joining NERA, I was a teaching assistant for an environmental economics course at the University of Texas at Austin, and I worked in the corporate finance department of the investment bank Keefe, Bruyette & Woods. My full curriculum vitae is provided in Attachment 2.

8. Q. HAVE YOU PREVIOUSLY TESTIFIED IN NEW HAMPSHIRE?

A. No.

II. OVERVIEW OF OUR TESTIMONY

9. Q. WHAT ARE THE PURPOSES OF YOUR TESTIMONY?

A. We were asked by PSNH to prepare an independent economic analysis of the economics surrounding the installation of a wet scrubber at the Merrimack Station power plant (referred to in our testimony as the "Scrubber Project") that PSNH undertook to comply with state legislative requirements (referred to in our testimony as the "Scrubber Law"[1]). To assess the Scrubber Project, we have undertaken an economic analysis of the going-forward costs to PSNH customers for Merrimack Station assuming the Scrubber Project is installed, and we have compared these costs to two alternatives: (1) the development of a natural gas unit that would provide comparable energy and capacity; and (2) market electricity purchases to replace future expected Merrimack energy and capacity.[2]

We evaluated the Scrubber Project and the alternatives as of two dates, mid-2008 and early-2009 ("the Analysis Dates"), as well as under different assumptions regarding key cost parameters. We understand that in mid-2008 PSNH conducted its own economic assessment of the scrubber project, after obtaining a substantially revised estimate of the cost of the Scrubber Project as a result of bids it had received from potential project contractors. In early-2009, we understand that the New Hampshire Legislature considered (but did not pass) two bills that would have changed the Scrubber Law. We have not been asked to evaluate the

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[1] The testimony of William H. Smagula in this proceeding provides a discussion of the Scrubber Law.

[2] We understand that there are legal issues regarding whether PSNH had any legal authority to pursue a course of action other than to proceed with Scrubber Project based upon statutory requirements in the Scrubber Law. Solely for purposes of our analysis, we make the assumption that PSNH had the discretion to go forward with the Scrubber Project as well as to develop a natural gas facility or to rely upon market purchases. Our testimony relates only to economic considerations, and we do not comment on the legal status or availability of the alternative options.

economic assessments prepared by PSNH or any information connected with the New Hampshire Legislature's consideration of the Scrubber Law.

In addition to developing our independent economic analysis of the Scrubber Project, we were asked to comment on the testimony related to similar economic issues from other parties in this proceeding. In particular, we were asked to comment on the testimonies of Dr. Elizabeth Stanton on behalf of the Conservation Law Foundation and Mr. Michael Hachey on behalf of TransCanada.

10. Q. CAN YOU PROVIDE A BRIEF SUMMARY OF YOUR ANALYSIS OF THE RELATIVE COSTS OF THE SCRUBBER PROJECT AND THE TWO ALTERNATIVES?

A. Using information available in mid-2008 and early-2009, we estimated the costs to PSNH's customers of proceeding with the Scrubber Project in comparison to the costs of building and operating a natural gas fired plant and the costs of purchasing electricity from the wholesale market. To account for major uncertainties, we developed 12 scenarios for each of the two Analysis Dates. The 12 scenarios differ across the following three dimensions: (1) expected future energy market prices, including natural gas, coal and electricity prices; (2) expected future costs to comply with environmental regulations, notably for CO_2 emissions; and (3) expected capital costs of a new combined cycle natural gas plant.

The major finding of our analysis is that based on the information we compiled from public sources and PSNH, the Scrubber Project was the low-cost option for ratepayers for many of the scenarios as of both Analysis Dates. We also found

some scenarios in which an alternative to the Scrubber Project was projected to involve lower costs to ratepayers. Such a situation is not surprising, particularly given the substantial uncertainties regarding energy prices and other factors that existed in mid-2008 and early-2009. The implication of these results is that it would have been reasonable in mid-2008 and early-2009 for PSNH to expect the Scrubber Project to lead to lower costs for its customers than the alternatives of building a natural gas unit or relying upon market purchases, alternatives that imply the divestiture or retirement of Merrimack Station.

11. Q. COULD YOU SUMMARIZE YOUR CONCLUSIONS REGARDING THE TESTIMONY OF DR. STANTON?

A. Dr. Stanton's testimony presents an analysis that uses a cost-comparison methodology similar to ours, although only for a single alternative (the projected costs of wholesale electricity) and a single time period (early-2009). She evaluates costs under five scenarios that differ in terms of projected natural gas prices and environmental costs. Similar to our analysis, Dr. Stanton's results show that whether the Scrubber Project was the expected low cost option to ratepayers depended on the scenario Dr. Stanton employed in her analysis. However, she finds that the Scrubber Project would lead to higher costs to PSNH's customers in four of the five scenarios considered in her analysis.

There are many differences between Dr. Stanton's analysis and ours, but the major driver of the differing results is the expectations regarding future costs related to environmental requirements, including the regulation of CO_2 emissions. We evaluated her assumptions regarding future costs related to CO_2 emissions, and we conclude that her estimates of costs are not consistent with reasonable

forecasts available as of early-2009 (her analysis date). When more realistic expectations of future costs related to CO_2 emissions are incorporated into Dr. Stanton's comparative cost analysis, her results become similar to ours, in that the Scrubber Project would lead to lower costs to PSNH's customers in four of the five scenarios considered in her analysis. We also consider other significant differences between our analysis and that of Dr. Stanton, including costs related to non-CO_2 environmental regulations and the "sunk costs" of the Scrubber Project that would be incurred in early-2009 if the project were cancelled (an element that Dr. Stanton acknowledges but does not quantify).

