STATE OF NEW HAMPSHIRE

BEFORE THE PUBLIC UTILITIES COMMISSION

Liberty Utilities Least Cost	**)**	
Integrated Resource Plan	**)**	**Docket No. DG 17-152**
	)	
	)	

DIRECT TESTIMONY OF

PAUL CHERNICK

ON BEHALF OF

CONSERVATION LAW FOUNDATION

Resource Insight, Inc.

SEPTEMBER 6, 2019

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EXHIBITS

I. Identification & Qualifications

Q: Mr. Chernick, please state your name, occupation, and business address.

A: My name is Paul L. Chernick. I am the president of Resource Insight, Incorporated, 5 Water Street, Arlington, Massachusetts.

Q: Summarize your professional education and experience.

A: I received a Bachelor of Science degree from the Massachusetts Institute of Technology in June 1974 from the Civil Engineering Department, and a Master of Science degree from the Massachusetts Institute of Technology in February 1978 in technology and policy.

I was a utility analyst for the Massachusetts Attorney General for more than three years. I was involved in numerous aspects of utility rate design, costing, load forecasting, and the evaluation of power supply options. Since 1981, I have been a consultant in utility regulation and planning, first as a research associate at Analysis and Inference, after 1986 as president of PLC, Inc., and in my current position at Resource Insight since 1990. In these capacities, I have advised a variety of clients on utility matters.

My work has considered, among other things, the cost-effectiveness of prospective new electric generation plants and transmission lines, retrospective review of generation-planning decisions, ratemaking for plants under construction, ratemaking for excess and/or uneconomical plants entering service, conservation program design, cost recovery for utility efficiency programs, the valuation of environmental externalities from energy production and use, allocation of costs of service between rate classes and jurisdictions, design of retail and wholesale rates, and performance-based ratemaking and cost recovery in restructured gas and electric industries. My professional qualifications are further summarized in Attachment PLC-1.

Q: Have you testified previously in utility proceedings?

A: Yes. I have testified over three hundred times on utility issues before various regulatory, legislative, and judicial bodies, including utility regulators in thirty-seven states and six Canadian provinces, and three U.S. federal agencies. This previous testimony has included many reviews of the economics of power plants, utility planning, marginal costs, and related issues.

Q: On whose behalf have you worked?

A: A large percentage of my testimony has been filed on behalf of consumer advocates (e.g., the Massachusetts, New Mexico, Washington, and Illinois Attorney Generals; other official public consumer advocates in Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, Pennsylvania, Illinois, Minnesota, Maryland, Ohio, Vermont, Indiana, South Carolina, Arizona, West Virginia, Utah, District of Columbia, and Nova Scotia; and such non-profit consumer advocates as AARP, East Texas Legal Services, Public Interest Research Groups, Alliance for Affordable Energy, citizens' groups, Ontario School Energy Group, Citizens Action Coalition, and Small Business Utility Advocates). I have also worked for regulatory bodies in Massachusetts, Connecticut, District of Columbia, and Puerto Rico, as well as the Vermont House of Representatives.

The remainder of my clients include investor-owned and municipal utilities, municipalities (New York City, Chicago, Cincinnati, several Massachusetts, New Hampshire and New York towns in various proceedings), large customers, power-plant developers and owners, labor unions, energy advocates and environmental groups.

II. Introduction

Q: On whose behalf are you testifying?

A: I am testifying on behalf of Conservation Law Foundation.

Q: What is the scope of your testimony?

A: I consider the following issues raised in Liberty's Least Cost Integrated Resource Plan (LCIRP), filed on October 2, 2017:

- The role of increased gas penetration in Liberty's load forecast.
- The imprudence of encouraging shifting energy load to gas.
- The uncertainty in future gas use and the resulting risk of commitment to new pipelines.
- The need to consider alternatives to the Granite Bridge Pipeline, the major project in Liberty's LCIRP (and the subject of Docket No. DG 17-198), and the upstream pipeline contracts that Liberty proposes to utilize Granite Bridge.

Q: Please summarize your conclusions and recommendations.

A: Liberty's LCIRP does not advance economically prudent or environmentally sound energy investments, and therefore is not consistent with New Hampshire's planning requirements.

Even with supplementary testimony required by the Commission's finding that the Company's LCIRP filing was incomplete, Liberty does not include an evaluation of alternatives to new natural gas infrastructure investments and commitments that it proposes will be borne by ratepayers.

The plan fails to recognize and incorporate the need to reduce fossil fuel use—including natural gas—to mitigate climate change and pollution impacts.

The plan fails to reasonably address future need in light of the availability of cleaner and lower cost resources, including electricity and high-performance air-source electric heat pumps.

There is significant risk that the plan will result in future stranded costs and higher customer costs, as New Hampshire transitions away from direct use of fossil fuels to cleaner energy resources.

Q: What is the global and national background to local decisions about natural gas use?

A: Natural gas use, in New Hampshire and nationally, must decline if we are to avoid the most severe consequences of global warming, as discussed in the testimony of CLF witness Elizabeth Stanton in this docket. About two dozen US regulatory jurisdictions have recognized this reality by establishing greenhouse-gas reduction targets, including California,[1] Connecticut, Massachusetts, Vermont, Maine, and New York. In order to minimize the economic burden of unsustainable long-term commitments, New Hampshire would be well advised to similarly reflect the carbon-constrained future in current decision-making.

Q: Does Liberty address the greenhouse-gas implications of its planned expansions of gas supply and sales?

A: In a sense. Mr. Killeen basically denies that Liberty needs to think about greenhouse gases at all, because the Company interpret[s] the requirement to assess the LCIRP's "integration and impact on state compliance with the Clean Air Act of 1990, as amended, and other environmental laws that may impact a utility's assets or customers," as required by RSA 378:38, V" in narrow terms:

> The goal of the Clean Air Act of 1990, as amended (the "Act"), is primarily to "curb three major threats to the nation's environment and to the health of millions of Americans: acid rain, urban air pollution, and toxic air emissions." (Killeen Direct at 7:14–20).

[1] Draft Results: Future of Natural Gas Distribution in California, CEC Staff Workshop for CEC PIER-16-011, June 6, 2019, available at https://ww2.energy.ca.gov/research/notices/2019-06-06_workshop/2019-06-06_Future_of_Gas_Distribution.pdf.

