STATE OF MAINE
PUBLIC UTILITIES COMMISSION

NORTHERN UTILITIES, INC. D/B/A UNITIL	)	
	)	Docket No. 2019-00101
Request for Approval of Precedent Agreements for Westbrook Xpress Phase III Project	)	

DIRECT TESTIMONY OF

PAUL CHERNICK

ON BEHALF OF

CONSERVATION LAW FOUNDATION

RESOURCE INSIGHT, INC.

AUGUST 13, 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, and 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 Exhibit 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 related to the request of Northern Utilities Inc. d/b/a Unitil to commit to 15-year gas supply contracts on the Westbrook Xpress (WXP) and other facilities, including the winters of 2022/23 through 2037/38:

- Unitil's proposal to increase its commitments to importing gas and to increase customer gas use is inconsistent with Maine's statutory carbon emissions reduction targets and commitment to high-performance air-source electric heat pumps.
- Electricity is preferable to natural gas as an energy source to displace oil, especially for space and water heating.
- Future gas use is uncertain, and a commitment to long-term gas-supply contracts nearly two decades into the future exposes customers to unnecessary risks.

III. Unitil's Forecast of Gas Needs

Q: What is the basis of Unitil's forecast of its gas requirements?

A: The case for Unitil's need for the proposed contracts is based on "an updated long-term forecast prepared for the pending 2019 Integrated Resource Plan" (Application, p. 18). The 2019 IRP forecast is driven by population and trend variables. The forecast is only minimally documented, but IRP Appendix 1 provides enough information to determine the following for the Maine forecast:

- The forecast of residential customer number is based on just four years of data, from February 2015 to March 2019.
- The forecast of residential customer number is driven by Population × Trend, so that:
    - Every additional unit of TREND increases customer count by 5.6% of the POPULATION.[1] Unitil never defines the TREND variable (other than as a "linear trend"), but the forecast of high-load-factor customers indicates that TREND is counted in months.[2] So the forecast customer count is driven upward by that 5.6% of POPULATION every month. Nor does Unitil provide the current or forecast POPULATION.
- Every additional unit of POPULATION increases customer count by 5.6% of the TREND variable in that year. Since we do not know how Unitil defined TREND, that might mean 5.6% of the number of months since January 2015, or since 2000, or something else.
- The forecast of residential use per customer is based on only a few more months than customer number, and the time trend is based on data only from November 2017 to February 2019, or just two winters. As shown in IRP Table IV-13, weather-normalized use per LLF customer fell by an average of 0.3% annually; whereas Unitil's decision to use data from only the last 16 months resulted in a forecast that rises 1.6% annually.

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[1] Each month after April 2018 adds an additional 0.94 customers.

[2] The regression for Maine HLF customers shows 1.00 customers being added per unit of TREND. Table IV-14 of the IRP shows alternating annual increases of 12 HLF customers, which is consistent with TREND being monthly.

- The forecast of low-load-factor customer count is structurally similar to the forecast of residential customers, including the use of the POPULATION and TREND variables.
- The forecast use per low-load-factor customer is based on a time trend from the winters of 2015/16 to 2018/19.
- The forecast for high-load-factor customers assumes that one of these customers will be added for each TREND interval, and that usage per customer will not show any time trend.[3]

Q: Do the trends in Unitil's Maine gas sales over the last few years reflect a marketing effort by Unitil?

A: Yes. Unitil has been extending its gas service area and encouraging customers to convert to natural gas, mostly from oil-fired space and water heating.[4]

Q: Does Unitil encourage any improvements in building or equipment efficiency as part of a gas conversion project?

A: Not that I can tell. In addition to not encouraging efficiency, Unitil has a program to rent conversion burners to customers who convert their oil heating to natural gas.[5] Since the boiler or furnace is not designed for natural gas, and may be old, the oil equipment with the gas conversion burner will tend to be rather inefficient, especially compared to new heating equipment designed to

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[3] The forecast in Table IV-14 of the IRP shows a pattern of alternating small increases and declines, apparently due to the auto-regressive terms. Usage per customer appears to be converging on about 23,670 therms, roughly equal to the highest historical value.

[4] *See, e.g.*, https://unitil.com/saco and https://unitil.com/switch/.

[5] *See, e.g.*, https://unitil.com/naturalgas/.

burn gas in the first place and compliant with current efficiency standards, let alone high-efficiency gas boilers or furnaces.[6]

Q: What is the relevance of Unitil's expansion efforts and its load forecast to this application for increased gas supply?

