Attachment PKC-1

Examination of Natural Gas Supply Resource Procurement and Management by Northern Utilities Inc. d/b/a Until

Final Report – Public Version
Confidential Material Redacted

Presented to:
State of Maine
Public Utilities Commission

Presented by:
The
Liberty Consulting Group

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Executive Summary

The Maine Public Utilities Commission (MPUC, or the Commission) selected The Liberty Consulting Group (Liberty) to conduct an examination of the natural gas supply procurement and management protocols and practices of Northern Utilities, Inc. d/b/a Unitil (NUI, or the Company). This summary presents our principal findings, conclusions and recommendations. This following chapters of this report presents the detailed results of our examination.

We have categorized the results of our review into six overall subject areas, which, combined, encompass a broad review of the matters affecting gas supply procurement and management:

1. Organization, Staffing and Controls
2. Gas Supply Planning and Forecasting
3. Gas Supply Procurement
4. Gas Supply Management
5. Measurement and Balancing
6. Price Risk Management.

We issued 101 data requests, and conducted two rounds of interviews with Company management. We issued a draft report to the Company, whose management responded with comments and requests for the redaction of confidential information. We made changes to the report to the extent consistent with the exercise of our independent judgment.

I. Organization, Staffing and Controls

NUI provides gas distribution and supply services in New Hampshire and Maine. Unitil, NUI's parent, also owns electric distribution companies in Concord and Hampton, New Hampshire, a combination electric and gas distribution utility in Massachusetts, and an interstate gas pipeline operating in New Hampshire and Maine.

Unitil acquired NUI and the interstate pipeline from Bay State Gas Company (now d/b/a Columbia Gas of Massachusetts) in 2008. That transaction left one important gas-supply process interrelationship with the former parent -- an exchange arrangement providing access to interstate pipeline capacity under contract to NUI, but to which NUI has no physical connection.

In 1984, Unitil formed a service company to provide joint management and administrative services to its subsidiaries. Essentially all management employees work for the service company. An Energy Contracts unit within the Financial Services Division of the service company conducts the gas-supply function. Gas Operations reports to a different Vice President of the service company. It has responsibility for supply-related functions such as gas control and measurement. The interstate pipeline operates as a separate entity, but most of its employees also work for the service company.

All three jurisdictions in which Unitil's gas distribution utilities operate permit varying degrees of customer choice for electricity and natural gas supply. NUI's Energy Contracts unit works with personnel in both Gas Operations and Electric Operations to ensure delivery of third-party supplies. Energy Contracts has a more comprehensive set of planning responsibilities for the gas business. Its role includes administration associated with deliveries of third-party supplies, supply

planning for customers who buy their supplies from the Company, and supply-capacity planning for both sales-service and distribution-service customers.

Qualified and experienced personnel staff Energy Contracts and Gas Operations. Performance measurement meets prevailing industry practice. However, we found a lack of written policies and procedures addressing gas-supply functions and activities (discussed below under Gas Supply Management). The lack of documented policies and procedures creates exposure to loss of continuity in understanding and executing them, particularly in a smaller organization. ***We recommended that management update personnel descriptions.***

We also found some controls weaknesses in the following areas:

- Documentation of gas supply decisions
- Limits on authority to approve transactions
- Separation of transaction-related functions
- Internal Audit examinations
- Employee acknowledgement of the Company's Code of Conduct.

We recommended that management: (a) add gas-price information, including estimated prices, to the record of daily gas-supply selections, and (b) re-examine its supply processes from a controls perspective. The process re-examination should conclude within six months of the issuance of this report, which will give management sufficient time to address the identified controls issues.

II. Gas Supply Planning and Forecasting

NUI's Integrated Resource Plan, filed in July of this year, comprehensively and clearly presented management's forecasting and supply-planning methods. We examined methods with reference to prevailing industry practices, and how and how well decisions about supply resources incorporate the results of applying those methods.

Management considered 30 years of history (the gas years of 1988/89 through 2017/18) to populate its normal- and design-weather data. The data capture effective degree-days (EDDs) by adjusting temperature data for wind speed. Separate calculations apply those parameters for the Maine and New Hampshire Divisions. Regression analysis of billing data supported the development of econometric models for forecasting numbers of customers and use per customer for each customer segment. Management made reductions to the resulting customer-segment forecasts to reflect energy-efficiency savings.

Management calculated Design Day requirements using regression analysis of actual daily throughput data, separately for each Division. Management also updated both the Residential Heating Use Per Customer model and the Peak-Day forecasting model between the 2015 IRP and the current one.

Unitil developed a comprehensive marketing program soon after it acquired NUI. That program identified customers on main but not connected, and low-use customers as targets with the highest potential. Management had also slated facilities in Maine for a Cast Iron Replacement program. Management continues special promotions and special incentives offers to prospective customers for connection in the areas affected by that program.

Energy Contracts remains informed about other company activities that might affect requirements for gas supply. Personnel gather at Seasonal Readiness Meetings to discuss new initiatives, such as a targeted area build-out. Other initiatives undergo discussion in the course of normal internal coordination.

Management inputs requirements forecasts into an optimization model. The model designs a portfolio of supply resources that provides the best fit for the input forecast. NUI uses SENDOUT, widely used for such purposes in the gas distribution business to solve for the least-cost mix of options for meeting demand, subject to user-defined constraints.

NUI has found that three pipeline options compare favorably with the alternative of relying on delivered supplies. For its seasonal and peaking requirements, management issues requests for proposals (RFPs) annually. It seeks seasonal supplies first, along with asset-management services for its legacy pipeline and storage assets. A second RFP for peaking supplies follows in mid-summer. Management has continued to discuss additional pipeline supply projects with potential offerors, and it has recently re-started work on on-system supply options.

We concluded that load-forecasting methods conformed to prevailing industry practice, but that weather-analysis methods warranted improvement. ***We recommended that NUI test the use of Monte Carlo-based weather distributions.*** Monte Carlo simulations are finding increasingly broad use in utility supply planning. ***We also recommended that management expand its analysis of additional gas-supply resources to include increased utilization of existing and newly-acquired pipeline capacity.***

III. Gas Supply Procurement

NUI's gas-supply capacity portfolio accesses the U. S. Gulf Coast, Central and Eastern Pennsylvania, Eastern Canada, and Dawn, Ontario supply sources. NUI had most of its current capacity when Unitil acquired it. Management has since renewed, converted or terminated essentially all pipeline and storage contracts then in place. The terminations sought cost reduction, or movement of receipt points closer to the NUI distribution system. NUI has also relocated its largest underground storage to Dawn, and increased capacity and maximum daily withdrawal capability.

NUI also accesses markets to supply its LNG storage and regasification facility in Lewiston, Maine. LNG enters the region at the Canaport receiving terminal in New Brunswick and at the Distrigas facility in Everett, Massachusetts. The NUI system also connects to the Maritimes & Northeast Pipeline system (M&NP); revaporized LNG from the Canaport terminal can reach NUI and other U. S. markets via M&NP pipeline facilities.

Management organizes these capacity resources into "paths" connecting each supply point to NUI's affiliated pipeline, which then delivers to the distribution system. At Lewiston, Maine, the only NUI distribution-system receipt point not served by that pipeline, NUI connects directly to M&NP, and buys supply delivered there. NUI shares all its pipeline capacity with the retail marketers who serve customers on its distribution system.

Management has sought to reduce the portion of supply bought on a delivered basis, pursuing alternatives taking the forms of pipeline connections and increases in underground storage. These resources have provided access to upstream supply points more liquid than those of New England. Capacity from such projects permits year-round use, but NUI's requirements are seasonal. Management's analysis, presented in the new IRP and in its applications for approval of participation in the new projects, holds that lower prices and greater price stability associated with access to the more-liquid supply points favor these projects over delivered supply.

NUI purchases gas supplies annually through two requests for proposals (RFPs). The first covers supplies provided as part of agreements to manage certain of NUI's capacity assets, winter-season supplies delivered through NUI's pipeline affiliate, and summer-season supplies delivered to storage-area pooling points or to injection points for storage. The second RFP covers peaking supplies delivered to the pipeline affiliate's receipt points or to NUI's receipt point on M&NP.