12. Q. COULD YOU SUMMARIZE YOUR CONCLUSIONS REGARDING THE TESTIMONY OF MR. HACHEY?

A. The testimony of Mr. Hachey is based fundamentally on his opinions that the gas price forecasts used by PSNH were imprudent and did not properly take into account the impact of gas fracking on the marketplace. Mr. Hachey includes an analysis in which he takes the PSNH analysis performed in mid-2008 and substitutes three different natural gas price forecasts. Mr. Hachey's calculations indicate that the Scrubber Project involved higher costs to ratepayers than alternatives under the three different natural gas forecasts. However, the three "different" natural gas price forecasts used by Mr. Hachey are very similar to one another, and thus his analysis does not properly reflect the substantial uncertainty in natural gas price projections in mid-2008. We conclude that information developed by Mr. Hachey does not provide an appropriate basis for assessing the prudence of the Scrubber Project. A more realistic range of natural gas price forecasts as of mid-2008—such as the forecasts used in our analysis or the June 2008 forecasts from Energy Security Analysis provided by TransCanada in

response to a discovery request from PSNH (see Attachment 3)—shows that the Scrubber Project would have lower costs than alternatives under plausible future natural gas price projections.

13. Q. DID YOU HAVE THE INFORMATION NECESSARY TO FULLY EVALUATE MR. HACHEY'S TESTIMONY?

A. No, we did not. We asked PSNH to obtain information in the possession of TransCanada regarding forecasts of fuel prices and the impact of gas fracking on the marketplace during the mid-2008 to early-2009 time period, a period of market turmoil and uncertainty on the future implications of natural gas fracking. TransCanada has not provided the requested information, which would have been significant in evaluating Mr. Hachey's testimony.

III. METHODOLOGY FOR ASSESSING THE COSTS OF THE SCRUBBER PROJECT RELATIVE TO ALTERNATIVES

14. Q. PLEASE EXPLAIN THE ROLE OF CONTEMPORANEOUS INFORMATION IN YOUR ANALYSES OF THE SCRUBBER PROJECT.

A. In evaluating an investment many years after it was made, it may be tempting to use the benefit of hindsight, because we now have information on actual conditions (and updated forecasts) to evaluate alternatives; indeed, when looking backward, what actually happened can have an air of inevitability around it. There is an additional temptation to use hindsight from the perspective of an economic modeler, because it is far easier to compile a dataset of historical information and projections from the current period than it is to find data and consistent projections from an earlier period when an investment was being considered.

Despite these temptations, it is crucial not to use the benefit of hindsight, a principle that the Commission has wisely emphasized in the past.[3] A utility manager cannot be expected to see into the future with perfect foresight. Only information, data, and forecasts contemporaneous to the time of a decision are relevant to our analysis.

15. Q. PLEASE EXPLAIN THE ROLE OF UNCERTAINTY IN YOUR ANALYSES OF THE SCRUBBER PROJECT.

A. Accounting for uncertainties associated with future market and other conditions is important in any economic evaluation. In terms of evaluating the Scrubber Project as of mid-2008 and early-2009, this principle is even more important than usual because of the extreme uncertainties regarding the overall economy at the time. The comparative costs of the Scrubber Project hinge on long-term forecasts of energy prices and other related goods and services, which are notoriously uncertain and difficult to project even under relatively stable market conditions. But market conditions in the United States in mid-2008 to early-2009 were far from stable. In the context of the government bailout of Bear Stearns in March 2008 and the failure of Lehman Brothers in September 2008, the country (and indeed the world) was experiencing a financial crisis of a scale unseen in generations. In October 2008, the head of the International Monetary Fund warned that the world financial system was teetering on the "brink of systemic meltdown."

[3] This issue is discussed in the testimony of John Reed in this proceeding.

Not surprisingly, energy markets were characterized by extreme volatility in 2008 and 2009. As shown in Attachment 4, average monthly Henry Hub natural gas prices approximately doubled between late 2007 and mid-2008, and then declined sharply through early-2009. These sharp price swings reflected major uncertainties in natural gas markets, including the effects of the overall economic decline on natural gas demand as well as the supply effects of expanded use of advanced technologies to drill for shale gas (notably horizontal drilling and hydraulic fracturing, typically referred to as "fracking"). These developments raised many questions in mid-2008 as well as in early-2009. When and how would the economy recover from the collapse brought on by the financial crisis? Would an eventual rebound in the economy as well as supply increases due to fracking reverse the trend of increasing natural gas prices that was seen up until mid-2008? Or did the higher natural gas prices experienced in mid-2008 represent a "new normal" that would re-emerge after the economy recovered? Looking backward, it is clear that the shale gas revolution (in conjunction with lower natural gas demand) led to substantially lower projected natural gas prices; however, these results were far from certain from the perspective of mid-2008 and early-2009. Attachment 5, which shows changes over time in forecasts of natural gas prices by the U.S. Energy Information Administration ("EIA") developed in its Annual Energy Outlook ("AEO") from 2004 to 2012, illustrates the wide swings in expected future natural gas prices over time.

In addition to the uncertainties related to the overall economy and U.S. energy markets, a coal plant such as Merrimack Station faced other significant unknowns related to future environmental policies. In 2008 and 2009, the future regulation of CO_2 emissions in the United States was uncertain. During this period, Congress

debated various economy-wide cap-and-trade programs that could have led to significant effects on the costs of operating fossil-fuel electricity generators. These cap-and-trade programs would ultimately fail to become law, but in 2008 and 2009, their potential impacts were uncertainties to be included in an analysis of going-forward costs. In addition, PSNH also faced uncertainties related to other environmental regulations, such as regulations of the water intake and effluent discharge from Merrimack Station.

For the reasons noted above, it is clear that appropriately accounting for uncertainties in an evaluation of the relative costs of the Scrubber Project and alternatives requires the development of a wide range of plausible future scenarios, based on reasonable expectations of market conditions and other factors as of mid-2008 and early-2009.

16. Q. PLEASE DESCRIBE HOW THE PRINICPLES NOTED ABOVE INFORMED YOUR METHODOLOGY.

A. The two key principles described above—use of contemporaneous information and a careful accounting for uncertainty—provide the basis for our strategy of developing the information used in our analysis. First, the information we use to assess the costs of the Scrubber Project and the alternatives—including historical data and expectations about the future—is developed from the perspective of the two Analysis Dates. In other words, only information that was knowable at these two Analysis Dates is used in our analyses.

Second, given the extraordinary uncertainties facing a coal plant in mid-2008 and early-2009, we considered numerous plausible future scenarios to develop this

contemporaneous information. Of course, it is not feasible to consider the full range of uncertainty related to every parameter. Thus in accordance with sound economic principles, we focused on the uncertainties we expected to have the greatest potential to affect the results of the analysis.