> To achieve these goals, and relevant here, the Act "requires states to make constant formidable progress in reducing emissions," through programs and policies that "promote[] the use of clean low sulfur coal and natural gas, as well as innovative technologies to clean high sulfur coal through the acid rain program [and] and create[] enough of a market for clean fuels derived from grain and natural gas to cut dependency on oil imports by one million barrels/day." *Id*.
>
> …the increased use of natural gas will have a positive contribution toward achieving New Hampshire's required emissions levels under the Act. Since the LCIRP describes how the Company can meet its growing customer demand over the planning period, and increased natural gas usage is specifically and favorably referenced in the Act (likely because natural gas most often displaces other more polluting fuels such as oil and propane for heating, as will likely be the case with most of EnergyNorth's new customers), the LCIRP would likely have a positive impact on New Hampshire's compliance with the Act.

Q: Is Mr. Killeen correct that only "acid rain, urban air pollution, and toxic air emissions" matter under the Act, and that the Act does not cover greenhouse gases?

A: No. The Supreme Court addressed a similar issue in the context of EPA's refusal to treat greenhouse gas emissions as pollutants and found that:

> The harms associated with climate change are serious and well recognized. The Government's own objective assessment of the relevant science and a strong consensus among qualified experts indicate that global warming threatens, inter alia, a precipitate rise in sea levels, severe and irreversible changes to natural ecosystems, a significant reduction in winter snowpack with direct and important economic consequences, and increases in the spread of disease and the ferocity of weather events….
>
> Because greenhouse gases fit well within the Act's capacious definition of "air pollutant," EPA has statutory authority to regulate emission of such gases….That definition—which includes "any air pollution agent… including *any* physical, chemical, …substance…emitted into…the ambient air…," §7602(g) (emphasis added)—embraces all airborne compounds of whatever stripe. Moreover, carbon dioxide and other greenhouse gases are undoubtedly "physical [and] chemical… substance[s]."[2]

[2] U.S. Supreme Court, Massachusetts v EPA, Decided April 2, 2007, Docket #05-1120.

The Supreme Court has found that the Act covers greenhouse gases. Mr. Killeen's attempt to rewrite the law is ill-founded.

Q: What portions of the Act was Mr. Killeen quoting in the section of his testimony that you copied above?

A: None that I could find. He cites to an EPA web page that purports to be a summary on the Clean Air Act. Neither Mr. Killeen nor the EPA web page cites to the actual Act. The language that Mr. Killeen cites does not appear in the January 17, 2017 snapshot of the site.[3]

Q: Where does the Act "specifically and favorably reference" increased natural gas usage, as Mr. Killeen claims?

A: He does not cite to the Act. Again, he misrepresents the recent EPA gloss as if it were the Act. I found three references to "natural gas" in Title V of the Act; two were involved in determining allowance assignments, and the third describes extra allowances allocated to a municipal or state utility that "furnishes electricity, electric energy, steam, and natural gas within an area consisting of a city and 1 contiguous county." The closest I find to an endorsement of natural gas is in the definition of "clean alternative fuel" to mean "any fuel (including methanol, ethanol, or other alcohols (including any mixture thereof containing 85 percent or more by volume of such alcohol with gasoline or other fuels), reformulated gasoline, diesel, natural gas, liquefied petroleum gas, and hydrogen) or power source (including electricity) used in a clean-fuel vehicle that complies with the standards and requirements applicable to such vehicle…" (42 U.S.C. §7581; §7554 has similar language with regards to urban buses).[4]

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[3] https://19january2017snapshot.epa.gov/clean-air-act-overview/clean-air-act-text.html.

[4] The Energy Independence and Security Act of 2007 (Title II.A) amended the renewable fuels standards in the Clean Air Act and mentioned natural gas in the contexts of setting efficiency standards for gas-fired ethanol plants and exempting ethanol plants fueled by natural gas or biomass from greenhouse gas emissions standards for a transition period in 2008 and 2009.

Q: Did Mr. Killeen establish that increased gas use will help mitigate New Hampshire greenhouse gas emissions, as required by the Supreme Court's finding that those emissions are covered by the Act?

A: No. He concentrates on criteria pollutants and compares natural gas only to dirtier fuels, not to cleaner electric energy from renewables or even high-efficiency gas. The analysis of "potential environmental, economic, and health-related impacts of each option proposed in the LCIRP" (Killeen Direct Testimony at 12:4–5) remains inadequate.

III. Gas Promotion in Liberty's Load Forecast

Q: What is Liberty's justification for Granite Bridge and the associated supply contracts?

A: Mr. Killeen explains that the Company's claimed need for Granite Bridge arises from forecast load growth:

> Q. Is the Company's existing delivery capacity sufficient to meet the forecasted demand requirements of its customers?
>
> A. No. The Company's design day demand during the planning period will exceed its capacity on the Concord Lateral, and there is no more capacity available on the Concord Lateral…(Killeen Direct at 7:5–8).

He similarly explains that forecast load growth drives the need for the new supply contracts:

> Q. Is the Company's existing gas supply sufficient to meet the forecasted demand?
>
> A. No. Although the Company currently has sufficient supplies to use all the available capacity on the Concord Lateral, the Company does not have the incremental supply to meet the forecasted increase in demand. Specifically, the Company requires incremental supply during the development of the Granite Bridge Pipeline, and to utilize the capacity of the Granite Bridge Pipeline once it is placed into service.

In other words, load growth drives Liberty's case for both Granite Bridge and the new long-term supply contracts.

Q: How much of Liberty's projected load growth would result from its promotion of conversion from other fuels to natural gas?

A: Table 1 reproduces Liberty's forecast based on historical trends (which would include some fuel-switching from other fuels to natural gas) and Liberty's total forecast, including the results of Liberty's fuel-switching efforts.[5]

Table 1: Effect of Fuel-Switching Promotion on Liberty Load Forecast (BBtu)

	Residential		C&I		Total
	Heating	Non-Heating	Heating	Non-Heating	
From LCIRP Table 20: Econometric Demand Forecast					
2017/18	6,025	68	6,242	1,984	14,319
2018/19	6,089	66	6,332	1,979	14,466
2019/20	6,168	64	6,422	1,963	14,617
2020/21	6,235	62	6,484	1,942	14,722
2021/22	6,308	59	6,568	1,922	14,858
From LCIRP Table 23: Demand Forecast Including Promotion					
2017/18	6,302	68	6,670	2,102	15,142
2018/19	6,427	66	6,871	2,119	15,483
2019/20	6,568	64	7,107	2,147	15,885
2020/21	6,733	62	7,375	2,192	16,360
2021/22	6,908	59	7,655	2,228	16,851
Promotional Load Growth					
2017/18	277	-	428	118	823
2018/19	338	-	538	140	1,017
2019/20	400	-	684	184	1,268
2020/21	498	-	891	250	1,638
2021/22	600	-	1,088	305	1,993

Q: Please describe Liberty's promotional efforts.