Management solicits offers to manage its path-based packages under asset-management agreements (AMAs) having one-year terms. Management requires asset managers to provide supply at a relevant index price, plus variable transportation and fuel charges. For each path, NUI provides the third-party managers an estimate of the amount of capacity that must be assigned to retail marketers. The third parties selected benefit in these arrangements by selling gas to NUI at agreed prices and by using any remaining capacity on the path (after meeting NUI and retail marketers' requirements) to serve other customers. NUI generally awards management of each path to the third party offering the largest asset-management fee. Over the last six years (2014-2015 through 2019-2020), asset-management revenue has covered an average of 23 percent of asset demand costs (between 11 and 36 percent in any given year).

NUI has required winter supplies significantly beyond the capacity of the capacity portfolio and pending supply projects. Management has addressed these winter needs recently with contracts for: (a) base-load supplies delivered in equal daily amounts, and (b) peaking supplies up to maximum daily quantities elected by NUI. Base-load supply contracts generally call for one delivery quantity for November through March and another for December through February. Peak-supply contracts address the five winter months.

New England gas market price volatility and constrained pipeline capacity create substantial risk for suppliers. While competition to provide commodity supply to NUI has been reasonably robust, some competitors have disappeared.

Management issues the RFP for delivered peaking service in late June or early July, with the service to begin November 1. Offerors provide the service from November 1 through the following March 31.

Management requires that prospective sellers of gas or asset-management services enter into a NAESB (North American Energy Standards Board) Base Contract for Sale and Purchase of Natural Gas with it in order to do business. Management evaluates the financial stability of those who seek to bid, but requests collateral rather than rejecting a possible supplier if it is concerned about the supplier's finances. NUI bought gas from 13 suppliers in 2018, an increase of two over the number in 2017. The top four suppliers accounted for 81.7 percent of volumes purchased.

We found NUI's management of supply procurement a notable strength. Management employed effective contracting practices, and entered contracts appropriate in meeting supply needs. ***We did, however, recommend that NUI initiate an intensive effort to reduce dependence on delivered peaking service.*** The effort should include both demand-side and supply-side options.

IV. Gas Supply Management

The challenges that NUI faces managing its gas supply include: (a) use of *multiple pipelines* to supply a *large number of delivery points*, (b) a *fragmented service territory* imposing locational requirements on deliveries, (c) a large penetration by *retail marketers*, (d) large swings in gas requirements due to high *weather variability*, and (e) NUI's *downstream location* on almost all pipelines serving, which produces narrow nominated-versus-delivered amount tolerances during the winter. We found planning, complex under these circumstances, attentive, comprehensive, and supported by appropriate systems and processes.

Operations planning begins with a general forecast to construct seasonal supply plans. The Energy Contracts staff assigns supply resources to particular delivery points. The staff then generates monthly plans that further detail and align sources and deliveries. A Daily Forecast file applies a seven-day weather forecast to generate a corresponding daily forecast of supply requirements at the pipeline delivery locations that serve NUI. Management then nominates from among the available supply resources the quantities that they want delivered to each receipt location. Management updates the Daily Forecast file every day with new weather data.

NUI's service territories, do not have robust connections among themselves. Five points of receipt bring gas into the pipeline connecting all but one of them; 38 points provide for deliveries from that pipeline. An NUI lateral connects Lewiston to the other portions of the service territory, but Lewiston depends also on winter access to an M&NP delivery point and NUI's liquefied natural gas (LNG) storage and regasification facility. Limits on the pipeline's flow capacity prohibit unlimited movement of gas from different receipt points to all the NUI points of delivery, necessitating consideration of location-specific requirements.

Management allocates shares of each NUI supply-capacity path to retail marketers in proportion to the design daily demands of each marketer's load. The marketers receive most resources directly, but NUI operates two of them -- the Lewiston LNG facility and a small storage contract and the pipeline capacity for delivering the stored gas. The marketers can trade their assigned "slices" of the NUI supply-capacity portfolio among themselves to optimize their capacity holdings, but must deliver their required amounts to specified pipeline receipt points.

NUI's primary reliance on asset-management agreements (AMAs) makes two primary activities the focus of supply-management: (a) nominating quantities for delivery to the relevant pipeline, including withdrawals from storage, under each AMA, and (b) calling on the small quantities of supply NUI manages directly as needed by marketers or NUI's system-supply customers. Management must address locational requirements first. After addressing that constraint, it can select among available resources on the basis of cost. Gas Control uses Energy Contracts' regression models relating weather conditions and sendout requirements to generate forecasts of requirements for the coming seven days, based on expected weather conditions.

NUI's lack of sizeable upstream pipeline capacity limits its occasions for secondary-market activities. Management places most available capacity into the path-based asset-management agreements, whose underlying RFPs estimate pipeline capacity required to serve NUI and retail marketer loads. Those bidding to supply asset management factor their ability to make economic use of any unused capacity into pricing their bids.

We found NUI's gas-supply management a strength, but a lack of written procedures risks operational continuity should NUI experience a loss of key skills. ***We recommended that management prepare written procedures to guide the nominations and dispatch functions.*** We also found that some short-term forecasting tools might be improved with an industry best practice known as "deep neural networks." ***We therefore recommended that management explore the application of neural network methods to short-term requirements forecasting.***

V. Measurement and Balancing

NUI's overall measurement scheme uses upstream-pipeline measurement of deliveries into NUI's pipeline affiliate (or NUI's distribution system for M&NP deliveries for Lewiston). The affiliate measures its deliveries into NUI's system; NUI, in turn, measures its deliveries to its customers. At year-end 2018, NUI's Maine Division had 34,119 active meters. NUI filed descriptions of how each of its meter types operates, and of the circumstances in which each is deployed, with its initial response in Docket No. 2018-00331, *Inquiry into Meter Testing and Standards of Local Distribution Companies*.

The interstate pipelines calibrate their meters at least annually. NUI's pipeline affiliate inspects its turbine and rotary meters monthly to verify their operation, and it calibrates its flow computers annually. NUI tests meters before installation and calibrates its largest ones quarterly. Field audits conducted each year sample the non-instrumented rotary and diaphragm meters. The audits seek to validate proper operation of the reading indexes and the automated meter reading (AMR) devices. The practice is to examine two percent of small-diaphragm meters and 25 percent of large diaphragm ones each year.

NUI's billing system identifies anomalies in billings, such as measurements showing no usage at customer locations known to be active. Upon detecting anomalies, technicians visit the meter to examine the circumstances. NUI also tests meters on customer request. NUI has identified certain meter types with known problems, replacing them as practical. Management also has a practice of retiring certain meter types to reduce the number of types in inventory. Otherwise, NUI retires meters that are more than 20 years old.

NUI takes a number of measures to reduce lost and unaccounted for (LAUF) gas. Management measures company use for office facilities and for vaporization and heaters at its LNG facility and district regulator stations. Management also installs correctors that compensate for variances in pressure and temperature for commercial and industrial customers. Another measure employed calls for checks of customer service regulators and adjustment of them on installation and routine meter changes. NUI also conducts an aggressive leak-repair program.

Management reports that most leaks occur along the cast-iron portions of its distribution system. It plots leaks on maps, to serve as a factor in planning the cast-iron replacement program. NUI has completed that replacement program in New Hampshire, now finding no leaks there. As do most gas distribution companies, NUI calculates (separately for Maine, New Hampshire, and Fitchburg) annual LAUF percentage by summing monthly calculations from July of the previous year through June of the reporting year.

Balancing consists of getting deliveries into the distribution system to match deliveries out of it. Balancing poses special challenges for NUI, because of its weather changes, penetration by retail marketers, and the company's location at downstream ends of the gas pipelines that serve it. Service interruptions on its four upstream pipelines affect it. NUI's Delivery Service Terms and Conditions provide for passing through to the marketers any flow restrictions, such as upstream imbalance warnings or operational flow orders (OFOs). Any penalties caused by marketer imbalances are passed along to the offender.