17. Q. PLEASE PROVIDE AN OVERVIEW OF YOUR METHODOLOGY FOR EVALUATING THE ECONOMICS OF THE SCRUBBER PROJECT.

A. To assess the Scrubber Project from an economic perspective, we estimate the future costs to PSNH customers of proceeding with the Scrubber Project and continuing to operate Merrimack Station ("Scrubber Project Case"). We compare these costs to two alternatives that, for the sake of our analysis, are assumed to have been options available to PSNH as of mid-2008 and early-2009 for providing PSNH customers with electricity services from the period of 2013 to 2027, the estimated book life of the scrubber and the time period used for our comparisons. As we mentioned earlier, the two alternatives are the following (both of which imply the divestiture or retirement of Merrimack Station)[4]:

(1) Building and operating a combined-cycle natural gas power plant ("Natural Gas Plant Case");

(2) Purchasing electricity from the wholesale market ("Market Purchase Case").

The costs of the Scrubber Project Case and the Natural Gas Plant Case (i.e. the "revenue requirements" for operating Merrimack Station or a natural gas plant) include the future costs of fuel and other operations and maintenance (O&M) costs, including costs of complying with potential future environmental

[4] The costs of such divestiture or retirement were not included in our analyses. If administrative costs associated with divestiture or retirement were included, those costs would favor the installation and operation of the scrubber.

regulations. Future revenue requirements also include property taxes, return on capital investments (i.e. depreciation expenses[5]) and return of capital investments at an allowed rate of return.

To estimate the revenue requirements for the Market Purchase Case, we assumed that PSNH would purchase from the wholesale electricity market the same amount of electricity services that are projected to be provided by Merrimack Station or a natural gas plant.

To provide the basis for cost estimates that can be properly compared to the costs of the Scrubber Project, both the Natural Gas Plant and Market Purchase Cases include some costs related to the Scrubber Project as of the two Analysis Dates. We understand from PSNH that the Scrubber Project was already underway by mid-2008 and that substantial additional expenditures and commitments were made by early-2009. If the Scrubber Project had been cancelled at either of the Analysis Dates, PSNH ratepayers would have been required to pay for Scrubber Project costs that had been prudently incurred to date as well as for any costs that PSNH was contractually obligated to pay (i.e. the costs of cancelling contracts that had already been signed). We refer to these as the "sunk costs" of the Scrubber Project, and their values as of the two Analysis Dates are added to the costs of the Natural Gas Plant and Market Purchase Cases in order to provide an appropriate comparison of the costs facing PSNH ratepayers.

[5] We assumed all incremental capital investments at Merrimack Station—including Scrubber Project expenses—are depreciated over a 15-year useful life using the straight-line depreciation method. We assumed the investment in the natural gas plant is depreciated over 30-year useful life using the straight-line depreciation method for plant value purposes, but a 20-year Modified Accelerated Cost Recovery System ("MACRS") schedule for tax purposes. These assumptions lower the relative costs of the Natural Gas Plant Case.

Finally, to compare the future revenue requirements across the three cases, the annual costs to ratepayers over time are converted into present values using PSNH's relevant discount rate; all else equal, it is assumed that ratepayers would prefer to incur costs later rather than earlier.

18. Q. PLEASE DESCRIBE THE SPECIFIC UNCERTAINTIES THAT YOU USED AS A BASIS FOR DEVELOPING MODELING SCENARIOS.

A. To develop the 12 scenarios for each Analysis Date, we compiled information related to the following five major (and often interrelated) uncertainties:

- *Natural gas prices.* Natural gas price projections are key determinants of expected costs for the Natural Gas Plant Case. As noted above, 2008 to 2009 was an exceptionally volatile time period for natural gas prices, and it was not clear at the time whether the volatility and price trends would be temporary or long-lasting. We therefore developed a range of plausible natural gas price scenarios, using U.S. Energy Information Administration (EIA) forecasts and future market prices available as of the Analysis Dates. As we note below, these price scenarios depend upon the expected regulation of CO_2 emissions.
- *Wholesale electricity prices.* The expected costs of the Market Purchase Case are of course dependent on wholesale electricity price projections, and electricity prices in turn are largely determined by natural gas prices because natural gas is the most common marginal electricity source in New England. It follows that projected wholesale electricity prices in New England are affected by the same uncertainties affecting natural gas prices, as well as additional uncertainties associated with the operation of the electricity grid and the markets for other fuels used to generate electricity

in New England. We therefore develop a range of plausible wholesale electricity price scenarios, again using EIA forecasts and future market prices available as of the Analysis Dates as guides and accounting for implications of potential CO_2 regulations.

- *Regulations on CO_2 Emissions.* Fossil-fuel power plants faced substantial uncertainties in 2008 and 2009 associated with potential future regulation of CO_2 emissions. In that period, the focus was on federal cap-and-trade programs, which impose an overall cap on CO_2 emissions, allocate the initial allowances (i.e., the right to emit a ton of CO_2) and allow regulated entities to comply by buying and selling CO_2 allowances. A cap-and-trade program creates a price for allowances to emit CO_2, and the program leads to changes in prices for electricity as well as for natural gas, coal and other fuels. New Hampshire is a member of the Regional Greenhouse Gas Initiative (RGGI), the cap-and-trade program that began regulating CO_2 emissions from fossil-fuel electricity generating units in 10 states in January 2009. RGGI created some uncertainties regarding future energy and electricity prices, but a more significant unknown at the time was the fate of national regulation of CO_2 emissions (and in particular, a national cap-and-trade program) for CO_2 that had the potential to lead to substantially greater effects on revenue requirements. Congress debated (though it ultimately did not pass) various economy-wide cap-and-trade programs for greenhouse gas emissions in 2008 and 2009. We consider two environmental cost cases, one based upon continuation of the RGGI program and one based upon passage of a national cap-and-trade program similar to those being considered by Congress at the time.