A: Unitil projects that its customer counts and total loads will grow, essentially because they grew in the last few years, which I interpret as being due to the extension of service to new areas and the connection of new customers, including customers converting space and water heating from oil to natural gas. Unitil continues to seek to expand its gas distribution, so as to deliver more gas to customers who could be served instead by high-efficiency electric equipment.

IV. Targets for Reducing Greenhouse Gas Emissions

Q: What is the environmental and policy background to decisions about natural gas use?

A: Natural gas use, in Maine and nationally, must decline if we are to avoid the most severe consequences of global warming. In 2018—a year of record-breaking weather extremes[7]—the Intergovernmental Panel on Climate Change released a report linking human-caused climate change to wide-ranging impacts on natural and human systems.[8] The report emphasized that "[f]uture

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[6] https://unitil.com/switch/.

[7] *See, e.g.*, NOAA National Centers for Environmental Information, State of the Climate: Global Climate Report for Annual 2018, published online January 2019. Available at https://www.ncdc.noaa.gov/sotc/global/201813.

[8] International Panel on Climate Change, Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global

climate-related risks depend on the rate, peak and duration of warming."[9] Climate-related risks are projected to be higher in scenarios assuming global warming of 2º Celsius than in scenarios with global warming of 1.5º Celsius.[10] Climate mitigation to reduce the global temperature would reduce climate-related risks.[11]

Maine has joined a number of other states in setting targets for emissions of greenhouse gases. The recently enacted *Act to Promote Clean Energy Jobs and to Establish the Maine Climate Council*, P.L. 2019, ch. 476, requires:

> By January 1, 2030, the State shall reduce gross annual greenhouse gas emissions to at least 45% below the 1990 gross annual greenhouse gas emissions level.
>
> By January 1, 2040, the gross annual greenhouse gas emissions level must, at a minimum, be on an annual trajectory sufficient to achieve the 2050 annual emissions level.
>
> By January 1, 2050, the State shall reduce gross annual greenhouse gas emissions to at least 80% below the 1990 gross annual greenhouse gas emissions level.

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greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y.Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]

[9] IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)], at 5. In Press.

[10] *Id.*

[11] *Id.*

Id. § 7.

Q: What does the 2030 load reduction target mean for Maine gas consumption?

A: Table 1 shows energy-related carbon dioxide emissions in Maine in 1990 and 2016, the latest available data.[12]

Table 1: Maine Carbon Dioxide Emissions (million tonnes)

	1990	2016
Buildings		
Coal	0.10	0.00
Oil	5.00	3.94
Natural Gas	0.12	0.61
Industry		
Coal	0.52	0.04
Oil	2.87	0.43
Natural Gas	0.11	1.04
Transportation		
Coal	0.00	0.00
Oil	8.24	8.89
Natural Gas	0.00	0.04
Electric Generation		
Coal	0.36	0.17
Oil	1.77	0.11
Natural Gas	0.01	1.21
Total		
Coal	0.98	0.21
Oil	17.89	13.36
Natural Gas	0.24	2.89
Total	19.12	16.46

Reducing CO_2 emissions 45% from 1990 levels would bring emissions to 10.5 million metric tonnes, 36% below 2016 levels.

Q: Could Maine reach the 45% reduction target by switching all fuel use to natural gas?

[12] https://www.eia.gov/environment/emissions/state/. I do not have comparable data for all other greenhouse gases.

A: No. Table 2 shows that switching 100% of coal and oil fuel use to gas would reduce emissions to 12.8 million tonnes, only 62% of the reduction required from 2016 to 2030.[13]

Table 2: Carbon Savings from Switching to Gas[14]

	2016	Gas:fuel Ratio	2030
Buildings			
Coal	0.00	56%	0.00
Oil	3.94	73%	2.85
Natural Gas	0.61	100%	0.61
Industry			
Coal	0.04	56%	0.02
Oil	0.43	67%	0.29
Natural Gas	1.04	100%	1.04
Transportation			
Coal	0.00		0.00
Oil	8.89	74%	6.58
Natural Gas	0.04	100%	0.04
Electric Generation			
Coal	0.17	56%	0.09
Oil	0.11	67%	0.08
Natural Gas	1.21	100%	1.21
Total			
Coal	0.21		0.12
Oil	13.36		9.79
Natural Gas	2.89		2.89
Total	16.46		12.80

This hypothetical, inadequate as it is, is clearly impractical. The gas distribution system will not be extended to every oil-heated building, and

[13] This computation excludes the additional emissions related to energy used for compressing gas for vehicle use, methane leakage from new gas mains and services, and upstream methane emissions from production, gathering and interstate transportation.