Management generally manages intra-day balancing needs by adjusting storage withdrawals for the first half of the winter, then with off-system sales in the second half. Its contracts for peaking supply and its on-system LNG facility are additional resources for addressing imbalances if necessary.

We found that NUI's metering and testing programs generally conform to prevailing industry practice. Management employed metering strategies are effective in isolating usage by customers and the Company. In particular, we found managements systems, practices and processes for balancing a strength. We had no measurement and balancing improvement recommendations

VI. Price Risk Management

NUI operated a financial hedging program when Unitil acquired it. NUI refocused the program and operated it subject to periodic review by the Commission. In early 2017, NUI petitioned the Commission to allow it to suspend the program for one year, followed by determining the best course going forward. Management also noted that it was replacing one of its gas storage contracts with a larger one that would result in an increase in the volume of gas with physically hedged pricing for the 2018-2019 Winter Period.

The next year, NUI requested that the Commission allow it to terminate the financial hedging program. The Commission approved the request, stating "the current hedging program benefits do not appear to warrant the ongoing cost …." The Commission proposed that NUI describe its price risk management objectives and actions taken to reduce customer exposure to gas price volatility in its IRP filing. Our report provides a brief history of NUI financial hedging, and reviewed the approach to inventory strategy as it relates to providing a physical hedge.

We concluded that NUI's hedging objectives have changed under Until ownership, but the Company has always stated the objective of protecting customers from natural gas price volatility. Volatility in the benchmark price for the natural gas futures contract (a monthly price at a Gulf Coast location) comprised the focus late 2008 and early 2009. Since that time, volatility in that price benchmark has generally reduced, while volatility in daily New England prices has increased.

NUI has substituted increased physical hedging and particular contracting strategies for financial hedging, but the objective is clear: to "insulate customers from the volatility of *daily* index prices".

We also found that NUI's focus on storage and contracting strategies to reduce exposure to gas-price volatility reflects its core strengths. Management has no other particular use for expertise in financial derivatives, and has chosen not to acquire it for the sole purpose of gas-price hedging.

NUI has established controls, policies and procedures that reflected the limited scope of its hedging activity. Its move to increased physical hedging and supply contracting make its processes sufficient, albeit informal. ***We recommended that additional structure be added to those functions.***

We also found that management has reviewed program results regularly, and recommended changes as market trends and program results have developed. Supply-contracting evaluations and decisions have been driven primarily by considerations of supply security and reduced operational risk, but the role of those decisions in protecting the Company's customers from price volatility has increasingly entered those deliberations as the potential benefits to price stability have been realized.

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I. Organization, Staffing, and Controls

A. Background

Organization sets the basic framework for conducting and managing gas supply activities. Those activities require a trained and capable staff with particular skills and knowledge of the gas markets in which they operate. Operational policies and procedures provide definition and control to the conduct of the supply function.

We employed the following evaluation criteria:

1. Ability of the organization structure for the gas-supply function to allow effective and prompt decision-making subject to appropriate controls
2. Quality of coordination and communication of gas-supply functions and resources with related functions and groups.
3. Sufficiency of skills and experience of key managers and contributors
4. Performance assessment transparency and connection to material performance drivers
5. Sufficiency, clarity, and efficiency of policies and procedures governing supply processes
6. Comprehensiveness and sufficiency of approval processes and authority levels to enable and control needed supply commitments and expenditures
7. Adequacy of documentation to support regulatory oversight and review.

B. Findings

Unitil, the parent of Northern Utilities, Inc. (NUI), also owns electric distribution utilities in Concord and Hampton, New Hampshire, Fitchburg Gas and Electric Light Company (FG&E, a combination electric and gas distribution utility in Massachusetts), and Granite State Gas Transmission, Inc. (GSGT), an interstate gas pipeline operating in New Hampshire and Maine. NUI provides gas distribution and supply services in New Hampshire and Maine. The two smaller electric distribution companies, Concord Electric Company and Exeter & Hampton Electric Company, merged in 2002 to form Unitil Energy Systems. The Company's home office is in Hampton, New Hampshire.

The parent owns no electricity-generating assets. Unitil sold an unregulated energy brokering and advisory business in early 2019, after which all of the operations it owns operate as fully rate-regulated businesses. Gas-supply assets include a small liquefied natural gas (LNG) storage and regasification plant in Lewiston, Maine, owned by Northern, and a small LNG plant and a propane-air peaking plant, owned by FG&E.

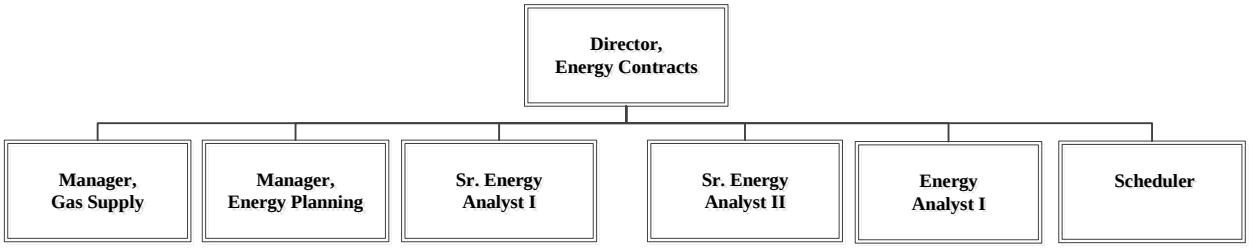
Unitil acquired NUI and GSGT in 2008 from Bay State Gas Company (now doing business as Columbia Gas of Massachusetts). That transaction left one important gas-supply process interrelationship with the former parent, an exchange arrangement which provides access to interstate pipeline capacity under contract to NUI, but to which NUI has no physical connection.

1. Organization

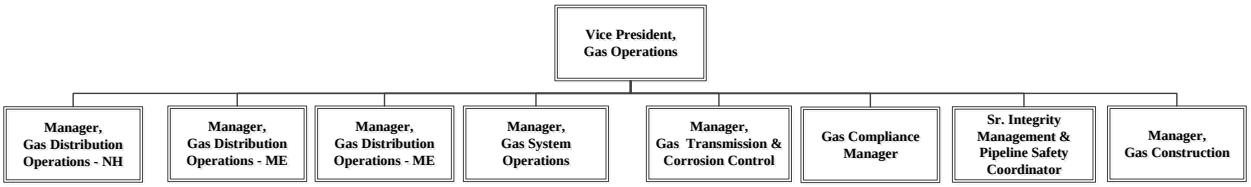
Unitil formed Unitil Service Corp. (USC) in 1984 to provide joint management and administrative services to its subsidiaries. Essentially all management employees work for USC. This service-company approach finds common application in holding companies operating in multiple

jurisdictions or through multiple operating entities. USC provides those services at cost, which it allocates among the utilities served, pursuant to settled cost-allocation policies. The operating companies make available to each of their regulators those costs for examination and approval, if not otherwise, then at least in general rate proceedings. Each utility also has employees dedicated to its individual management and operations. Their costs get charged directly to the utility involved. Gas supply operates as one of the centrally-provided services, subject, like the others, to cost allocation.

Two key organizations under USC work together in performing the principal activities required to manage supply for NUI and for the other Unitil utilities. First, the Energy Contracts unit within USC's Financial Services Division manages the gas supply function. The diagram below shows the components of that unit. The Director, Energy Contracts reports to the Financial Services Division's Senior Vice President, Chief Financial Officer & Treasurer.



The second major organization, Gas Operations, has responsibility for gas distribution system operations, reporting under a different USC Vice President. Gas Operations is responsible for supply-related functions such as gas control and measurement. The components of that organization are shown in the diagram below. As we explain below, Energy Contracts' principal interaction with the Gas Operations organization involves Gas System Operations.



USC's Financial Services Division operates from Hampton, New Hampshire. The Gas Control personnel of the Gas Operations Division operate from the Operations Center in Portsmouth, New Hampshire. GSGT operates on a co-located basis with Unitil's Operations Center in Portsmouth, New Hampshire, but as a separate entity. Most GSGT personnel are employees of USC. The U. S. Federal Energy Regulatory Commission's Order 717, regarding standards of conduct for transmission providers, applies at the employee level, and prohibits the flow of information from transportation-function employees to market-function employees.