- *Other Environmental Regulations.* Electricity generating units also faced the possibility of costs related to various potential environmental regulations, including regulations related to water, air, and waste permits. We consider two non-CO_2 environmental cost cases that differ in expected costs related to Merrimack Station's cooling water intake structure, as reflected in its National Pollutant Discharge Elimination System (NPDES) permit required under Section 316(b) of the Clean Water Act.
- *Natural Gas Plant Costs.* A particularly large source of uncertainty for the Natural Gas Plant Case is the expected cost of building a new combined-cycle natural gas plant in New England. Among other factors, the markets for various materials and services necessary to build a combined-cycle plant were in flux during 2008 and 2009. To reflect this uncertainty, we rely on a range of natural gas plant capital costs provided by the Federal Energy Regulatory Commission (FERC) in June 2008.

Using assumptions surrounding these five key modeling uncertainties, we developed 12 plausible future scenarios and estimated the costs of the Scrubber Project Case and two alternatives under each scenario and as of each Analysis Date. However, it should be noted that by focusing on uncertainty in a limited number of parameters, other uncertainties are ignored for the sake of a tractable analysis. The implication is that our analysis will understate the actual uncertainties regarding the relative costs of the alternatives.

19. Q. PLEASE SUMMARIZE THE SPECIFIC SCENARIOS YOU CONSIDERED.

A. Attachment 6 summarizes the 12 scenarios for each of the two Analysis Dates. The 12 scenarios are based upon five energy price trajectories (from three underlying sources), two environmental cost assumptions, and two natural gas plant capital cost estimates.

20. Q. PLEASE DESCRIBE THE SOURCES OF INFORMATION FOR THE ALTERNATIVE NATURAL GAS AND ELECTRICITY PRICE SCENARIOS.

A. Our natural gas and electricity price forecasts are displayed in Attachments 7, 8, 9 and 10. The forecasts are based on EIA projections[6] and quotes from futures market contracts as of the two Analysis Dates,[7] and are correlated across scenarios. Three long-term forecasts are used. One is based on EIA forecasts from the Reference Case of its Annual Energy Outlook reports, which assume no national cap-and-trade program. The second is based on EIA forecasts of the U.S. electricity sector assuming a national cap-and-trade program was passed (leading to a price on CO_2 emissions as well as higher natural gas and electricity prices). The third is based on prices of the available futures contracts as of the Analysis Dates. The major benefits of using data from futures contracts are that they reflect the actual expectations of market participants and they are more current than the

[6] We used EIA forecasted electricity prices (excluding transmission and distribution) for the New England region; we then adjusted these prices to reflect the average differences in wholesale electricity prices in New Hampshire and New England as a whole. We used EIA forecasted natural gas prices for the electric power sector in New England.

[7] For our electricity forecasts, we used NYMEX futures market contracts for ISO New England Internal Hub locational marginal prices; we then adjusted these prices to reflect the average differences in energy market prices in New Hampshire and at the Internal Hub, and to include adders for capacity prices and other relatively small components of wholesale electricity prices. We used NYMEX futures market contracts for Henry Hub natural gas prices and transportation adders provided by PSNH.

EIA forecasts; for example, the Annual Energy Outlook 2008 forecasts were first developed in late 2007, but natural gas prices nearly doubled between December 2007 and July 2008, so the EIA forecasts were arguably out-of-date. The drawback of using data from futures markets is that long-term contracts are generally either unavailable or seldom traded; our futures market scenarios assume prices would grow at the rate of inflation for years beyond the dates for which futures market data were available.

Because of these trade-offs among data sources, we developed additional "hybrid" projections that utilized futures market data for short-term prices and EIA forecasts (with and without a national cap-and-trade program for CO_2 emissions) for long-term prices. In these hybrid cases, prices are based on futures market contracts for two years from the Analysis Date; for the next decade, prices are assumed to converge to the EIA long-term forecasts; starting in 2020, prices are equal to the EIA forecasts.

The methodology used to produce the natural gas and electricity price forecasts used in our analysis reflects the substantial uncertainty surrounding future natural gas and electricity prices; therefore it was important to develop a range of price forecasts based on the best available information from market data and expert forecasts. The ranges implied by the five forecasts described above serve as proxies for the substantial uncertainties facing a utility executive in PSNH's position in mid-2008 and early-2009.

21. Q. PLEASE DESCRIBE THE SOURCES OF INFORMATION FOR THE ALTERNATIVE ENVIRONMENTAL COMPLIANCE COST SCENARIOS.

A. As noted above, a major uncertainty facing Merrimack Station was whether a national cap-and-trade program for CO_2 emissions would be enacted by Congress during the lifetime of the Scrubber Project, and if so, how stringent the program would be. We developed two CO_2 price scenarios to reflect this uncertainty, again using both futures market information and long-term forecasts.

RGGI was implemented in 2009, and according to futures market contracts on RGGI emissions allowances, the price of CO_2 emissions was expected to be roughly $4 per ton in 2012 when the Scrubber Project was completed. Government modeling of the most prominent proposed cap-and-trade programs indicated that if a national cap-and-trade program were passed, allowance price expectations would be in the range of $20 per ton of CO_2 when the Scrubber Project was completed in 2012 (and increasing at an expected rate of interest over time). However, it is important to recognize that in these prominent cap-and-trade proposals, a significant percentage of emissions allowances would have been freely allocated to utilities in the early years, so the effective price on CO_2 emissions for utility ratepayers would have been considerably lower than the allowance prices.

Our analysis considered two possibilities related to the costs of CO_2 emissions. The "Low Environmental Compliance Cost" case assumes that PSNH would continue to face RGGI prices, in which case price expectations could be derived from the futures markets. The "High Environmental Compliance Cost" case

assumes a national cap-and-trade program would be enacted by Congress, in which case price expectations can be derived from EIA modeling of the prominent cap-and-trade proposals (and assumptions on the free distribution of allowances to fossil fuel power plants based on the methodology described in a relevant cap-and-trade legislative proposal).

For the sake of internal consistency within scenarios, we developed prices for natural gas and other fuels, electricity and CO_2 allowances that are consistent with the environmental compliance cost assumptions. For the scenarios that assume high environmental compliance costs, natural gas and electricity price forecasts are compiled from the same EIA model of national cap-and-trade programs from which we obtained the CO_2 price forecasts. In addition, we adjusted the coal expenditures (based initially on historical Merrimack Station expenditures) in the "High Environmental Compliance Cost" scenarios to reflect the percentage change in coal prices forecasts from the EIA simulations of the energy sector with and without the cap-and-trade program.