A: The difference between the model results in LCIRP Table 20 and the enhanced forecast in LCIRP Table 23 is due to the effect of two Liberty programs, as estimated by EnergyNorth's Sales and Marketing Group:

[5]The values in both LCIRP Table 20 (before the load-promotion efforts) and Table 23 (with load promotion) are both prior to the inclusion of energy efficiency.

> Two out-of-model adjustments were made to the econometric forecast to account for additional growth that is not reflected in the historical billing data. Those out-of-model adjustments were related to: (1) expected increases in the number of customers in the Company's existing service territory related to increasing sales and marketing efforts; and (2) estimates of the number of customers in new service territories in which the Company is expanding. (LCIRP, pages 21–22).

The additional natural gas use by new customers resulting from Liberty's planned promotion efforts accounts for 68% of the load growth that Liberty projects over the forecast period. Without these new heating customers, Liberty's forecast would fall from 2.7% annually to 0.9%.

Q: What are the implications of the large role of fuel-switching in Liberty's forecast?

A: If Liberty were not promoting the shifting of customer loads from other fuels to natural gas, its need for additional resources would be dramatically reduced. Liberty's case for acquiring additional gas supplies is driven by Liberty's own plans to increase sales, but Liberty has not shown that such increases in natural gas combustion are in the public interest. Thus, the LCIRP is neither integrated nor least-cost.

IV. Shifting Energy Load Among Fuels

Q: Does Liberty consider whether shifting customer energy use to gas would have environmental effects?

A: Yes, to some extent. That position is presented in the testimony of Paul J. Hibbard, who states that:

> Meeting customer service needs can result in local and regional health impacts. This is because the combustion of fuel to meet home and business heating (and other service needs) is a source of harmful pollutants - including NOx, SO2, PM, Hg, and CO2. CO2 (and other GHGs involved in energy production and use, such as methane) contribute to the risks associated with climate change. The rest of the pollutants can have local and regional impacts, and can lead to or exacerbate premature deaths, asthma, and other major health problems for the state's residents" (Hibbard Direct 23:3-19)

> The use of natural gas to meet [heat, hot water, and cooking] needs can reduce the emissions that otherwise would occur if they were met with alternative fuels. To the extent meeting service needs with natural gas avoids using alternative and higher-emitting fuels, it can reduce public health and environmental impacts. (Ibid, 25:15–26:3)

Q: Do you agree with Mr. Hibbard's assertions?

A: Only partially. The burning of almost any fuel produces pollutants and greenhouse gases. Natural gas burns more cleanly at the burner tip than some other fuels (particularly oil). On the other hand, methane (the major component of natural gas) is a very potent greenhouse gas and contributes much more to climate change than CO_2 per molecule or gram of gas emitted. Depending on the amount of methane leaked to the atmosphere in extraction, processing, transportation and distribution, natural gas can actually result in more global warming per MMBtu of delivered energy than oil.[6]

The only significant sources of mercury (which is the Hg in Mr. Hibbard's list) in energy supply result from burning coal and waste materials. Coal heats only about 0.2% of New Hampshire homes and is vanishing from the New England electric generation system.

Q: Does the Company's witness Killeen also address environmental impacts of natural gas?

A: Mr. Killeen purports to provide the Company's assessment of the environmental, economic and health impacts of the options considered in the LCIRP, but he fails to adequately do so for several reasons.

First, he admits that the company only identified three resource options: two pipeline delivery options and LNG purchases (Killeen Direct at 7). The Company failed to consider additional options to balance natural gas demand and supply, including

[6] Methane gradually breaks down in the atmosphere, to its climate-forcing effects are strongest in the first couple decades after it is emitted. Unfortunately, the next few decades have been recognized as being critical to determining whether the most severe consequences of global warming can be avoided.

suspension of the promotional efforts and enhanced energy-efficiency programs. Nor did the Company test cases with lower demand and smaller supply options. As a result, he simply provides a cursory comparison of these two very limited options, and concludes that of the two, Granite Bridge is superior. He does the same for the gas supply sources, again failing to analyze other available energy resources.

Second, Mr. Killeen makes conclusory statements (without any supporting analysis) about the increased use of gas in the state having positive contributions to achieving selected aspects of the Clean Air Act. As I note above, his argument does not address the breadth or actual language of the Clean Air Act. He also fails to consider any other environmental laws. For these reasons, his testimony does not address the gaps in the LCIRP identified by the Commission.

Q: Is natural gas the preferred energy choice for space and water heating?

A: No. Compared to natural gas combustion at the end use, electricity can provide energy services while emitting less greenhouse gases, so long as it is either (1) sourced largely from renewable resources, including wind, solar and hydro or (2) produced and used in a manner that is more efficient than direct gas use at the end use.

Q: Is electric heat-pump space heating as efficient as gas heating?

A: Yes. Heat pumps are much more efficient than gas furnaces, boilers and water heaters. Modern high-efficiency heat pumps have a seasonal performance factors in the range of 9.5 to 12 Btu/kWh, which means that they provide 2.8 to 3.5 units of usable heat for each unit of input electric energy.[7] In other words, they are 280% to 350% efficient. A very efficient gas furnace or boiler might be in the 90%–95% range. The heat pump is thus three to four times as efficient as the gas space heating appliance. So unless the electricity for the heat pump comes from a mix of power plants that emit three or four times more