All three jurisdictions in which Unitil's gas distribution utilities operate permit varying degrees of customer-choice for electricity and natural gas supplies. The Unitil utilities therefore must provide various third-party administrative services, referred to as Supplier Services, and manage their systems to deliver supplies from multiple suppliers who provide electricity or gas to end users. As typical in restructured jurisdictions, Unitil retains the obligation to provide "default service,"

which includes the acquisition of supplies for those of its gas-system customers who do not choose competitive suppliers.

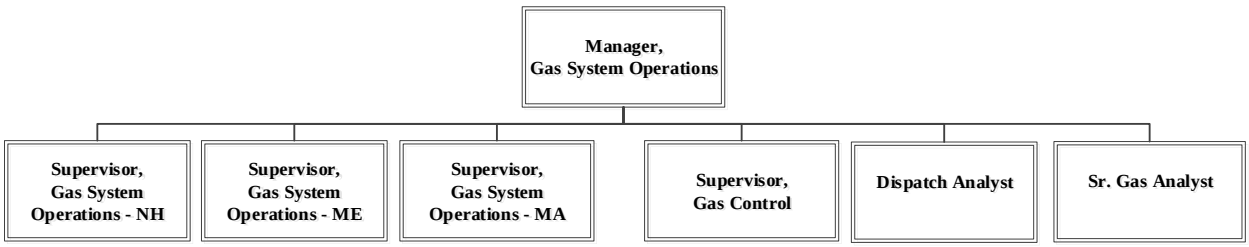
The Energy Contracts unit works with personnel in both Gas Operations and Electric Operations to ensure delivery of third-party supplies. The Manager, Energy Planning spends nearly all of his time on gas work. The electric work of Energy Contracts includes supply contract administration; the New England Independent System Operator (ISO-NE) has responsibility for power-supply planning. Thus, Energy Contracts has a more administrative role in electricity-related planning, but also responding as needed to occasional needs, such as response to regulatory initiatives (*e.g.*, renewable power supplies). Energy Contracts also buys supplies of both gas and electricity to provide default service. Two Energy Contracts personnel, the Manager, Gas Supply and the Senior Scheduler, spend 100 percent of their time dedicated to gas work. The unit dedicates two Senior Energy Analysts I to activities undertaken for electric customers. The Senior Energy Analyst II and an Energy Analyst spend about half of their time on gas work, including the Supplier Services activity.

Energy Contracts has a more comprehensive set of planning responsibilities for the gas business. Its role includes not only all of the administration associated with deliveries of third-party supplies, but also supply planning for customers who buy their supplies from the Company, and supply-capacity planning for both sales-service and distribution-service customers. The Manager, Gas Supply, and the Manager, Energy Planning, have primary responsibility for gas-supply procurement and capacity planning; the Manager, Energy Planning, and Senior Scheduler collaborate on the allocation of capacity to third-party suppliers; the Manager, Gas Supply, and the Senior Scheduler have major responsibilities for daily deliveries of system supply.

NUI serves a substantial number of "capacity-exempt" customers, for whom it does not acquire supply capacity. These customers accounted for 22 percent of distribution-system throughput for the Maine Division in 2018, and almost 29 percent of throughput for the New Hampshire Division. Distribution-system planning must account for these customers, but supply planning does not.

Energy Contracts' Manager, Gas Supply, works regularly with the Supervisor, Gas Control, to identify each day's pipeline supplies in the appropriate amounts to the Company's major delivery points into GSGT for those supplies. The Senior Scheduler must get the supplies nominated from the Company's upstream receipt points to the proper GSGT receipt points and subsequent delivery into NUI's distribution system.

The diagram below shows the organization of the Gas System Operations unit.



2. Staffing

a. Personnel

The Director, Energy Contracts has 25 years of utility experience, including negotiation of supply agreements, resource planning, portfolio management, and participation in regulatory proceedings. He joined the Company in 1994 and has held positions in finance and energy contracts groups. He has responsibility for supply planning and procurement for Unitil's electric distribution companies and gas distribution companies, as well as the structure and operation of the retail choice programs operated by each of the distribution companies. He also serves as a logistics section chief in the Company's emergency response organization.

The Manager of Gas Supply has spent her 20-year career at the downstream end of the gas industry in New Hampshire and Maine. She has held customer sales and service, accounting and administration, and scheduling and trading positions for a variety of participants in those markets, including pipelines and marketers, before beginning with NUI in 2010. She has held her current position since the beginning of 2013.

The Manager of Energy Planning has worked for the Company since graduating from college in 1995. He worked on supply planning, worked for Unitil's brokering business, and worked on energy supply for both the electric and gas sides of the business prior to Unitil's acquisition of NUI in late 2008. Since that time, his primary responsibilities have encompassed gas-supply planning and acquisition, including designing the capacity assignment provisions of the retail choice programs operated by each of the distribution companies. He performs yearly analyses of supplier performance, which the Company uses to assess and make changes in its gas-supply arrangements. He plays a major role in cost-of-gas proceedings before the Maine and New Hampshire Public Utility Commissions, and in other regulatory proceedings before state and federal agencies.

The Senior Scheduler has held gas scheduling positions with the Company since 2012. He has responsibility for nominating and scheduling gas on the interstate pipelines and storage facilities within the asset portfolios of NUI and FG&E. He also has a key role in implementing the capacity assignment provisions of the retail choice programs that each of the distribution companies operates and is now largely responsible for their day-to-day operations.

The Senior Energy Analyst II has worked for the Company since graduating from college in 2008. He has responsibility for natural gas demand forecasting, including long-term demand forecasts and daily operational forecasts, as well as day-to-day operations of gas and electric Supplier Services, including monthly cash-outs of third-party gas suppliers under the retail choice programs.

Outside of Energy Contracts, the Supervisor of Gas Control has important gas-supply responsibilities. She works in the Gas Operations organization and has worked in Gas Control for NUI since 1984, spanning changes in NUI ownership by different parents. During periods of cold weather, she coordinates closely with the Manager, Gas Supply in daily operation of the Company's gas-supply assets. She also provides direct supervision, coordination, and training for other Gas Control personnel.

b. Performance Measurement

Each employee receives a minimum of one written performance appraisal each year. Supervisors, managers, and Department Heads are encouraged to do written quarterly updates. Compensation adjustments tie to successful performance for specific accountabilities stated in each person's position description.

Part of the annual performance appraisal process is Goals for Next Year, which can be used to build performance and document achievement. Training is prescribed for individuals as appropriate as part of their annual performance reviews. All supervisors, managers, and Department heads receive formal training in performance management to ensure that Unitil does the best possible job of recognizing and documenting performance.

c. Position Descriptions

Unitil uses position descriptions for the jobs within each unit to provide sufficient detail about what the unit does and who has responsibility for the roles needed to accomplish unit work activities. Position descriptions describe each of the incumbent's principal accountabilities, with an estimate of what portion of time will be spent on each one. Each position description also describes the incumbent's principal challenges, decision-making authority, and required competencies. We found some of the job descriptions outdated when compared with current position responsibilities. Management agrees that an updating process is warranted.

3. Policies and Procedures

We found a lack of written policies and procedures addressing the gas-supply functions and activities. Incumbents are well experienced and familiar with their responsibilities. However, upon departures of key personnel, the lack of documented policies and procedures creates exposure to loss of continuity in understanding and executing them, particularly in a smaller organization. The Company's responses to our data requests in this examination provide a sound starting point for documentation. Management has agreed to develop it.

4. Controls

a. Documentation of Gas Supply Decisions

NUI's documentation of its gas-supply decisions takes several forms. First, for its capacity-commitment decisions (such as the decision to participate in the proposed Westbrook Xpress Project), Energy Contracts preserves its quantitative evaluations in its files. Qualitative factors generally enter final decisions, but they are not separately recorded. Rather, the Company presents all of its analysis, quantitative and qualitative, in its filings with its regulatory agencies for approval of its commitments.