To account for the uncertainty facing the regulation of cooling water intake at Merrimack Station, we also developed two scenarios of environmental costs with respect to regulation under Section 316(b) of the Clean Water Act. The "High Environmental Compliance Cost" case assumes that cooling towers are installed at Merrimack Station in 2014, whereas the "Low Environmental Compliance Cost" case assumes that no additional costs are required. We use information from a NERA study for PSNH on the costs of cooling towers at Merrimack.[8]

[8] Sufficient information on potential costs of Section 316(b) regulations for Merrimack Station is not available from prior to the Analysis Dates. A NERA study from 2012 (*Preliminary Economic Analysis of Cooling Water Intake Alternatives at Merrimack Station*, February 2012, see:

Both the "Low Environmental Compliance Cost" case and the "High Environmental Compliance Cost" case include relatively small costs to comply with other environmental regulations. We discuss these additional costs below in the context of our assessment of Dr. Stanton's assumptions regarding the costs of non-CO_2 environmental regulations.

22. Q. PLEASE DESCRIBE THE SOURCES OF INFORMATION FOR THE ALTERNATIVE SCENARIOS FOR NATURAL GAS PLANT COSTS.

A. As noted above, FERC provided a range of plausible costs of a new natural gas plant in June 2008. As displayed in Attachment 11 (p. 11), the range of costs for a combined-cycle plant was approximately $800 to $1500 per kilowatt (kW).[9] We use the low end of this range as the "Low Natural Gas Plant Cost" case and the high end as the "High Natural Gas Plant Cost" case.

23. Q. PLEASE CHARACTERIZE YOUR SOURCES FOR THE REMAINDER OF THE DATA USED IN YOUR ANALYSIS.

A. We used publicly available information from mid-2008 and early-2009 whenever reliable data were available. When reliable public forecasts were unavailable, current or historical data (as of the two Analysis Dates) were used as a proxy for reasonable expectations of the future. For example, projections of Merrimack Station capacity factors are based on average annual capacity factors from the previous five years, and the costs to operate Merrimack Station (including capital,

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http://www.epa.gov/region1/npdes/merrimackstation/pdfs/comments/PC-21.pdf) is thus used as a proxy for what might have been expected in 2008, although the specific information developed in that report would have been unavailable to PSNH.

[9] Middletown Kleen, a combined-cycle natural gas plant actually built in Connecticut starting in 2009, had actual installed costs of roughly $2100 / kW – significantly higher than the EIA estimates.

fuel and O&M costs) are based on the average annual costs over the previous five years.[10]

We also relied upon information from PSNH regarding various costs and related parameters for which PSNH was the only or the most knowledgeable source. In particular, PSNH provided the following information:

- Capital costs, O&M costs and the construction schedule for Merrimack Station and the Scrubber Project;
- Assumed tax rate and costs of equity and debt at Merrimack Station, which are used to calculate the relevant discount rate and allowed return on rate base;
- Capacity price forecasts;
- Forecasts of the costs of property taxes at Merrimack Station;
- Forecasts of year-end fuel inventories at Merrimack Station;
- Natural gas transportation adders for Merrimack Station;
- Estimates of the "sunk costs" that ratepayers would have been responsible for had the Scrubber Project been cancelled at either Analysis Date;
- Assessments of the implications to the Merrimack Station of various potential future environmental regulations.

[10] For both Analysis Dates, the historical period of 2003 to 2007 is used. We did not use 2008 data for two reasons. First, full year 2008 data would not have been available to PSNH until well into 2009. Second, we understand from PSNH that Merrimack Station experienced various one-time outage events in 2008 that would not have reasonably been expected to affect going-forward costs.

V. RESULTS OF OUR ANALYSIS

24. Q. WHAT ARE YOUR CONCLUSIONS REGARDING THE ECONOMICS OF THE SCRUBBER PROJECT?

A. Attachment 12 summarizes the present values of the cost savings of the Scrubber Project relative to the two alternatives. A more detailed set of results is provided in Attachments 13a and 13b for the mid-2008 Analysis Date, and Attachments 14a and 14b for the early-2009 Analysis Date. Positive values indicate that the Scrubber Project Case was the lower-cost alternative, whereas negative values indicate the opposite. Thus the values represent the savings to PSNH ratepayers in each scenario if the Scrubber Project were undertaken relative to each of the two alternatives. Of course, a negative savings indicates that the Scrubber Project would have been viewed as more costly to PSNH ratepayers than the alternative.

For both the mid-2008 and early-2009 Analysis Dates, the Scrubber Project is the low-cost alternative to PSNH ratepayers for many of the scenarios considered. As one would expect, the cost savings of the Scrubber Project relative to alternatives are greater when natural gas plant costs are relatively high and when environmental costs are relatively low. Similarly, the cost savings of the Scrubber Project relative to the alternatives are greater when natural gas and electricity prices are relatively high, which they were in the futures market in mid-2008 and in long-term forecasts in early-2009. The sunk costs of the Scrubber Project were higher in early-2009 than in mid-2008, leading to larger costs for the Natural Gas Plant and Market Purchase Cases and thus greater cost savings for the Scrubber Project.

Our analysis shows that based on the inputs described above, and compared to alternatives of building a natural gas plant or relying on market purchases (alternatives that imply the divestiture or retirement of Merrimack Station), the Scrubber Project was the low-cost alternative for ratepayers for various plausible future scenarios as of both Analysis Dates, with one or the other alternatives having lower costs under some scenarios. Mr. John Reed provides expert testimony on behalf of PSNH regarding the "prudence" standard utilized by utility regulatory commissions throughout the country and provides his opinion on the prudence of PSNH's actions under the Scrubber Law based upon his expertise and relevant information, including the results of our analysis.