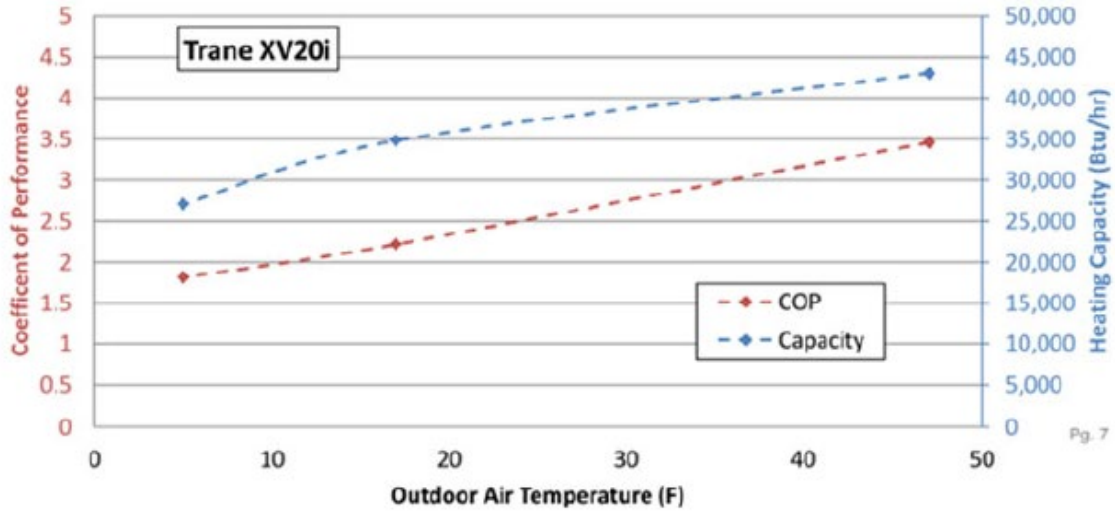
[7] The ratio of heat output to electric energy input is called the coefficient of performance, or COP.

CO_2 than direct gas combustion per unit of energy delivered to the home, emissions will be less with the heat pump than with a gas furnace or boiler. As I show below, the emissions of the New England electric system are far below those levels, so using electricity rather than natural gas will almost always reduce annual carbon emissions.

Q: Is that true for heat-pumps, even at New England winter temperatures?

A: Yes. Figure 1 shows the efficiency and capacity of a relatively inefficient heat-pump (HSPF 10) as a function of temperature. Both the COP and the heating capacity of the heat pump fall at low outdoor temperatures, but at the average January temperature in Manchester, in the low 20s, the COP is still about 2.5.

Figure 1: Example Heat-Pump Efficiency and Capacity[8]



Q: What sources would serve loads shifted to electricity?

A: The emissions associated with electricity depend on the type of generator that provides the energy. Additional wind, solar and hydro added to serve the loads have nearly zero emissions. The New Hampshire RPS requires that 8.8% of energy load be met with Class I non-thermal and Class II renewables in 2019, rising to 13.5% in 2025. Additional New

[8] ACEEE. Field Assessment of Cold Climate Air Source Heat Pumps, Ben Schoenbauer, et al. https://aceee.org/files/proceedings/2016/data/papers/1_700.pdf.

Hampshire electric load would thus be met about 10% with clean resources over the next several years.

The portion of new load that is not offset with new renewable resources is served by the marginal energy supply on the ISO-NE system. According to the 2018 Annual Markets Report from the ISO Internal Market Monitor (May 23, 2019), the real-time marginal energy supply was from natural gas over 70% of the time, with nearly another 20% from pumped storage (which generally would be refilled by energy from natural gas) and 2% from other hydro (which was probably be mostly storage hydro that would otherwise have saved the water to generate at a later hour, competing displacing gas). The remaining 7% or so of marginal supply was provided by about equal parts oil, coal, wind, and unspecified. New England coal is rapidly being retired.

Hence, the energy for a marginal electric load, like a new heat pump, would come mostly from clean renewables or from natural gas.

Q: Will coal continue to be a significant contributor to New England electricity supply?

A: No. Since 2011, about 66% of New England coal capacity has retired. The largest remaining coal unit, Bridgeport Harbor 3 (42% of the remaining capacity), is committed to retire in 2021, while Schiller 4 has not cleared in the capacity market for 2021/22 or 2022/23 and Schiller 6 has dropped from clearing its full 47.8 MW for 2020/21, to 30 MW in 2021/22 and 14.5 MW in 2022/23. Schiller 4 and 6 have been running at very low capacity factors (8% and 7% in 2017, 11% and 15% in 2018, 6% and 8% in January–May 2019), which are unlikely to cover the costs of keeping them in service. Once those three units are gone, New England will be left with only Merrimack 1 and 2, which have run very little in recent years: 9% and 5% in 2017, 17% and 13% in 2018, and 14% and 8% so far in 2019. Since the first part of the year includes most of the winter conditions in which coal and oil plants are most likely to operate, the decline in operation from the

coal plants is even more striking. Output for the first five months is down 54% from 2018 to 2019 for Merrimack 1, 63% for Merrimack 2, and 67% for Schiller 4 and 6.[9]

Q: How do the emissions from natural gas combustion for electricity compare to the emission from natural gas combustion for space heating?

A: From the EIA 923 database for 2018, I calculate that the average natural gas heat rate (MMBtu of fuel per MWh of output) for New England was 7.4 MMBtu/MWh, or 46% efficient. Some of the energy generated is dissipated as heat in the transmission and distribution system, and the marginal gas heat rate may be higher than average heat rate, but the delivered efficiency is still over 40%. So long as the electricity is converted to heat at an efficiency of more than about 2.5 (= 95% high-efficiency gas boiler ÷ 40% generation and T&D efficiency), electric space heating uses less gas than highly efficient direct gas combustion at the end use. Since some 10% of the electric energy would be from clean renewables, the gas used for electric heating would be less than that for gas heating, at an even lower electric space heater efficiency.

Q: How does that comparison work out for water heating?

A: Heat-pump water heaters (HPWH) are less efficient than heat-pump space heaters. A 2016 report of HPWH performance in the Northeast, presumably using a mix of older heat pumps, reported both rated Efficiency Factor (measured using a particular set of temperature and usage parameters) and measured coefficient of performance (COP) in Massachusetts and Rhode Island.[10] Table 2 shows the results of those studies, along with an extrapolation to current EF ratings.

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[9] The poor performance of Merrimack is not surprising, since its operating costs (just fuel and O&M from the FERC Form 1, p. 402, excluding capital additions and overheads, such as insurance, taxes, and employee benefits) were 9.0¢/kWh in 2016, 11.5/kWh in 2017, and 14.9¢/kWh in 2018. Schiller 4 and 6 were reported with wood-fired Schiller 5 in PSNH's FERC Report, so I do not have similar data for those units.

[10] Field Performance of Heat Pump Water Heaters in the Northeast, Carl Shapiro and Srikanth Puttagunta, Consortium for Advanced Residential Buildings, National Renewable Energy Laboratory, February 2016, available at https://www.nrel.gov/docs/fy16osti/64904.pdf.