[14] Assumes that oil is #2 distillate for buildings, mostly gasoline for transportation, and #6 residual for other sectors.

natural gas is unlikely to ever serve a large share of the transportation fuel market.

Reaching Maine's emission goals will require reducing the amount of fuel burned, by some combination of end-use efficiency, replacing fossil-fueled electric generation with renewables, and shifting end-use combustion of fossil fuels to higher-efficiency electric equipment, served by increasing amounts of renewable resources and declining reliance on fossil generators.

V. Shifting Energy Load

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

A: No.

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 Canadian hydro or (2) produced and used in a manner that is more efficient than direct gas use at the end use.

Q: Is electric space heating as efficient as gas heating?

A: Yes. Modern high-efficiency air-source 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. In other words, they are 280% to 350% efficient.[15] An efficient gas furnace or

[15] Ground-source heat pumps are even more efficient than air-source heat pumps and may be preferable when space is available for a horizontal or vertical exchange fields.

boiler might be in the 90%–95% range.[16] 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 power plant that emits three or four times more 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.

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. Maine's Renewable Portfolio Standard requires that 40% of electric energy load be met with Class I, Class IA and Class II renewables, rising to 80% in 2030 and 100% in 2050.[17] The definition of "renewable" resources in Maine is rather broad, including fuel cells and plants that burn wood and municipal solid waste. Nonetheless, a large portion of incremental electric load in Maine is likely to be met by wind and solar generation.

My conclusion is confirmed by a study of the sources of renewable energy likely to meet the expanded Maine RPS, which estimates that about 65% of the additional energy will be from wind, 20% from solar, 5% from hydro, and 10% from other renewables, which the authors expect to be mostly expanded biogas facilities.[18]

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[16] A conversion gas burner in a boiler or furnace designed for oil would probably be even less efficient.

[17] An Act To Reform Maine's Renewable Portfolio Standard, P.L. 2019, ch. 477, § 1.

[18] Maine Renewable Portfolio Standard: Examination of the Benefits and Costs of a Proposed RPS Policy Reform, Technical Appendix, Sustainable Energy Advantage, LLC & Synapse Energy Economics, Inc., May 2019, pp. 9–10.

Q: What about the portion of the electric supply for new loads that is not served by new renewable resources?

A: The remainder of incremental load will be 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 or surplus renewables) and 2% from other hydro (which was probably 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.

Hence, the energy for a marginal electric load, like a new heat pump, would come almost entirely from clean renewables or from natural gas. Over time, the gas portion of power supply will shrink as renewables dominate Maine’s energy supply.

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

A: No. New England coal is rapidly being retired. 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 New Hampshire’s 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.[19]

In addition, 1,500 MW of gas-fired capacity are expected to enter operation in 2019–2023, which will further push coal (and oil, and inefficient older gas plants) out of the dispatch stack.

Q: How do the carbon emissions from natural-gas combustion for electricity compare to the emissions 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, 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, electric space heating uses less gas than direct gas combustion at the end use. Since the majority of the incremental electric energy delivered to new loads during the life of the Westbrook Xpress contracts would be from low-carbon renewables, the gas used for electric heating would be much less than that for gas heating.

[19] 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.

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.[20] Table 3 shows the results of those studies, along with an extrapolation to current EF ratings.

Table 3: HPWH Efficiency

		pre-2016		**2019**	
Model	**Capacity (gal)**	**Rated Energy Factor**	**Average New England COP**	**Rated Energy Factor**	**Extrapolated New England COP**
		a	*b*	*c*	*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 $c \times b \div a$

Gas-fired water heaters have rated efficiencies of 0.65 to 0.93.[21] 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 3), 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.

[20] 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.

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

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.

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 entirely benign, but it produces very little CO or particulates, and most gas-fired power plants have controls to dramatically 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 pointed out the economic and environmental benefits of switching New England electric end-uses to burn gas.[22] 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 still in the future. In addition, cold-climate heat pumps had not been developed, so electric heating used much more energy than today's new efficient heating systems.

Q: What is Maine's statutory position with respect to replacing fossil fuels with heat pumps?