VI. QUESTIONS RELATED TO THE TESTIMONY OF ELIZABETH STANTON

25. Q. PLEASE SUMMARIZE DR. STANTON'S ANALYSIS.

A. Dr. Stanton estimated the revenue requirements as of early-2009 of Merrimack Station with the Scrubber Project over the period from 2013 to 2027, including projections of total expenses and a return on the rate base. She calculated "net revenue" by subtracting the discounted revenue requirements of Merrimack Station with the Scrubber Project from the discounted projected revenue from Merrimack Station's electricity output. Dr. Stanton calculated net revenues for five scenarios which differed based on the costs to comply with environmental regulations and the forecasted prices of electricity. Dr. Stanton found that in four of the five scenarios, the net revenue of the Scrubber Project was negative. Based on these results, she concludes that PSNH was imprudent to proceed with the Scrubber Project in early-2009.

26. Q. HOW DOES YOUR METHODOLOGY COMPARE TO THE METHODOLOGY USED BY DR. STANTON?

A. The methodology of Dr. Stanton's analysis is in general quite similar to the methodology of our analysis. We both assess the relative costs of the Scrubber Project by estimating the present value of revenue requirements over the period from 2013 to 2027. Dr. Stanton estimates "net revenue" by comparing projected costs to projected revenue at Merrimack Station, which is conceptually equivalent to the comparison of the Scrubber Project to the "Market Purchase Case" in our analysis. Dr. Stanton does not consider a case in which a combined-cycle natural gas plant is built. While our analysis considers two Analysis Dates (mid-2008 and early-2009), Dr. Stanton considers only early-2009.

27. Q. WHY DO DR. STANTON'S RESULTS DIFFER FROM YOUR RESULTS?

A. As noted above, our analysis shows that the costs of the Scrubber Project were lower than the costs of alternatives in many plausible future scenarios, whereas Dr. Stanton found the "net revenues" of the Scrubber Project to be negative in four out of five scenarios. There are numerous differences between the detailed methodology, assumptions and scenarios chosen for our analyses, but most of these differences have relatively small effects on the results. To explain why Dr. Stanton's results differ, it is useful to focus initially on one key element—the projected costs of CO_2 emissions. In our opinion, the projected costs of CO_2 in Dr. Stanton's analysis are unreasonably high, leading her to overestimate the costs of the Scrubber Project.

28. Q. PLEASE EXPLAIN WHY DR. STANTON'S ASSUMPTIONS ON THE PRICE OF CARBON DIOXIDE EMISSIONS ARE UNREASONABLY HIGH.

A. As explained above, the future regulation of CO_2 emissions in the United States was uncertain in mid-2008 and early-2009. To reflect this uncertainty, we developed two scenarios for the future regulation of CO_2 emissions from Merrimack Station. One scenario assumed relatively lenient regulation, with PSNH continuing to face prices due to the RGGI cap-and-trade program. The other scenario assumed relatively stringent regulation, in which case we assumed that PSNH would be required to have emissions allowances equal to its emissions in accordance with a national cap-and-trade program similar to that being considered by Congress at the time. Independent expectations of allowance prices were available for both scenarios (futures market prices for RGGI, and EIA modeling of the prominent cap-and-trade proposals),[11] and these expectations formed the basis for the CO_2 price inputs to our analysis. The net price of CO_2 emissions to PSNH also depends upon the fraction of allowances that are provided for free under the terms of the legislation.

Dr. Stanton includes CO_2 prices that are significantly higher than prices predicted by contemporaneous studies of the prominent national cap-and-trade proposals, and there is no indication that her prices incorporate the effects of free allowances. Attachment 15 shows the CO_2 price trajectories she used (adjusted to nominal dollars) compared to the values we used in our analysis. All three of her CO_2 price

[11] As noted above, the prominent cap-and-trade bill proposals from 2008 and 2009 contemplated that a certain percentage of allowances would be allocated to fossil fuel electricity generators, with that percentage declining over time. We used the methodology of the Lieberman-Warner cap-and-trade proposal to implement these provisions in our analysis.

scenarios imply much higher CO_2 prices than Merrimack Station would have been likely to face under RGGI. Moreover, her "reference" CO_2 price scenario is a great deal higher than prices based upon modeling of the national cap-and-trade programs that were being considered in this time period (particularly when the effects of free allowances are considered).

The certainty that a stringent national cap-and-trade program would be passed by Congress without any free allowance allocation is not consistent with the expectations of many observers for the prospects of CO_2 regulation in mid-2008 and early-2009. Indeed, when the Senate debated the Boxer-Lieberman-Warner cap-and-trade bill in June 2008, only approximately 40 Senators voiced support for the bill (at a time when 60 votes would have been required for passage).[12] Even after the 2008 election, the global financial crisis and the continued lack of support in the Senate meant that passage of stringent climate change legislation would be difficult to achieve. Thus, it was not a surprise when efforts to pass stringent climate change legislation ultimately failed in Congress in 2009 and 2010. Greenhouse gas emissions from the electricity sector remain largely unregulated by the federal government to this day, although the EPA now intends for such regulation to begin in 2020 (delays could push this date further into the future).

[12] *Overview of U.S. Climate Policy.* Vicki Arroyo, Vice President for Policy Analysis and General Counsel, Pew Center on Global Climate Change, October 2008.

29. Q. HOW ARE THE RESULTS OF DR. STANTON'S ANALYSIS AFFECTED BY HER ASSUMPTIONS ON CARBON DIOXIDE PRICES?

A. To assess the sensitivity of Dr. Stanton's results to the assumptions on CO_2 prices, we inserted our assumptions for RGGI prices ("low") and national cap-and-trade prices ("high") into her Exhibit 2 as substitutes for her "low" and "high" prices, respectively (with the midpoint of our two price forecasts inserted as substitutes for her "reference" case). As noted, our prices incorporate the effects of expected free allocation of allowances under a national cap-and-trade program. We then compared the resulting "net revenues" of the Scrubber Project to Dr. Stanton's original results (leaving all other inputs to her analysis unchanged).

The results are displayed in Attachment 16. In Dr. Stanton's original analysis, four of the five scenarios show negative net revenues of the Scrubber Project. With the CO_2 prices changed to reflect more realistic expectations for CO_2 costs in early-2009, four of the five scenarios show positive net revenues of the Scrubber Project.

30. Q. DOES DR. STANTON'S ANALYSIS INCLUDE OTHER ASSUMPTIONS THAT ARE SIGNIFICANTLY DIFFERENT FROM YOURS?

A. Yes. There are two other important differences between the inputs in our analyses and those of Dr. Stanton: (1) the costs to comply with other (non-CO_2) environmental regulations; and (2) the sunk costs of the Scrubber Project.