Management uses the same process to document other evaluations, such as integrated resource plans, energy-efficiency programs, etc. There may be some internal analysis prior to filing, but the Company presents all evaluations, quantitative and qualitative, in its filings with its regulators, and considers those filings to be its documentation of any decisions taken as a result of those evaluations.

Management documents its commodity-purchase decisions in several ways. Annual request-for-proposals processes (RFPs) produce asset-management agreements (AMAs), winter and summer base-load purchase contracts, and contracts for delivered peaking services. Retained documentation includes all of the offers received, the Company's analysis of the offers, and the signed contracts for the offers selected. The signed contracts generally take the form of confirmations, issued under previously-executed standard contracts, such as the North American Energy Standards Board (NAESB) contract.

All of the term-purchase contracts – AMAs, base-load contracts, and contracts for delivered peaking service – use externally-determined pricing: either published index prices or the last-day-settlement price of the New York Mercantile Exchange (NYMEX) gas futures contract. Almost all use monthly prices; only a few sources, such as daily swing quantities under one AMA, use daily prices. Those daily prices are also externally-determined; they are generally also published index prices, but daily ones, rather than monthly.

Gas in storage also has an externally-determined price. NUI requires its storage asset manager to fill the storage ratably (at a uniform rate) over the storage-injection period with gas priced at a monthly index. Thus, when withdrawn, the storage gas comes to NUI at the weighted average price determined by the specified fill rate times the specified price, adjusted for any storage injection and withdrawal charges.

With this contract structure, almost all of NUI's day-to-day decisions are quantity nominations from sources with established prices. Management documents those decisions by retaining the spreadsheets containing each day's nomination information. Those spreadsheets are designed for input into the reports that the Company files with its Cost of Gas filings. Thus, its Cost of Gas filings reflects its records of sources of gas used each day. Filings with the Commissions add gas price information.

We selected at random a fall day and a spring day for identifying the nature and types of transaction records available to document supply choices available and the selections made. Conducting the supply function in the winter requires utilization of all sources, permitting fewer choices. Summer supply mostly uses base-load resources, which involve few choices that change day to day. Energy Contracts staff produced the records for the days we selected, and we confirmed that the choices made were appropriate. We also examined with Company personnel decisions made on a peak day in January 2019. Full records of the weather conditions had been saved, along with records of the decisions made. We judged those decisions to have been reasonable in the circumstances.

We had one issue with the documentation. For each of the days that we requested, a decision was made using estimated pricing. Those prices were not recorded. In comments on the draft of this report, the Company pointed out that, for the fall day, the selection was driven by locational considerations. Given the physical limits of GSGT and the Company's distribution system, not all sources can be delivered to every service area. Where the supply is needed dictates some choices.) Thus, while price might have played a role, it was not the determining factor in the choice.

On the fall day, Energy Contracts staff elected to take some daily swing gas available under two of the AMAs. One agreement provided for the gas to be priced at a daily index. Those indexes are not published until the day after transaction execution. Thus, transactions like that one must be entered on the basis of an estimated price.

Indicative prices are available each day. The Intercontinental Exchange (ICE) provides an on-line platform that shows offers and some transactions on a real-time basis. When deciding whether to enter a particular daily transaction, Energy Contracts staff generally consults ICE to view similar offers. It is likely that they did so on the day that the daily swing supply was taken, but there is no record of such action and what prices they might have observed.

In comments on the draft of this report, the Company pointed out that, due to illiquidity on their supplying pipelines, indicative pricing may or may not be available each day. Moreover, the time when Northern must make decisions can further affect the availability of indicative pricing. For example, Northern's next-day nominations to asset managers are due before 9 a.m., before active trading on ICE begins. Thus, the best pricing reference (for next day) is current-day published Gas Daily indices for nearby pipelines, such as Algonquin Gas Transmission and Tennessee Gas Pipeline. Northern also makes late-day sales between 7 and 8 a.m., when there is no activity on ICE. Spot-market purchases, which are very rare, would likely occur during business hours and ICE would be consulted if any nearby pipeline activity is posted.

The spring day presented the same documentation issue. Energy Contracts staff had decided by that time that the Company was "long" on supply at that point in the winter. Thus, on the day we selected, the staff was looking for a one-day sale to an off-system customer. Such a customer made an offer, at a price that it specified. As in the case of the fall transaction, the staff would likely have consulted ICE to see whether to accept the offer or to look for another. Whether they did, and what price information they found, was not recorded.

b. Dollar Limits on Authority to Approve Transactions

We did not initially find clear, documented definition of expenditure authority levels, which form an important measure for controlling commitments. Management advised that the Company has embedded those levels into its accounting system and specified responsibility for setting levels in its Security Administration policy. That system prevents Company personnel from approving payments in an amount that exceeds an individual's authority.

That system does not, however, address employees' ability to commit the Company to an expenditure. We learned that the authority to commit relies primarily on term:

- The Manager, Gas Supply can commit to transactions shorter than one month
- The Director, Energy Contracts can commit to any term for gas supply
- The CFO commits for any incremental supply capacity.

Company personnel are generally aware of who has what level of authority. Furthermore, we did not find any examples of employees exceeding their authority levels. We did not, however, find that those levels could be communicated explicitly to a party outside of the Company seeking some kind of commitment.

c. Separation of Transaction-Related Functions

For purposes of financial controls, companies with energy-trading operations separate transactions functions among transaction execution (front office), confirmation (middle office), and invoice verification (back office). Such separation ensures that transactions take place under controls that promote accuracy, measurement, and integrity.

NUI does not employ such a clear separation. Members of the Energy Contracts staff perform these functions together. When we raised the separation issue, management responded that Internal Audit is now reviewing needs and methods for strengthening such controls.

d. Examinations of Gas Supply by Internal Audit

As with most gas distribution utilities, supply operations and transactions bring large costs and impose risk. It is common to see periodic reviews by the internal audit function of gas supply costs and operations. We did not find that practice at NUI. Management has agreed that internal audit's 2019 activities plan will include gas supply, and that it will expand its Sarbanes-Oxley testing of financial controls to include gas supply.

e. Code of Conduct

We find use of a comprehensive code stressing the importance of ethical, objective conduct a material element in creating an effective controls environment for gas supply. Such codes should clearly specify values, expected conduct, prohibitions, and consequences. Regular acknowledgement of receipt, understanding, and acceptance of the behavioral standards and the limits such codes play an important role in ensuring that conduct regarding gas supply transactions has the objectivity and integrity necessary to optimize costs for customers.

Unitil has such a code. We found it appropriate in stressing the importance of ethical conduct, communicating appropriate values, describing promoted and prohibited behaviors, and specifying the consequences of failure to conform to expectations and requirements. Company officers acknowledge it and agree to be bound by it annually. New employees are given the code and asked to acknowledge it when they join the Company.

We did not find a requirement for annual acknowledgement by Energy Contracts staff. Management agreed that this should be done and undertook to initiate it going forward.

f. Gas Supply Risk Management

The gas-supply function presents considerable risks to Unitil as an enterprise. We examined the Company's approach to identifying and addressing these risks. We found this function to be addressed satisfactorily.

C. Conclusions

1. Organization of the gas-supply function is compact, efficient, and effective.

The Company plans for and manages a rather complicated supply system with relatively few people. Individuals' roles in supply processes are well defined, and coordination with essential functions in other organizations is well established and smooth.

The same individuals shift from an intense focus on operations in the winter to analysis, planning, and re-contracting in the spring and summer. Because the same individuals do both, operating experience is brought directly to bear on evaluation and planning going forward. As the Manager, Energy Planning is also the Company's principal witness in its gas-cost recovery proceedings, the Commission and the Company's customers have access to as much detail as they want regarding what the Company has done and what it plans to do.

Seasonal readiness meetings support higher-level coordination with other Company operations. Distribution-system planning holds these meetings in the fall and spring and other business functions attend, as well as Energy Contracts. Energy Contracts also occasionally asks distribution-system planning for analysis of particular supply problems.