A: An Act To Transform Maine's Heat Pump Market To Advance Economic Security and Climate Objectives requires the Efficiency Maine Trust to administer the Heating Fuels Efficiency and Weatherization Fund to reduce heating fuel consumption and to achieve the following goal:

> From fiscal year 2019-20 to fiscal year 2024-25, to install 100,000 new high-performance air source heat pumps in the State to provide heating in residential and nonresidential spaces. "High-performance air source heat pump" means an air source heat pump that satisfies minimum heating performance standards as determined by the [Efficiency Maine Trust].[23]

Q: How will the installation of 100,000 new high-performance air-source heat pumps in Maine affect the market for new gas service?

A: The US Census's American FactFinder web site reports that about 400,000 Maine households heat their homes with oil (Fuel oil, kerosene, etc.), propane

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[22] Any gas appliances installed as a result of my analyses will be nearing the end of their useful lives.

[23] An Act to Transform Maine's Heat Pump Market to Advance Economic Security and Climate Objectives, P.L. 2019, ch. 306, § 6.

(bottled, tank, or LP gas) or coal.[24] Switching nearly 100,000 households to high-performance air-source heat pumps (some homes may use more than one heat pump, some heat pumps will replace resistance electric, and some heat pumps may be installed in commercial properties) would reduce the market for fuel conversions by about 25%. In addition, after installation of so many heat pumps, the distribution and delivery services for heat pumps (wholesalers, retailers, contractors) will be well-developed and many energy consumers will have friends and neighbors with heat pumps and will be comfortable with using that technology. The result would be additional installations of heat pumps, even if Efficiency Maine stops promoting conversion after the first 100,000 units.

As customers become comfortable with heat pumps for space heating, they are also likely to look for similar benefits for water heating and install HPWHs.

All else equal, I would expect that Unitil would lose something like a quarter of the prospects that might otherwise choose to switch to natural gas. In addition, some existing gas customers will install heat pumps, reducing their gas loads.

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.[25]

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[24] https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk.

[25] 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

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

A: Yes. For example, the Draft 2019 New Jersey Energy Master Plan found that:[26]

> 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.
>
> **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.
>
> 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.
>
> **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.

Economy, Report A1803; Ductless Heat Pump Meta Study, Faesy, R., et al, Northeast Energy Efficiency Partnerships, November 13, 2014.

[26] 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.

> 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.[27]

Analysis for the California Energy Commission found that "building electrification was shown to be one of the lower cost GHG mitigation strategies" and that "replacing gas equipment with electric equipment upon burnout lowers the societal cost of achieving California's climate policy goals."[28]

The Massachusetts Comprehensive Energy Plan recommends, based on analysis of four scenarios including both average and extended cold weather conditions, increased electrification of the thermal sector.[29] Specifically, the plan recommends providing incentives for switching to air source heat pumps for heating.[30]

The Québec 2030 Energy plan shows electricity backing out oil and coal, without expansion of natural gas use.[31]

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:[32]

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[27] Draft EMP at 71–72.

[28] Aas, et al, 2019 (op cit) at 3, 6.

[29] Massachusetts Comprehensive Energy Plan, Commonwealth and Regional Demand Analysis, Massachusetts Department of Energy Resources, December 12, 2018, § 9.2.1.

[30] *Id.*

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

[32] 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.)

> 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. (NY PSC Case 17-G-0606, February 7, 2019 Order)

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 (ibid at 8).

VI. Risk of Pipeline Commitments

Q: To what risks are ratepayers exposed as a result of Unitil committing to long-term gas delivery contracts?

A: There is a significant risk that an increase in gas supply in November 2022 will not remain useful through 2037. As Maine follows through on its commitment to reducing greenhouse gas emissions, Unitil will face a declining need for the WXP delivery capacity. The fixed costs of the contracts are likely to be spread over diminishing load by the late 2030s, leaving Unitil with the choice of maintaining excess capacity or giving up lower-cost resources that would otherwise renew before the end of the WXP contracts. Unitil's remaining gas loads may face higher costs if Unitil locks in additional supply before Maine clarifies the trajectory of the winddown of gas consumption.[33]

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[33] Even after 2050, some gas may continue to flow through Unitil's mains, carrying biogas and perhaps other energy-bearing gases produced from excess renewable electricity. Those volumes are likely to be much smaller than Unitil's current loads, let alone its projection for 2022/23 and beyond.

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, to drive a much slower turnover of the installed stock, as shown in Figure 1.