Table 2: HPWH Efficiency

Model	Capacity (gal)	pre-2016 Rated Energy Factor *a*	pre-2016 Average New England COP *b*	2019 Rated Energy Factor *c*	2019 Extrapolated New England COP *d*
GE	50	2.35	1.82	3.25	2.52
A,O. Smith	60/80	2.33	2.12	3.24	2.95
Stiebel Eltron	80	2.51	2.32	3.05	2.82

a Shapiro and Puttagunta, Table 3
b Shapiro and Puttagunta, Table 1
c https://mozaw.com/heat-pump-water-heater-reviews/
d b ÷ a × c

Gas-fired water heaters have rated efficiencies of 0.65 to 0.93.[11] So electric heat-pump water heating is 2.7 times as efficient as gas water heating (comparing the best gas storage water heater to the worst HPWH in Table 2), so less gas is used for HPWH than for the best gas water heaters. And as more of the electric supply is provided by renewables over time, the advantage of the electric equipment increases.

Q: What are the implications of the higher efficiency of electricity, as opposed to direct gas combustion, for space and water heating?

A: Since using electricity reduces gas use, it reduces greenhouse gas emissions, reduces pollutants (assuming the same emissions per therm burned), and could help relieve regional concerns about winter availability of gas capacity and supplies by freeing up space in existing pipelines to deliver gas to gas-fired generators in New England. In addition, since the gas-fired generation has emission controls and closer operational control than gas-fired end-use appliances, the emissions per therm from the power plants will tend to be lower than emissions from the gas appliances, and whatever pollutants are released are not in buildings or as near them as for gas appliances.

[11] https://www.energystar.gov/productfinder/product/certified-water-heaters/.

Q: Does electricity have advantages over natural gas in terms of pollutants, other than greenhouse gases?

A: Yes. Natural gas combustion emits NOx, CO, and (depending on combustion conditions) particulates. Burning gas for space heating, water heating and clothes drying emits the pollutants close to occupied building space (or in it, if the equipment is not working properly), while gas cooking emits pollutants inside those buildings. Non-combustion renewables produce none of those pollutants. Burning gas to produce electricity is not benign, but it produces little CO or particulates, and most gas-fired power plants have controls to reduce NOx emissions. And whatever NOx is emitted by electric generation is not in (or usually adjacent to) occupied buildings.

Q: Has electricity always been preferable to direct fossil-fuel heat sources environmentally or in terms of efficiency, for New England energy users?

A: No. In the late 1980s and early 1990s, I testified to the economic and environmental benefits of switching New England electric end-uses to burn gas.[12] At that point, the New England electric system was largely fueled with high-sulfur heavy fuel oil, which produced much more CO_2, sulfur, NOx, particulate and other pollutants than modern gas-fired combined-cycle units. Solar and wind were not significant parts of the incremental power supply, and renewable portfolio standards were not yet in place. In addition, cold-climate heat pumps had not been developed, so electric heating used much more energy than today's new efficient heating systems.

[12] Any gas appliances installed as a result of those analyses would be nearing the end of their useful lives.

Q: Are cold-climate heat pumps economically competitive with oil heat, from the consumer's perspective?

A: Yes. Several analyses have found that the lifecycle costs of heat pumps are lower than those of oil and propane heat.[13]

Q: Have other jurisdictions determined that fossil end uses should be shifted to high-efficiency electric equipment?

A: Yes. For example, the Draft 2019 New Jersey Energy Master Plan found that:[14]

> Over the next ten years, the state should prioritize buildings with the lowest cost, and the most pollution, for electrification by incentivizing electrification for existing oil or propane-fueled buildings. NJBPU should also provide incentives for natural gas-fueled properties to transition, as well as *terminate existing programs that incentivize the transition from oil heating systems to natural gas heating systems.* (emphasis added)

> **Goal 4.2.1: Incentivize transition to electrified heat pumps, hot water heaters, and other appliances**. New Jersey should prioritize buildings with oil and propane heating systems for electrification given the cost benefits and pollution reduction potential. … In addition, since the heat pump can also provide high-efficiency air conditioning, there is also an electricity savings. NJBPU should develop a program to ease the financial burden of making this one-time upgrade.

> Prioritizing the transition away from oil and propane for residential and commercial buildings is an aggressive but achievable goal with a low-cost impact and a noticeable gain in carbon reductions. It will also set the stage for the more complicated transition away from natural gas in the out years.

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[13] See, *e.g.,* Energy Savings, Consumer Economics, and Greenhouse Gas Emissions Reductions from Replacing Oil and Propane Furnaces, Boilers, and Water Heaters with Air-Source Heat Pumps, Steven Nadel, July 2018, American Council for an Energy-Efficient Economy, Report A1803, available at https://aceee.org/research-report/a1803; Ductless Heat Pump Meta Study, Faesy, R., et al, Northeast Energy Efficiency Partnerships, November 13, 2014, available at https://neep.org/neep-ductless-heat-pump-meta-study-report.

[14] Draft 2019 New Jersey Energy Master Plan, Policy Vision to 2050, June 10, 2019. "statewide, multi-agency effort is led by New Jersey Board of Public Utilities (NJBPU)." https://nj.gov/bpu/pdf/publicnotice/EMP Press Release 610_Revised.pdf.

> Additionally, NJBPU should offer financial incentives for natural gas-heated properties to upgrade to electric heating and cooling now, and *ramp down approval of new subsidies that incentivize building owners to retrofit from oil heating systems to natural gas heating systems*. ,,, (emphasis added)
>
> **Goal 4.2.2: Develop a transition plan to a fully electrified building sector…**. It is expected that heat pumps will become more economically attractive in colder regions as technology continues to improve and becomes more efficient. …NJBPU expects that beyond 2030, state policy will have to aggressively target existing natural gas-heated buildings.
>
> An interagency task force should be established to work in close coordination with relevant stakeholders to establish a roadmap through 2050 that transitions existing building stock away from fossil fuels.[15]

Analysis for the California Energy Commission found that "Building electrification was shown to be one of the lower cost GHG mitigation strategies." "Replacing gas equipment with electric equipment upon burnout lowers the societal cost of achieving California's climate policy goals."[16]

The Massachusetts Comprehensive Energy Plan repeatedly cites the benefits of "fuel switching, both electrification and biofuels" and recommends in "Policy Priorities and Strategies" that the Commonwealth "Increase electrification of the thermal sector by providing program incentives for air source heat pumps for heating. Promote fuel switching in the thermal sector from more expensive, higher carbon fuels to lower cost, lower carbon fuels such as electric air source heat pumps and biofuels."[17] The Plan also finds that "the Aggressive Conservation and Fuel Switching scenario most significantly reduces 2030 greenhouse gas emissions" and also produces the lowest household energy costs.

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[15] Draft NJ EMP at 71–72.