31. Q. PLEASE DESCRIBE DR. STANTON'S INPUTS FOR THE COSTS OF COMPLYING WITH OTHER ENVIRONMENTAL REGULATIONS.

A. Dr. Stanton assumed that PSNH was certain to face significant additional capital and O&M costs related to the following regulatory requirements and environmental regulations: (1) activated carbon injection; (2) coal combustion residuals; and (3) effluent limitations. While Dr. Stanton appeared to base her cost estimates for these regulations on what might be required for generic coal power plants, we obtained information specific to Merrimack Station to assess the potential for additional costs related to each of these environmental regulations. This information indicates that Dr. Stanton substantially overstated the likely costs to Merrimack Station associated with these potential environmental regulations.

32. Q. PLEASE DESCRIBE YOUR ASSESSMENT OF DR. STANTON'S INPUTS RELATED TO REGULATIONS OF MERCURY EMISSIONS AND ACTIVATED CARBON INJECTION TECHNOLOGY.

A. Activated carbon injection ("ACI") is a technology used by some coal-fired power plants to reduce mercury emissions. We understand from PSNH that a benefit of the Scrubber Project is that Merrimack Station complies with all relevant mercury standards without the need to install ACI. Indeed, according to PSNH, the Scrubber Project put Merrimack Station in compliance with the subsequent Mercury and Air Toxics Standards ("MATS") Rule finalized by EPA in 2013. Based on a March 2014 report to the Commission by ESS Group[13], we added $360,000 in capital costs and $43,500 in operating costs to our analysis for

[13] ESS Group. *PSNH Asset Environmental Review*. Memorandum from Steve Wood to Dick Hahn. March 31, 2014 (seehttp://puc.nh.gov/Electric/PSNH%20Asset%20Env%20Rpt%2003312014Rev.pdf).

MATS compliance. Of course, this information was not available to PSNH in 2008 or 2009, but we assume it is a reasonable proxy for the minor additional costs that PSNH may have anticipated at the time. Dr. Stanton's estimate of up to $7 million in capital costs and up to $1.4 million in annual operating costs was based on the cost of a technology (ACI) that we understand was not reasonably foreseen as necessary at Merrimack Station to meet air quality regulations.

33. Q. PLEASE DESCRIBE YOUR ASSESSMENTS OF DR. STANTON'S INPUTS ASSUMPTIONS RELATED TO EFFLUENT GUIDELINES AND COAL COMBUSTION RESIDUALS?

A. EPA has recently proposed regulations related to the wastes produced as byproducts of electricity generation at a coal power plant. Coal combustion residuals ("CCR") are the materials that remain after burning coal from electricity (e.g. fly ash, bottom ash, boiler slag). Effluent guidelines are technology standards for wastewater discharges at power plants and other industrial facilities.

Certain coal power plants may expect significant costs from the regulation of CCR or effluent guidelines, which appears to be the basis for Dr. Stanton's estimates of up to $199 million in total capital costs and up to $13 million in annual operating costs to comply with these regulations. However, we understand from PSNH (and the ESS Group report described above) that no significant costs were expected (or are currently expected) for the regulation of CCR or effluent guidelines at Merrimack Station. PSNH recycles as much as 90 percent of the CCR generated at Merrimack Station and does not manage its CCR in traditional wet storage impoundments. In addition, the wastewater treatment facility and systems active at Merrimack Station put the facility in compliance with expected

regulations of effluents. Based on the March 2014 ESS Group analysis, we incorporated capital costs of $100,000 (assumed to be incurred in 2013, to be conservative) and $27,500 in annual operating costs to account for the minor costs PSNH may have anticipated as of the Analysis Dates for additional groundwater quality monitoring.

34. Q. PLEASE DESCRIBE HOW YOUR ANALYSIS DIFFERED FROM DR. STANTON'S IN REGARD TO THE SUNK COSTS OF THE SCRUBBER PROJECT.

A. In her testimony, Dr. Stanton states that none of the major construction contracts were substantially implemented before March 2009 but she acknowledges that provisions in major contracts would require PSNH to make monetary payments to contractors if it were to terminate contracts. These monetary payments would be included in the "sunk costs" of the Scrubber Project at any point in time, since they would be incurred even if the Scrubber Project were terminated. However, Dr. Stanton did not account for these "sunk costs" of the Scrubber Project in her quantitative analysis. As noted above, if the Scrubber Project were cancelled in early-2009, PSNH customers would have been responsible for the costs prudently incurred or committed to the Scrubber Project as of that date. As discussed in Mr. Smagula' s rebuttal testimony, PSNH has undertaken an analysis to estimate these sunk costs, including money already spent and all future unavoidable liabilities for the Scrubber Project for various dates. PSNH concluded that total sunk costs were roughly $142 million as of April 1, 2009. These sunk costs are added to the costs of the Natural Gas Plant Case and Market Purchase Case in our analysis.

35. Q. PLEASE EXPLAIN HOW MODIFIFYING INPUTS RELATED TO NON-CO_2 ENVIRONMENTAL REGULATIONS AND SUNK COSTS WOULD CHANGE THE RESULTS OF DR. STANTON'S ANALYSIS.

A. The assumptions of substantial additional costs of non-CO_2 environmental compliance at Merrimack Station and zero sunk costs of Scrubber Project both lead to higher relative costs of the Scrubber Project in Dr. Stanton's analysis than is justified by the circumstances as of early-2009. Therefore, revising these input assumptions to reflect more reasonable assumptions means that the net revenues of the Scrubber Project would be even more favorable than the results displayed in Attachment 16.

36. Q. DOES DR. STANTON'S ANALYSIS CHANGE YOUR CONCLUSIONS REGARDING THE ECONOMICS OF THE SCRUBBER PROJECT?

A. No. Dr. Stanton performed a similar analysis of the relative costs of the Scrubber Project, using different scenarios and assumptions. When more reasonable assumptions on CO_2 prices are inserted into her model, the results show that the net revenues of the Scrubber Project were positive in four of the five scenarios she considered. These positive estimates would be even greater if appropriate assumptions were made for non-CO_2 environmental compliance costs and the sunk costs of the Scrubber Project as of early-2009. Therefore, when modified to use more reasonable input assumptions, Dr. Stanton's analysis reinforces our conclusion regarding the economics of the Scrubber Project relative to the market alternatives.