Figure 1: Projected California Residential Heating Transition[34]

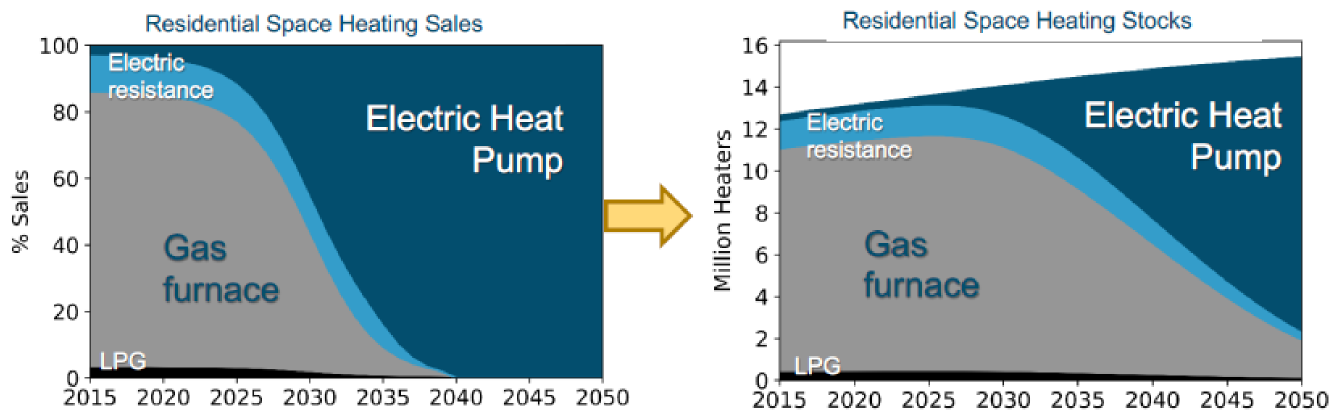
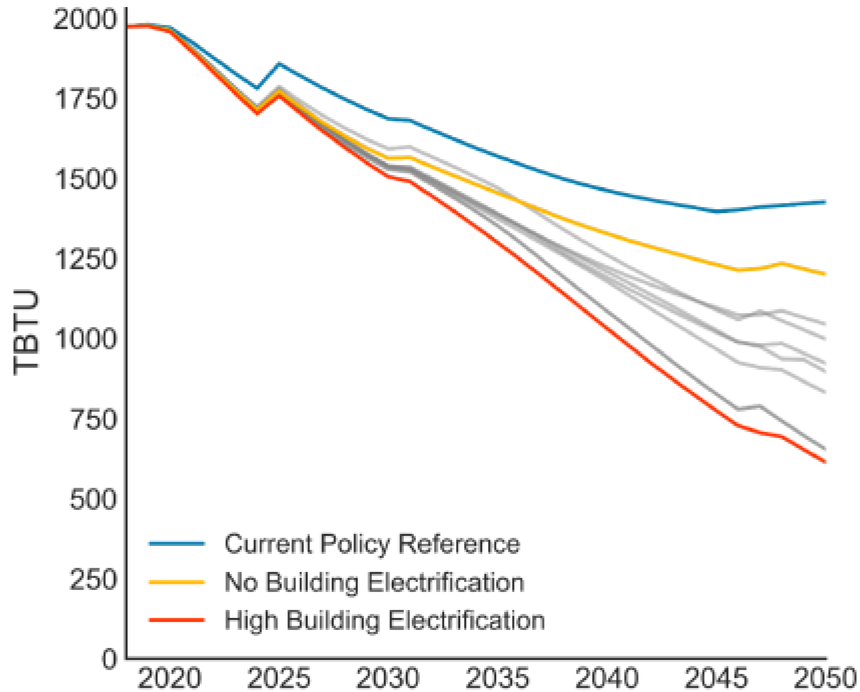


Figure 2 shows the projected deliveries of natural gas (along with biogas and other renewable gas) under the range of approaches considered in the study. The High Building Electrification case is the lowest-cost option.

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

Figure 2: California Gas Distribution Futures[35]



Q: How are these California results relevant to Maine?

A: Maine'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.

VII. Alternatives

Q: What alternatives does Unitil have to balance load and capacity?

A: Much of the demand growth that Liberty expects would likely be eliminated by ceasing efforts to expand the system and promote gas space and water heating. For meeting the remainder of the load, above current supply, Unitil's options include energy conservation and imports of LNG.

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

A. *Energy Efficiency*

Q: Does Efficiency Maine Trust operate an aggressive energy-efficiency effort?

A: No. The most recent ACEEE scoreboard (for 2017 savings) shows gas savings of more than 1% of sales in four northern states (including two in New England), compared to about 0.5% for Maine.[36] Unitil's forecasts assume annual energy-efficiency reductions of just 0.2% of sales (IRP Tables IV-12 and IV-17).