[16] Aas, D, et al, Draft Results: Future of Natural Gas Distribution in California, CEC Staff Workshop for CEC PIER-16-011, Energy and Environmental Economics, June 6, 2019), available at https://ww2.energy.ca.gov/research/notices/2019-06-06_workshop/2019-06-06_Future_of_Gas_Distribution.pdf, at 3, 6.

[17] Massachusetts Comprehensive Energy Plan, Commonwealth and Regional Demand Analysis, Massachusetts Department of Energy Resources, December 12, 2018, available at https://www.mass.gov/files/documents/2019/01/10/CEP%20Report-%20Final%2001102019.pdf.

The Québec 2030 Energy plan shows electricity backing out oil and coal, without expansion of natural gas use.[18]

The New York PSC approved a Con Edison proposal to avoid a pipeline expansion by, among other things, accelerating gas energy-efficiency efforts and shifting gas and oil heating load to electric heat pumps:[19]

> The planned programs …include the installation of: (1) ground-source heat pumps at 8,800 single-family residences in Westchester County; (2) air-source heat pumps at over 1,000 small and mid-sized multi-family buildings that currently use fuel oil for heating in the Bronx and other areas of the Company's natural gas service territory; and, (3) heat pumps to pre-heat boiler return water at more than 1,000 small commercial and large residential facilities throughout the Company's natural gas service territory.[20]

Even in Con Edison's territory, with very high costs for electric energy, generation capacity and transmission and distribution capacity, the heat pump program was expected to have a benefit-cost ratio of 1.7.[21]

Q: What lessons do you draw from these four jurisdictions?

A: Jurisdictions that have thought through the process of addressing the environmental and economic impacts of energy supply and investments, to get to a post-carbon energy economy have concluded that efforts to increase natural gas use should end and that fossil end uses (including gas) should be shifted to electricity. New Hampshire would almost certainly reach the same conclusion if it were to model a future with major carbon emission reductions.

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[18] https://mern.gouv.qc.ca/english/energy/strategy/pdf/Highlights-The-2030-Energy-Policy.pdf.

[19] Many of the oil-heated building would be required to switch fuels by 2030. NY PSC Case 17-G-0606, Petition of Consolidated Edison Company of New York, Inc. for Approval of the Smart Solutions for Natural Gas Customers Program, Order Approving with Modification the Non-Pipeline Solutions Portfolio, February 7, 2019.

[20] *Id.*

[21] *Id.* at 8.

Increasing natural gas use, and committing to long-term contracts to support increasing (or even current) gas loads, will just increase the cost of transitioning away from fossil fuels.

V. Risks of Pipeline Commitments

Q: To what risks are ratepayers exposed as a result of Liberty investing in a major supply pipeline?

A: Liberty has not demonstrated that the planned investments and commitments will be beneficial to customers, even in the near term. There is a significant risk that the resources will not remain economic through their expected terms of service. The Granite Bridge Pipeline would be in place and available for several decades, with maintenance expenditures and investments that will need to be recovered from ratepayers, but Liberty is unlikely to need the delivery capacity for very long, leaving its customers vulnerable to having to pay for stranded assets.

Q: Have other jurisdictions recognized the likelihood that natural gas use must decline?

A: Yes. In California, analysis of options for meeting greenhouse gas goals found that the least-cost pathway would require a relatively rapid transition of new and replacement heating equipment to electricity. Even once the vast majority of new equipment installed in homes and businesses is electric, the slow turnover in appliances means that many gas furnaces, once installed, are likely to operate for decades longer, as illustrated in Figure 2.

Figure 2: Projected California Residential Heating Transition[22]

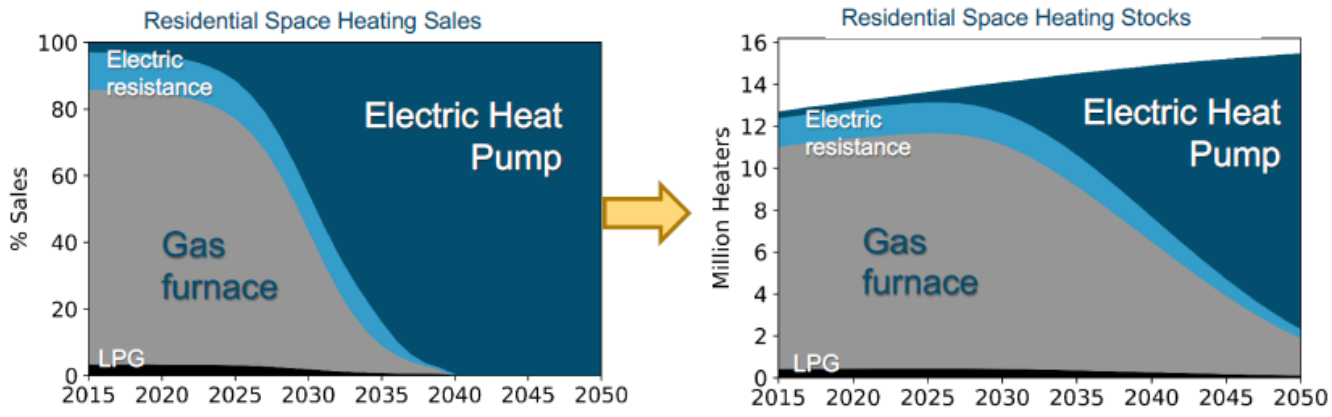
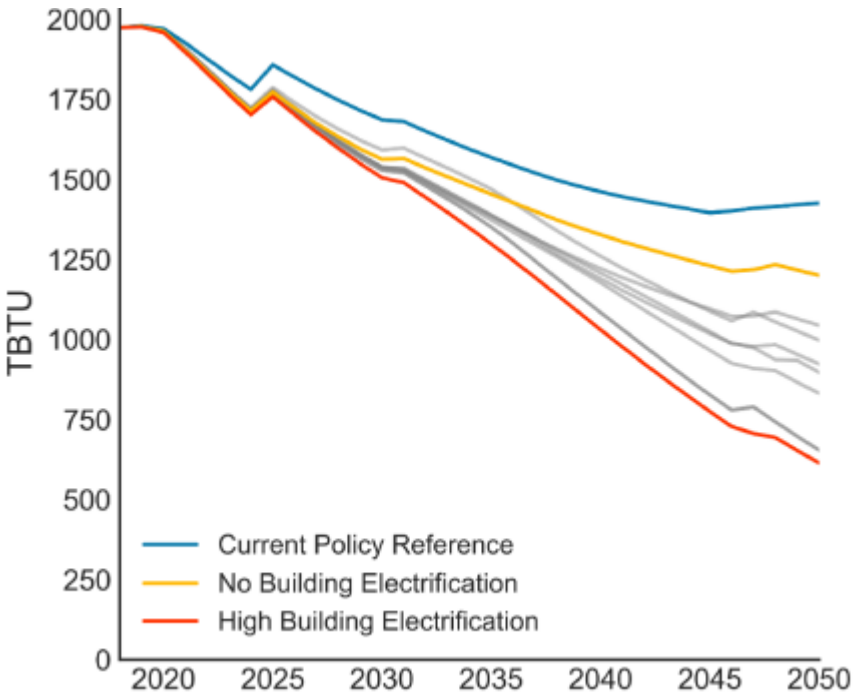


Figure 3 shows the projected deliveries of natural gas (along with biogas and other renewable gas) under the range of approaches considered in the study. The High Building Electrification case is the lowest-cost option.