2. The training and experience of gas-supply personnel is commensurate with system needs and with what we have observed at other similarly-sized entities.

The Company is fortunate to have extremely capable and highly experienced individuals in the gas-supply function. The staff is very small for the amount of work they do.

3. Performance assessment is consistent with prevailing industry practice.

Annual performance reviews with quarterly updates is the standard among most industries. Relating compensation adjustments to performance in identified accountabilities is best practice. Unitil's practice of providing formal training in performance management is a strong one.

4. Some position descriptions are out of date. *(Recommendation #1)*

The Company uses position descriptions in several ways, including comprehensive statements of an individual's role in his or her organization, and careful statements of accountabilities that can be used in performance assessment.

The Company's policy is that position descriptions are to be updated annually. Some have not been but should be. Management has agreed to do so.

5. Documentation of supply decisions is not quite adequate. *(Recommendation #2)*

The results of NUI's gas-supply evaluations are presented in various filings with the Maine and New Hampshire Public Utility Commissions: primarily Integrated Resource Plans, requests for Commission approval of long-term supply contracts, and periodic Cost of Gas filings. With the assistance of Energy Contracts staff, we examined daily records for four different days within the past gas year (November through October). Records were generally adequate to support review of the decisions made. However, we found no documentation of the estimated prices of supply options considered on the day that the choice was made.

NUI pays indexed prices for almost all its daily gas-supply transactions, with spot-market purchases (only occasionally) and off-system sales the exceptions. The gas-supply contracts, typically part of asset-management agreements, specify the indexes that apply. While the value of any of those indexes for any given day can be retrieved currently or after the fact, they are generally not settled until the day after a transaction is agreed to. Thus, agreement must occur with respect

to an estimated price. Management does not retain those estimates, but should. Similarly, for the occasional off-system sale, prices at the time of the transaction can only be estimated. Those estimates are not retained, but they should be.

6. Controls are insufficiently formal. *(Recommendation #3)*

NUI employs less formal controls than we have seen elsewhere, an approach it considers generally appropriate to its small size. For example, although individuals who conduct supply processes show familiarity with procedures, they are not documented. Expenditure-authority levels exist for payments, but are not clear in limiting authority to make commitments including matters like signing gas-purchase contracts. Also, widely employed controls, such as who compares supplier confirmations to Company nominations or purchases, and who approves invoices for payment, are not applied in a structured way.

controls need to become more comprehensive and formal. Management should place less reliance on the integrity of individual staff members. When we brought our concerns in this area to the Company's attention in a Roundtable discussion., the Company provided some additional information and undertook to correct deficiencies in others.

D. Recommendations

1. Update position descriptions. *(Conclusion #4)*

Management has agreed to do this.

2. Add gas-price information, including estimated prices, to the record of daily gas-supply selections. *(Conclusion #5)*

Our review of supply-selection records for individual days did not reveal records of gas-price information, including estimated prices used to decide on daily-priced transactions, for that day in those records. We believe that information should be recorded in order to complete the transaction records.

We think the correction for this deficiency is to add another tab containing all price information to the spreadsheet that serves as the record for decisions made each day. This fix should be made immediately.

3. Re-review supply processes from a controls perspective. *(Conclusion #6)*

NUI's supply processes function smoothly and competently. We had some concerns that we shared with the Company about the controls environment for those processes, and the Company undertook to address them. We recommend that the intended solutions be reviewed after the Company has had time to implement them, which we estimate to be in about six months from the time that this report is issued.

Particular areas to be reviewed include the following:

1. The Energy Contracts unit, which conducts the gas-supply function, does not have Mission and Function statements; it uses detailed job descriptions instead. The job descriptions must

be updated, but they must also assign clear responsibilities in areas of control: the person who evaluates supply-related decisions cannot be the same person who made the decision.

2. Regarding policies and procedures, the responsibilities, accountabilities, activities, and interactions with others involved in conducting the gas-supply function are not recorded in a way that allows someone to perform the function if an incumbent is absent for some reason, or to evaluate the results. The Company's accountants and auditors can now verify that the costs produced by those processes are accurate; the question is whether they are appropriate; *i.e.*, free of mistakes and free of any possible malfeasance.
3. The processes of transaction execution, confirmation and invoice verification should be separated to ensure accuracy and integrity.
4. At the time of our review, Unitil's Internal Audit unit was due to perform a comprehensive evaluation of the gas-supply function soon. Conduct of gas-supply operations was to be examined, and strengthening controls had been identified as a key objective of that review.

II. Gas Supply Planning and Forecasting

A. Background

Ensuring sufficient supply to fill requirements at optimum prices requires sound supply planning. We applied the following criteria in examining supply planning at Northern Utilities (NUI):

1. Conformity of weather data handling and analysis methods with industry norms and unique service territory circumstances
2. Consistency of assumptions, variables and probabilities in capacity planning should comport with observable supply obligations
3. Existence of efforts appropriate to identifying and establishing alternate sources of supply.
4. Regularity and comprehensiveness of evaluations of peak-period performance
5. Strength of the correlation between the capacity portfolio and the load duration curve
6. Gas plans should be consistent with related corporate planning elements.

This chapter explores the supply-planning processes, how they produce the identification of supply requirements, and how management plans for supplying those requirements. We also generally address the relationship of supply planning to other areas of system planning, especially marketing plans.

B. Findings

The newly-filed Integrated Resource Plan comprehensively and clearly presents management's forecasting and supply-planning methods. Section V.B describes weather analysis; Section V.C. addresses Planning Standards and Design Weather; Section V.D. covers forecasts of numbers of customers, use per customer and peak-day analysis. We examined Company methods with reference to prevailing industry practices, and how and how well decisions about supply resources incorporate the results of applying those methods.

1. Weather Analysis

The Company uses 30 years of history (the gas years of 1988/89 through 2017/18) to populate its normal and design weather data. The data capture effective degree-days (EDDs) by adjusting temperature data for wind speed. Data for the Maine Division came from the Portland, Maine weather station at the Portland International Airport, and for the New Hampshire Division from the weather station at Pease International Tradeport.

Management calculated normal-year EDDs separately for its Maine and New Hampshire Divisions, by summing for each their 30-year average billing-cycle EDDs for each month. Management used a 1-year-in-30 return period to determine winter period (November through March) design-year EDDs It used normal (average) weather for summer month (April through October) determination of design EDDs. The Company calculated design-winter EDD by summing the billing-cycle EDD for each winter in the data set (1988/89 through 2017/18), then using the 30-year average and standard deviation to select the winter EDD with a once-in-30-years probability of occurrence. It then distributed the winter design EDDs among the individual winter

months by multiplying the normal EDD for each winter month by an adjustment factor equal to the design-winter EDD divided by the normal-winter EDD.

2. Requirements Forecasting

The new IRP presents the methods for requirements forecasting and the results of applying them. The Company combined its rate classes into customer segments: residential, commercial and low-load-factor industrial, and high-load-factor commercial and industrial (C&I), driven by characteristics of their consumption. Regression analysis of billing data supported the development of econometric models for forecasting numbers of customers and use per customer for each segment. Separate equations drove the results for the Maine and New Hampshire Divisions.

Management made reductions to the resulting customer-segment forecasts to reflect energy-efficiency savings, applying separate adjustments for each segment and for each of the two Divisions. Those adjustments yielded Net Demand by segment for each Division. Adjustments to total Company-wide Net Demands for Company Use and for lost and unaccounted for gas (LAUF) yielded forecasts of Normal Year Throughput for each Division.

Planning Load comprises another important planning parameter. This parameter measures Normal Year Throughput adjusted to design weather conditions, less the projected loads of Capacity Exempt customers. The Company developed Planning Load forecasts for Design Year and Design Day conditions for both Maine and New Hampshire Divisions.

Management uses estimated Design Day requirements to calculate its need for peak-day supply capacity. It calculates Design Day requirements using regression analysis of actual daily throughput data, separately for each Division.