Table 4: Commercial and Residential Gas Conservation, 2017

State	Savings as % of sales
Minnesota	1.35%
Massachusetts	1.08%
Rhode Island	1.02%
Michigan	1.01%
Utah	0.78%
California	0.78%
Oregon	0.73%
District of Columbia	0.73%
Vermont	0.68%
Iowa	0.64%
Arkansas	0.56%
Maine	0.53%

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.[37]

Acceleration of the Efficiency Maine Trust's energy-efficiency programs would be a lower-cost approach to meeting Unitil's customers' energy needs

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

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

and would be more consistent with the State's decarbonization targets than the WXP contracts.

Q: If Unitil ended its promotional efforts and worked with Efficiency Maine Trust to implement the equivalent of Massachusetts's current plan, how much would that reduce its loads?

A: If Unitil loads remained constant before energy-efficiency savings, and the energy-efficiency programs were raised to Massachusetts's 1.25% annual savings, over 2020/21 through 2023/24 (the end of the IRP forecast period), Unitil's usage forecast for 2023/24 would be 11.4% and 1,378 BBtu lower than reported in the IRP.[38] That would be 92% of Unitil's projected 1,551 BBtu take of gas from Westbrook Xpress in 2022/23, the last year for which IRP Appendix 4 reports Westbrook Xpress utilization.[39] Since Maine uses only about 56% of Unitil's throughput (Table IV-32 and Table IV-33), the efficiency option would reduce throughput by more than the gas that WXP would provide to the Maine Division, by 2022/23.

Q: What is Maine's official policy with respect to installation of heat pumps?

A: Efficiency Maine Trust is required, "by 2030, to provide cost-effective energy efficiency and weatherization measures to substantially all homes and businesses whose owners wish to participate in programs established by the trust." 35-A M.R.S. §10119(2)(A)(1). Furthermore, Efficiency Maine Trust is obligated to implement heat pumps:

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[38] The usage of existing customers would tend to decline naturally, as older gas equipment and converted oil boilers are replaced with more efficient modern equipment and as customers improve their building shells. On the other hand, some customers might decide to connect to Unitil's existing gas system without any promotional efforts.

[39] Continued energy-efficiency efforts would further reduce load in later years.

> Cost-effective energy heating fuel efficiency measures must include measures that improve the energy efficiency of energy-using systems, such as heating and cooling systems, through system upgrades or conversions, including conversions to energy-efficient systems that rely on renewable energy sources, high-performance air source heat pumps or other systems that rely on effective energy efficiency technologies.

Id. §10119(2)(B)(3).

As I note above, the Legislature has codified a goal of the addition of at least 100,000 high-performance air source heat pumps over the next six years.

B. Supplemental LNG Supplies

Q: What are Unitil's stated concerns with gas supply?

A: Unitil expresses three concerns. First, it worries that the supply of gas from offshore supplies in Nova Scotia and Newfoundland is disappearing. Application at 21–22. While that is true, Unitil also presents evidence that the existing Canaport LNG terminal has not been used much, indicating that delivery capacity is under-utilitized. New England and the Maritimes have not been using most of their LNG capacity. Figure 3 shows the history of imports through Canaport, from Application Figure 5.