Figure 3: California Gas Distribution Futures[23]



[22] Aas, et al., 2019 (op cit) at 48.

[23] Aas, et al., 2019 (op cit) at 52.

Q: How are these California results relevant to New Hampshire?

A: New Hampshire's climate and energy use mix differ from California's, so the optimal decarbonization trajectory will not be identical for the two states. But the general relationships are likely to be similar. A low-carbon future for New Hampshire and the region requires replacement of fossil-fueled space-and water-heating with electric appliances, as well as increased energy efficiency.

Q: What would a shorter useful life of Granite Bridge Pipeline mean for Liberty and its customers?

A: Either the near-term recovery of the pipeline cost would need to be accelerated, such as through a higher depreciation rate, or Liberty and the Commission will need to deal with recovering the stranded costs in the out years, spreading the costs over a falling sales base. The same would be true for associated supply contracts that are no longer needed or economic as regional gas load falls; Liberty would need to accelerate contract cost recovery through creation of a regulatory liability, creating a fund to pay down contract costs in the last years of the contract, rather than burdening the declining customer base with the full annual costs of the contracts.

Q: If Liberty does not need its full contract capacity during the life of the new supply contracts and the Granite Bridge Pipeline, could Liberty balance its supply by allowing other contracts to expire?

A: Yes, but at a significant cost. As Liberty witness William Killeen says, "The Company's existing gas supply portfolio consists of various legacy contracts for pipeline capacity and storage that can move gas to the Company's city gates along the Concord Lateral. Bates 038–041. These existing contracts have favorable terms that could not be obtained in today's market." (Killeen Direct Testimony at 8:12–15) So ratepayers would be stuck paying for the new supply contracts and Granite Bridge, while giving up lower-cost existing contracts.

Q: Are there regulatory precedents for these situations?

A: Yes. A number of electric utilities have found that continued operation of their coal plants—which were typically being depreciated over a 60-year life—would be uneconomic in the near future. For example, a plant might be 30 years old, with its original investment half depreciated and subsequent capital additions (for example, for environmental retrofits, perhaps including some very recent ones). When the falling cost of renewables and market power prices means further operation would increase rates, the utility is faced with a decision as to how to recover the remaining investment. Some utilities have accelerated the depreciation of these plants in their final years, while others have promptly retired the uneconomic assets and requested recovery of the investment balance through a regulatory asset. In either case, customers wind up paying more than if the utility had never built the plant or had retired it prior to large recent retrofits. The same was true for the above-market power purchases at the time of restructuring; there is a substantial risk of similar outcomes for new long-term gas contracts and pipeline construction.

VI. Alternatives to the Granite Bridge Pipeline

Q: What alternatives does Liberty have to balance load and capacity, without prohibiting new gas uses?

A: Most of the demand growth that Liberty has proposed would be eliminated by ceasing Liberty's efforts to promote new gas space and water heating (and some other end uses). For meeting the remainder of the load, above current supply, Liberty's options include energy conservation, including facilitating the penetration of heat pumps; a limited expansion of LNG supply in its service territory as needed to cover needle peaks; and (if necessary during a transition period) limited imports of LNG. The LCIRP notes that Liberty has been purchasing LNG and associated vapor from ENGIE.

A. Energy Efficiency

Q: Does the LCIRP include an aggressive energy-efficiency effort?

A: No. The LCIRP shows only minimal amounts of energy-efficiency load reductions. Table 3 shows the energy-efficiency savings that Liberty reports in its load forecast. LCIRP Table 24 subtracts the energy-efficiency column from the total pre-efficiency forecast to derive the total net forecast, so the data must be cumulative. Hence, I added a column for the incremental energy-efficiency savings in each year.

Table 3: Energy-efficiency Savings in Liberty LCIRP Forecast (BBtu)

Year	Pre-Efficiency Forecast	Energy Efficiency	Forecast net of Energy Efficiency	New Energy Efficiency	Energy Efficiency as % Load
	a	b	c	d	e
2017/18	15,142	108	15,034		
2018/19	15,483	114	15,369	6.2	0.04%
2019/20	15,885	122	15,763	8.2	0.05%
2020/21	16,360	127	16,234	4.7	0.03%
2021/22	16,851	131	16,720	3.9	0.02%

a, b, c LCIRP Table 24 MMBtu ÷ 1,000
d *b* minus *b* previous year
e *d* ÷ (*a* - *b* previous year)

Q: How do the forecast energy efficiency savings compare to Liberty's reported past energy efficiency savings?

A: Table 4 shows the historical energy efficiency savings that Liberty claims for each year, from LCIRP Appendix 2, Table 2-1. Liberty describes these as annual savings, and they bounce up and down, so they appear to be the new savings each year.

Table 4: Historical Energy-Efficiency Savings in Liberty LCIRP (BBtu/year)

Year	Annual Savings
2003	38
2004	73
2005	76
2006	84
2007	153
2008	97
2009	121
2010	78
2011	76
2012	148
2013	115
2014	117
2015	144
2016	110
Cumulative	1,430

Liberty witness Eric M. Stanley provides an estimate of Liberty's 2018 incremental annual savings of 130 BBtu, or 0.73% of 2018 sales.

Q: Does Liberty explain why it projects its savings to fall from about 100 BBtu/year annually to less than 10 BBtu, as you compute in Table 3?

A: No.

Q: You assumed that the energy-efficiency values in your Table 3 and LCIRP Table 24 are cumulative values from some unspecified starting year. Is it possible that Liberty intended that those values be interpreted as incremental annual savings, as in LCIRP Table 2-1?