On January 21, 2019, the Company experienced a new system record peak-day throughput. To test its Design Day forecasting model, the Company put that day's weather conditions into it. The model ended up under-forecasting actual throughput on that day for both Divisions - - by 3.0 percent combined, by 3.8 percent for Maine, and by 2.1 percent for New Hampshire. The Company concluded that the Design Day model is "reasonably accurate, and does not show a bias towards over-predicting Design Day demand."

a. Analysis of Forecast Performance

In preparing the new IRP, management compared the forecasts of its prior IRP with actual performance. That comparison led to two modifications. First, it removed from the Residential Heating Use Per Customer model a price variable. The re-specified model more accurately predicted actual use per customer for the period between the previous IRP (2015) and the current one. Second, management updated the peak-day forecasting model to improve its performance.

The 2015 IRP comprised the most recent version as we began our field work. In reviewing it before the new one became available, we observed that actual throughput on January 2, 2014 was well below what the Company's peak-day forecasting model would have predicted. Management explained that it reviews daily forecast performance regularly, given the importance of forecasts for day-to-day operations. The Company noticed the discrepancy for that date immediately, and investigated it promptly. It found several explanatory circumstances:

- An extreme snow/blizzard event closed schools and businesses
- A large change in temperature occurred extremely quickly
- With New Year's Day the day before, resumption of normal work-day activities on January 2nd may have ramped up more slowly than usual.

b. Interaction Between Gas Supply and Marketing

The Company developed a comprehensive marketing program soon after it acquired NUI. That program identified customers on main but not connected, and low-use customers as targets with the highest potential. The Maine service territory had lower saturation than New Hampshire, thus presenting the better opportunities. Management had also slated facilities in Maine for a Cast Iron Replacement program. The Company continues special promotions and special incentives offers to prospective customers for connection in the areas affected by that program.

Management annually updates details of its marketing programs; *e.g.*, locations of special focus. The Energy Contracts unit, which is responsible for gas supply, uses these details to anticipate where additional supply might be needed.

Energy Contracts is informed when other Company activities might affect requirements for gas supply. Company personnel gather at Seasonal Readiness Meeting to discuss new initiatives, such as a targeted area build-out. Other initiatives are discussed in the course of normal internal coordination.

3. Portfolio Analysis

Gas distribution companies like NUI use three types of supply assets to meet customer demand:

- Year-round asses, primarily pipeline capacity
- Seasonal assets, typically storage facilities that are filled in summer, then re-deliver in winter
- Peaking assets, most often liquefied natural gas (LNG) storage and revaporization facilities or propane-air plants, that provide high deliverability for short periods in response to peak weather events.

Prior to Unitil's acquisition of NUI, the Company was assigned some still-operating "legacy" pipeline and storage capacity as part of the wholesale gas market restructuring required by FERC Order No. 636. This group of assets included capacity on the Iroquois Gas Transmission System (IGTS), the Tennessee Gas Pipeline system (TGP), and the Algonquin Gas Transmission Company system (AGT). Most of these assets are relatively old, considerably depreciated, and therefore, attractively priced. They comprise the foundation of NUI's supply portfolio.

Also prior to Unitil's acquisition of NUI, the Company contracted for resources known as "the Wells Replacement Contracts." Those contracts served seasonal and peaking requirements, but with supplies delivered to NUI's principal receipt points. NUI entered into them as part of a settlement regarding an LNG manufacturing and storage facility planned for installation in Wells, Maine. NUI did not actually construct the facility, choosing instead to enter three replacement contracts involving: (a) delivered pipeline supply from Duke Energy, (b) a combination liquid/vapor LNG service from Distrigas, and (c) liquid-only LNG supply from Distrigas. Distrigas

owned an LNG receiving terminal located in Everett, MA. Distrigas sold the facility to ENGIE North America, Inc., which recently re-sold it to Exelon Generation Company, LLC. Constellation LNG, LLC, a subsidiary of Exelon, operates the facility.

The last of the Wells Replacements Contracts expired in late 2011. Their expiration, plus growth in NUI's load since that time, have created a significant requirement for additional supplies in both seasonal and peaking roles.

Weather is the primary driver of supply requirements for companies like NUI. Current forecasting techniques provide forecasts of daily supply requirements for most any weather, with normal-year and design-year weather used most often.

Management inputs requirements forecasts into an optimization model. The model designs a portfolio of supply resources that provides the best fit for the input forecast. NUI uses SENDOUT, widely used for such purposes in the gas distribution business. SENDOUT considers demand forecasts, available supply and delivery options, and the costs associated with them, to produce projections of costs for meeting demand with various combinations of supply options. It solves for the least-cost mix of options for meeting demand, subject to user-defined constraints. The model incorporates the legacy assets, enabling it to solve for the least-cost mix of *additional* supply options.

As the IRP notes (See, *e.g.*, Section III), NUI has limited supply options, both in number and in type. Several options for expanding U. S. pipelines to New England have been abandoned. Suppliers of regasified LNG mostly offer supply on a delivered basis.

For its seasonal and peaking requirements, NUI issues requests for proposals (RFPs) annually. It seeks seasonal supplies first, along with asset-management services for its legacy pipeline and storage assets. A second RFP for peaking supplies follows in mid-summer.

The offers that NUI receives in response to the RFPs essentially all provide supply on a delivered basis. Delivered supplies mean that the provider bears the burden of getting the gas to NUI's principal receipt points. The resulting contracts are mostly on a year-to-year basis. [redacted]

NUI has found that three pipeline options compare favorably with the alternative of relying on delivered supplies. Accordingly, the Company has entered contracts for three increments to its pipeline-capacity resources:

- 9,965 MMBtu/day on Phase III of the Portland XPress Project, scheduled to enter service in November 2020
- 7,500 MMBtu/day on the Atlantic Bridge Project, also anticipated to enter service in November 2020
- 9,965 MMBtu/day on Phase III of the Westbrook XPress Project, anticipated to enter service in November 2022.

The Company's applications for approval of its participations in the Portland XPress and Atlantic Bridge Projects have been approved by the Commission. Its application for the Westbrook XPress Project recently secured approval.

Each of these three projects would replace a portion of what NUI would otherwise require in the way of delivered supplies. The Company's analysis indicates that primary benefits these projects would bring lies in access to reliable supply points having lower and more stable pricing than is available with delivered supplies. These features make them preferable to management.

The new IRP shows changes from the Company's current winter-period mix of pipeline, storage and delivered supplies after these new projects enter service. Figure IX-1, reproduced below, shows the Company's assessment that it would require delivered supplies (seasonal and peaking) for almost 100 days under design-winter conditions, before any of the three projects goes into service. It would meet almost half of peak-day requirements with delivered supplies. Figure IX-2, also reproduced below, shows the Company's view of requirements for delivered supplies after the three new projects go into service. Those requirements drop to about 40 days, and accounts for significantly less (about one-third) of the design day. Comparison of the two figures shows that the three new projects push the Union Dawn Storage resource up in the dispatch stack, reducing considerably the requirement for delivered supplies. (As a seasonal resource, the Union Dawn Storage should be above year-round capacity, old and new, in the dispatch stack.)