Figure 3: Utilization of the Canaport LNG Import Facility

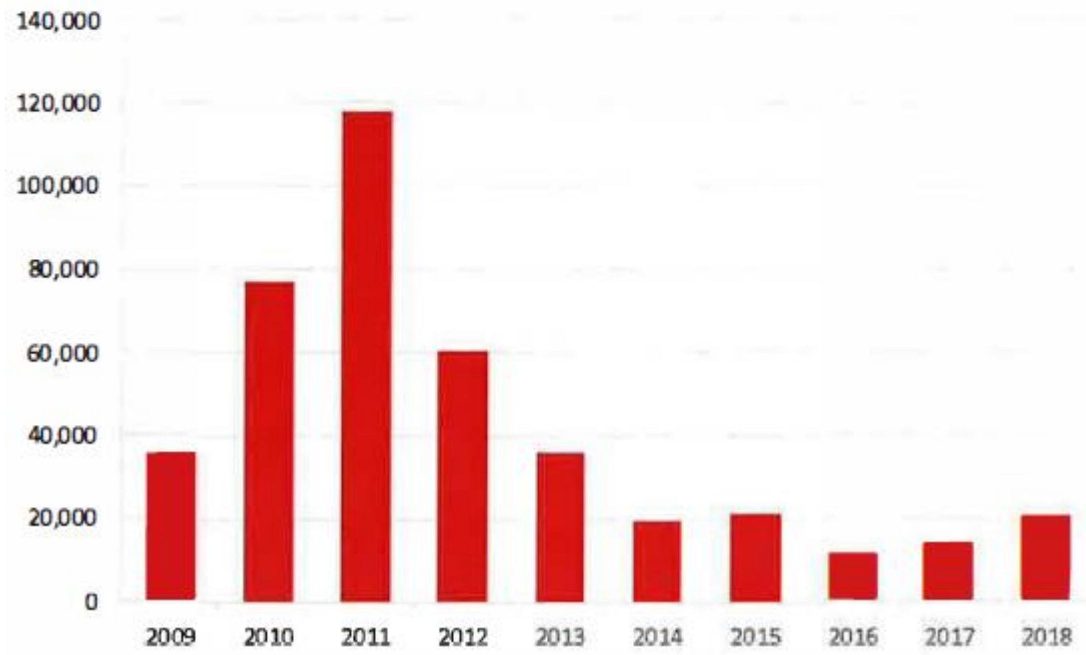
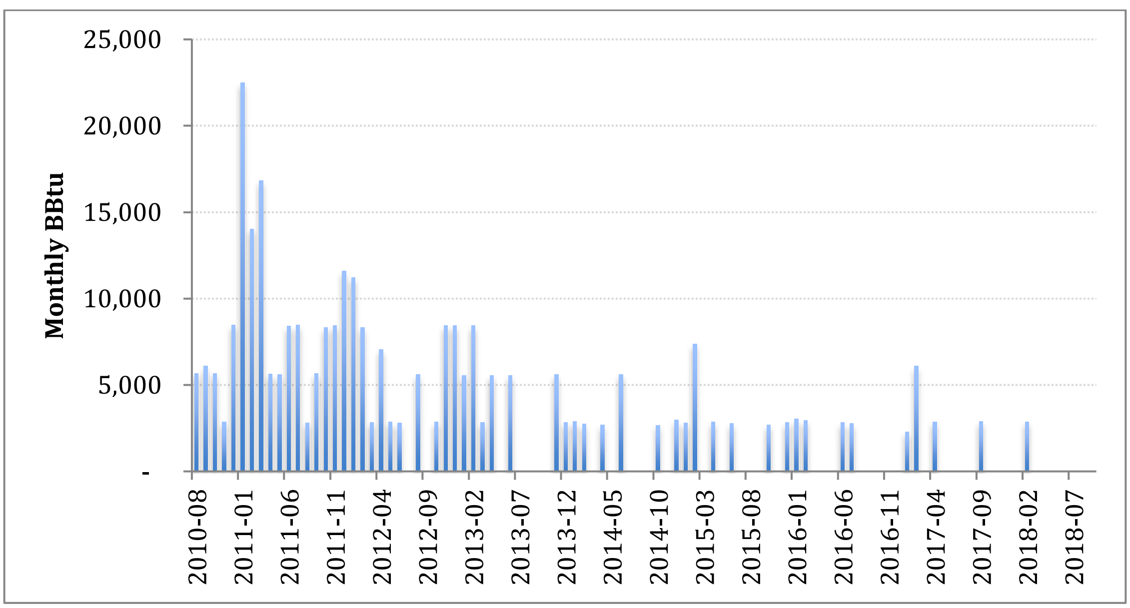


Figure 4 breaks down the deliveries by month, from the Canadian National Energy Board's "Imports of Liquefied Natural Gas."[40]

Figure 4: Canaport Monthly Deliveries



[40] https://apps.neb-one.gc.ca/CommodityStatistics/Statistics.aspx.