A: That interpretation would mean that Liberty incorrectly computed the post-energy-efficiency forecast in LCIRP Table 24. Table 5 computes the net-of-energy-efficiency forecast, assuming that Liberty intended the energy-efficiency values in LCIRP Table 24 to be annual.

Table 5: Alternative Interpretation of Liberty LCIRP Energy-efficiency Savings (BBtu)

Year	Pre-Efficiency Forecast	Annual Energy Efficiency	Cumulative Energy Efficiency	Forecast net of Energy Efficiency	Energy Efficiency as % Load
	a	*b*	*c*	*d*	*e*
2017/18	15,142	108	108	15,034	
2018/19	15,483	114	222	15,261	0.7%
2019/20	15,885	122	344	15,541	0.8%
2020/21	16,360	127	471	15,889	0.8%
2021/22	16,851	131	602	16,249	0.8%

a, b Table 24
c *b* plus *c* previous year
d *a* minus *c*
e *d* ÷ (*a* - *c* previous year)

This correction would reduce the forecast for 2021/22 by 471 BBtu, or 28% of the post-energy-efficiency forecast load growth from Table 3.

Q: If this interpretation of Liberty's energy efficiency plan is correct, what would be the effect of this energy efficiency plan on the load forecast without Liberty's vigorous fuel-switching plans?

A: Table 6 subtracts the cumulative energy-efficiency savings (under the alternative interpretation in Table 5) from Liberty's load forecast without the promotional program, from Table 3.

Table 6: Liberty Forecast without Promotion (BBtu)

	Pre-Efficiency Demand	Post-2016/17 Efficiency	Post-Efficiency Demand
2017/18	14,319	108	14,211
2018/19	14,466	222	14,244
2019/20	14,617	344	14,273
2020/21	14,722	471	14,251
2021/22	14,858	602	14,256

Eliminating the promotional efforts and maintaining the energy-efficiency savings would essentially eliminate Liberty's load growth.

Q: Are Liberty's energy efficiency programs particularly aggressive?

A: No. Taken literally, LCIRP Table 24 reports very small savings. Under the alternative interpretation, Liberty would be conserving 0.7% or 0.8% of energy use annually, just about enough to offset non-promotional load growth, and the LCIRP load forecast would need to be adjusted downward. Mr. Stanley's testimony supports that alternative interpretation, that Liberty intended to include much more energy efficiency in its forecast.

The Massachusetts Joint Statewide Electric and Gas Three-Year Energy Efficiency Plan 2019–2021 (October 31, 2018) includes gas savings of 1.25% of statewide sales.[24] The most recent ACEEE scorecard (which analyzes 2017 savings) shows gas savings of 1.35% of sales in Minnesota, 1.1% in Massachusetts, and 1% in Rhode Island and Michigan. It appears likely that Liberty could do more, cost-effectively, than the 0.8% it reports in the LCIRP.[25]

Q: Does Liberty witness Stanley's testimony address the failures of the LCIRP to adequately consider demand-side alternatives?

A: No. Mr. Stanley largely defends the Company's current gas efficiency programs, which are approved in a separate docket. While those programs might well be the most cost-effective programs to meet the state's minimum Energy Efficiency Resource Standard, Liberty has failed to consider whether additional cost-effective demand-side programs warrant investment as a more prudent way to meet its customers' needs in the future. Indeed, my understanding is the LCIRP law includes a hierarchy of resources that places demand reduction and energy efficiency at the top. Mr. Stanley's supplemental testimony fails to address whether enhanced demand reduction would contribute to reducing the cost of balancing supply and demand.

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[24] http://ma-eeac.org/plans-updates/.

[25] https://aceee.org/research-report/u1808

B. LNG

Q: Does New England have adequate LNG import capacity?

A: Yes. The Liberty LCIRP notes as much:

> Although the New England region continues to have certain volumes of imported LNG, those volumes have been variable and are becoming winter season focused. …[T]he two off-shore LNG importation facilities (i.e., Northeast Gateway and Neptune LNG) had limited activity since commencing service in 2009 and 2010, respectively, and ENGIE's Distrigas LNG facility has experienced a declining trend in LNG import volumes since 2009. (LCIRP, p. 45)

> The volume of LNG imported into the region is influenced by various factors, including…the need for the New England market to pull the supply by contracting for imported LNG volumes." (LCIRP, p. 46)

While the LCIRP may be painting the lack of demand for LNG in the New England market as some sort of problem, it is in fact an advantage for gas buyers, since import (and associated storage) capacity is readily available.

By the end of 2018, domestic gas liquefaction and shipping capacity, along the Gulf and the Southeast, was expected to more than double in 2019, from 4.9 Bcf/day to about 10 Bcf/day.[26] As of July 31, 2019, 13 Bcf/day of supply was in operation, in commissioning or under construction.[27] Additional LNG supply is under construction in Canada, Australia, Indonesia, Russia, Mozambique, Malaysia, Senegal and Argentina, with more projects proposed.[28]

If New England needs some supplemental gas, before the regional transition to electricity reduces gas load below the capacity of the existing pipeline system, LNG should be available. Of course, LNG is still natural gas, with its carbon emissions from

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[26] https://www.eia.gov/todayinenergy/detail.php?id=37732.

[27] https://www.eia.gov/naturalgas/U.S.liquefactioncapacity.xlsx.

[28] https://www.igu.org/sites/default/files/node-news_item-field_file/IGU%20Annual%20Report%202019_23%20loresfinal.pdf.

combustion and methane emissions from leaks, so New England should not be planning on using large amounts of LNG for the long term. However, using small amounts of LNG in the near term would avoid the build-out of infrastructure and associated capacity contracts that lock in high costs to consumers, with a substantial risk of eventually being stranded costs.

VII. Conclusions

Q: Please briefly summarize your recommendations.

A: Liberty's LCIRP and supplementary filings are not consistent with New Hampshire's planning requirements, failing to include the necessary analysis of very real alternatives to new natural gas infrastructure projects that the Company insists are the only options for meeting Liberty's need to balance supply and demand.

The LCIRP fails to assess how Liberty can meet future needs through cleaner and lower cost resources that are currently available, including electric options such as high-performance air-source electric heat pumps. That approach is becoming common throughout North America.

If Liberty's proposed supply plan is implemented, there is significant risk that it will result in future stranded costs and higher customer bills, as New Hampshire customers transition away from fossil fuels to cleaner electric resources, but continue to pay for imprudent natural gas investments far into the future.

Q: Does this conclude your testimony?

A: Yes.