VI. QUESTIONS RELATED TO THE TESTIMONY OF MICHAEL HACHEY

37. Q. PLEASE SUMMARIZE THE ECONOMIC ANALYSIS CONDUCTED BY MICHAEL HACHEY OF TRANSCANADA.

A. Mr. Hachey performed a "cost to go" analysis, which he explains is an estimate of the net financial benefits to PSNH ratepayers of the Scrubber Project over its 15-year depreciation schedule. This is similar to the analysis performed by Dr. Stanton. Mr. Hachey's analysis is conducted from the vantage point of mid-year 2008. According to Mr. Hachey, the only significant difference between his inputs and those used by PSNH in its mid-2008 analysis is that Mr. Hachey uses three publicly available natural gas price forecasts from the time period. According to Mr. Hachey's calculations, when these alternative natural gas forecasts are used, the net financial benefits of the Scrubber Project to PSNH ratepayers are negative. Based on these results, he concludes that it was imprudent for PSNH to proceed with the Scrubber Project. (As noted earlier, TransCanada has not provided complete information regarding forecasts of fuel prices during the 2008 to 2009 time period. This information would have been significant in evaluating Mr. Hachey's testimony.)

38. Q. PLEASE DESCRIBE THE SOURCES FOR THE NATURAL GAS PRICE FORECASTS USED BY MR. HACHEY.

A. The price forecasts used by Mr. Hachey are displayed in Attachment 17.

The three forecasts can be summarized as follows:

(1) *EIA forecast*. The Reference Case of EIA's Annual Energy Outlook 2008, which was first published in December 2007.[14]

(2) *Brattle Group forecast.* This forecast was developed for a Connecticut Integrated Resource Plan. It is based on prices from the NYMEX futures market as of September 2007 and long-term growth rates from EIA's Annual Energy Outlook 2007, published in February 2007.

(3) *Synapse Energy Economics forecast.* This forecast was developed as part of the Avoided Energy Supply Costs in New England, 2007 Final Report. It is based on prices from the NYMEX futures market as of May 2007 and long-term growth rates from EIA's Annual Energy Outlook 2007 forecasts.

We have identified two problems with the use of these sources to inform an analysis of the economics of the Scrubber Project: (1) none of the forecasts are contemporaneous to the mid-2008 or early-2009 Analysis Dates; (2) the forecasts do not appropriately reflect the considerable uncertainty associated with the future trajectory of natural gas prices as of the Analysis Dates.

[14] The final Annual Energy Outlook 2008 report was published in June 2008, but the natural gas price forecasts were virtually identical to those in the Annual Energy Outlook Early Release published in December 2007, indicating that the forecast was developed in late 2007.

39. Q. PLEASE EXPLAIN YOUR COMMENT THAT MR. HACHEY'S NATURAL GAS PRICE FORECASTS ARE NOT CONTEMPORANEOUS TO THE ANALYSIS DATES.

A. As noted above, all three forecasts used by Mr. Hachey were developed prior to 2008. As displayed in Attachment 4, natural gas prices nearly doubled between December 2007 and July 2008. A forecast developed prior to this significant change in the market is arguably out-of-date. While it is not unreasonable to continue to use long-term forecasts developed in late 2007 on the presumption that the changes to the market in 2008 might not persist, it is unreasonable to completely ignore the current state of the market and not also consider scenarios that account for the price increases of early-2008.

40. Q. PLEASE EXPLAIN YOUR COMMENT THAT MR. HACHEY'S FORECASTS DO NOT APPROPRIATELY REFLECT THE CONSIDERABLE UNCERTAINTY ASSOCIATED WITH THE FUTURE TRAJECTORY OF NATURAL GAS PRICES?

A. It is clear from Attachment 17 that the three forecasts used by Mr. Hachey are quite similar; each starts around $8 to $9 per MMBtu in 2013 and gradually increases to around $13 to $14 per MMBtu in 2027.

As noted, one of the key principles of evaluating a utility investment is to properly account for the uncertainty in the market. On account of the considerable uncertainty associated with the future of natural gas prices in the mid-2008 time period, it is crucial to consider an appropriately wide range of plausible future natural gas prices.

Attachment 17 shows Mr. Hachey's natural gas price forecasts compared to the range used in our analysis, which includes up-to-date information from futures markets in mid-2008. The range of forecasts used in our analysis is far wider than the range used by Mr. Hachey.

Attachment 17 also displays the June 2008 natural gas price forecasts of Energy Security Analysis, Inc., which were provided to PSNH by TransCanada in this proceeding.[15] Although data is only provided until 2017, this range is even wider than the range used in our analysis.

Viewed in this context, it is clear that Mr. Hachey's three "different" forecasts all describe a very similar future trajectory of natural gas prices and therefore do not reflect the considerable uncertainty in the market in mid-2008.

41. Q. DO MR. HACHEY's NATURAL GAS PRICE FORECASTS PROVIDE A USEFUL BASIS FOR ASSESSING THE ECONOMICS OF THE SCRUBBER PROJECT TO PROCEED WITH THE SCRUBBER PROJECT IN MID-2008?

A. No. By using a narrow range of natural gas forecasts, Mr. Hachey has in effect assumed that as of mid-2008, a particular natural gas price trajectory would occur with certainty. In addition, by using natural gas price forecasts that were all developed prior to 2008, none of Mr. Hachey's forecasts account for the current state of the natural gas market as of mid-2008. We conclude that while Mr. Hachey's analysis may be useful in depicting the costs of Scrubber Project for one

[15] As noted, we asked PSNH to obtain TransCanada's natural gas price projections to provide additional context for the narrow range of prices used by Mr. Hachey. TransCanada instead provided only limited information from third party sources such as Energy Security Group.

plausible future outcome, a far wider range of natural gas price forecasts is required to provide an appropriate analysis to assess the economics of the Scrubber Project.

IX. CONCLUSION

42. Q. DOES THIS COMPLETE YOUR TESTIMONY?

A. Yes, it does.