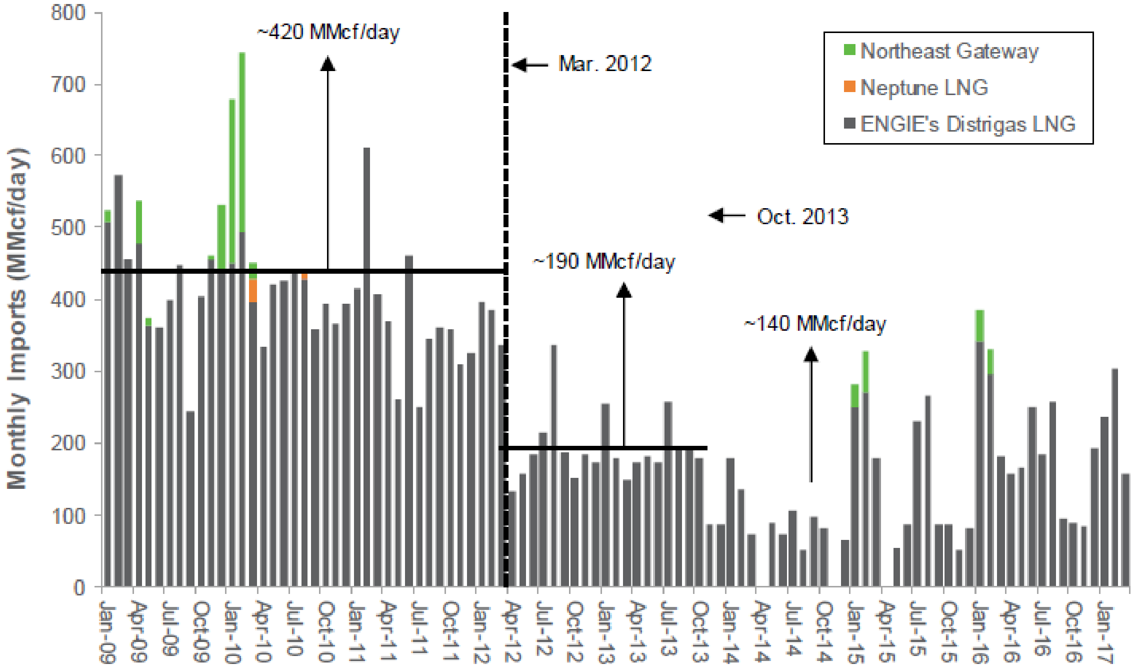
While the Application suggests that the lack of demand for Canaport LNG is some sort of problem, it is in fact an advantage for gas buyers, since import (and associated storage) capacity is readily available to supplement Unitil's supplies during times of high winter demand, without burdening customers with the cost of a long-term capacity contract.

Second, Unitil worries that there is surplus capacity available at the Distrigas LNG import facility in Everett, Massachusetts, and that a major customer for the Distrigas output (the Mystic combined-cycle plant) might retire in the future (Application at 24–26). Just as with Canaport, the excess capacity at the New England LNG import facilities is a benefit to gas buyers.

Figure 5 shows the deliveries to the three Massachusetts LNG import facilities—Distrigas, Excelerate Energy's Northeast Gateway Deepwater Port and ENGIE's Neptune LNG facility).[41] This figure is copied from Liberty's 2017 New Hampshire IRP.

[41] Neptune may be decommissioned, due to lack of demand.

Figure 5: LNG Deliveries to New England Ports



Application Figure 7 shows similar data, extending to show 2017 and 2018 deliveries continuing in the range of 2013–2016 deliveries.[42] Again, excess capacity on the existing resources reduce the need for new resources and allows Unitil to supplement supplies during times of high winter demand, without committing to a long-term capacity contract.

Third, Unitil expresses concern that spot gas purchased on a small number of winter days can be very expensive (Application at 31–34). While this problem was particularly severe in the cold winter of 2013/14, prices have been more stable in later (and colder) winters, due to improvements in the gas and electric spot markets and the coordination between those markets.

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[42] Excelerate reports that Northeast Gateway “reached a peak send-out flow rate of over 800,000 MMBTU per day of natural gas on February 1, 2019,” allowing dual-fuel power plants to continue burning gas (https://www.maritime-executive.com/article/record-gas-flow-from-northeast-gateway-deepwater-terminal). That gas was apparently not needed by the LDCs.

Buying gas at the last minute (one to three days in advance) exposes the buyer to considerable risk. Fortunately, most gas requirements can be purchased much further in advance, in the less-volatile futures markets. Thus, the daily volatility values are of limited import for a gas LDC, such as Unitil.

Q: Does New England have adequate LNG import capacity to supplement Unitil's gas supply in the near term?

A: Yes. Even if Neptune is retired for lack of demand, there is considerable excess capacity at Canaport, Distrigas and Northeast Gateway.

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.[43] As of July 31, 2019, 13 Bcf/day of supply was in operation, in commissioning or under construction.[44] Additional LNG supply is under construction in Canada, Australia, Indonesia, Russia, Mozambique, Malaysia, Senegal and Argentina, with more projects proposed.[45]

To the extent that Unitil periodically needs supplemental winter gas during the transition to a low-carbon economy, the LNG system appears to be adequate to provide that supply.

Q: Does this conclude your testimony?

A: Yes.

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

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

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