Figure IX-1: Load Duration Curve, Design Winter 2019/20

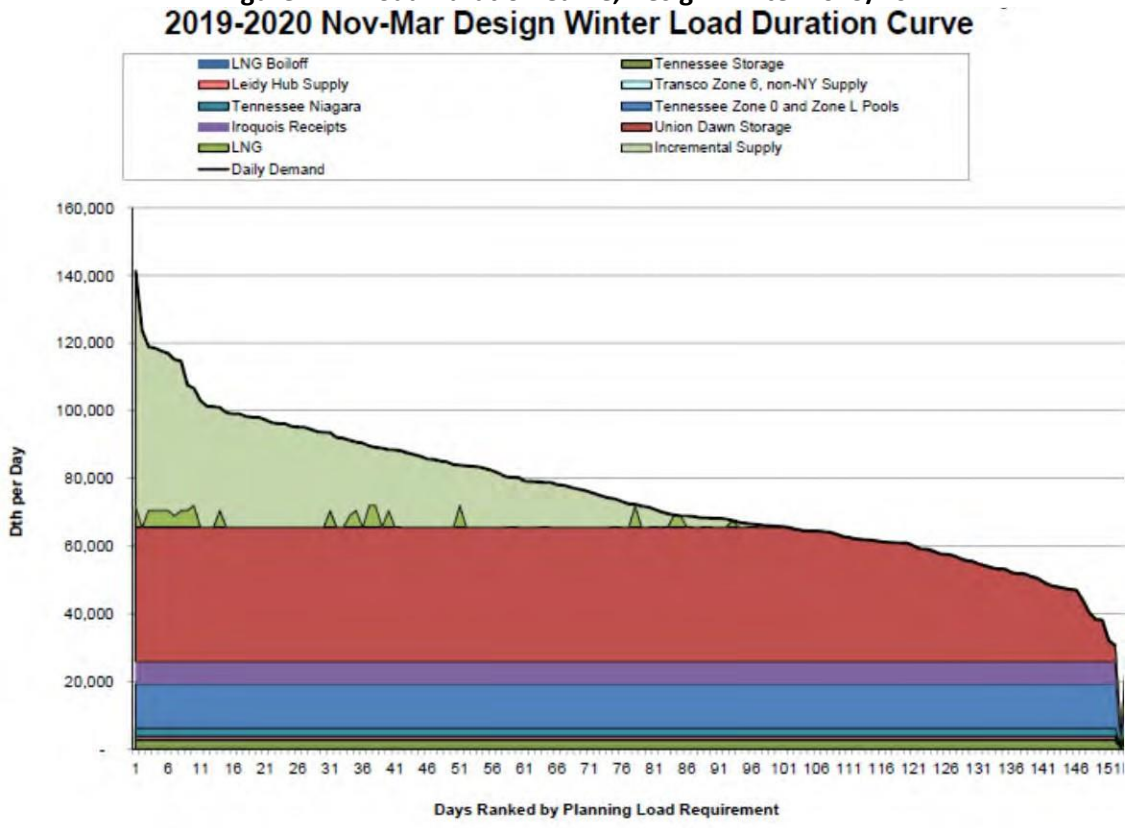
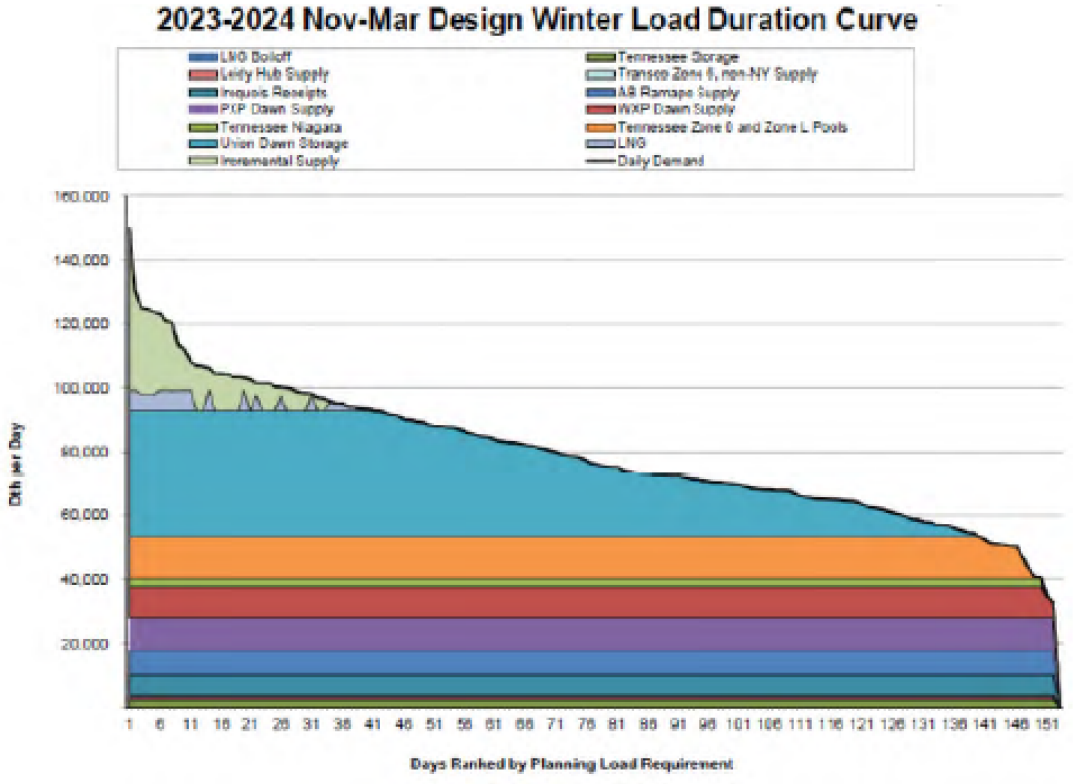


Figure IX-2: Load Duration Curve, Design Winter 2023/24



4. Development of Supply Options

Management believes that its continued dependence on delivered supplies, even after adding the three increments of pipeline capacity, entails risk. Particular concerns include constrained delivery capacity on peak days, and the limited number of offerors for delivered supplies. The Company continues to discuss additional pipeline supply projects with potential offerors, and it has recently re-started work on on-system supply options.

C. Conclusions

1. The Company's weather analysis could be improved. *(Recommendation #1)*

Management's use of averages and standard deviation in its weather analysis implies normally-distributed weather. Normal distributions have most values clustered around the mean (average), which falls in the middle of the range of values. Other values taper off symmetrically in both higher and lower directions. Standard deviation measures the dispersion of a distribution. For a normal distribution, 68 percent of values lie within one standard deviation of the mean, and 95 percent within two standard deviations.

With 2.5 percent of observations higher than two standard deviations above the mean, and 2.5 percent lower, there exists a 2.5 percent probability that a value will fall above the mean-plus-two-standard-deviations, and a 2.5 percent probability that a value will fall below mean-minus-two-standard-deviations. Analysis of design weather should focus on concern about EDD values higher

than the mean plus two standard deviations. A normal distribution indicates a 2.5 percent probability of such an occurrence. That probability corresponds to a 1-in-40 chance of occurrence. If weather observations such as EDD values fit a normal distribution, the 1-in-30 standard would correspond to a probability of occurrence of 3.33 percent.

Careful studies of weather data usually show it not normally distributed; *i.e.*, values do not cluster around averages as much as they would be if normally distributed. They vary more than a normal distribution would suggest. Extreme values may occur more often than standard-deviation analysis would suggest.

Some of the analysis in the new IRP implicitly provides evidence that weather data for both Divisions does not fit a normal distribution. Recorded Peak Day EDD and Cold Snap EDD for both Divisions exceed the values calculated with the 1-in-30 standard. This demonstrates that weather more severe than would be predicted by the 1-in-30 standard has occurred in both Divisions within the past 30 years.

Industry best practice now calls for use of Monte Carlo simulation to develop distributions representing the actual occurrence of weather variables in particular locations, such as the weather stations that NUI uses for its analysis. Using such a distribution would enable management to choose for each variable values having the probability of occurrence desired for planning. Normal- and Design-Year requirements could be calculated for the weather that has actually occurred, rather than for weather that fits a normal distribution. Simulation of actual weather may also enable NUI to estimate more precisely the requirements of customers served by retail marketers. More precise estimates could enable NUI to release more of its contracted capacity to asset managers, thereby increasing the amounts they would be willing to pay for the rights to manage the assets.

2. Load forecasting methods conform to prevailing industry practice and they adequately serve the Company's needs.

Numbers of customers times use per customer for forecasting supply requirements reflects currently prevailing industry practice. Regression analysis for developing forecasting models for both parameters also finds commonly utility-industry use.

3. Management routinely evaluates the performance of its forecasting methods.

Management compares forecasts with actuals in the course of preparing succeeding IRPs. It conducts examinations of daily forecast models soon after any discrepancy occurs, given that daily operations rely on these models. This reflects an appropriate level of attention to accuracy.

4. Management adequately coordinates gas supply planning with other areas of corporate planning.

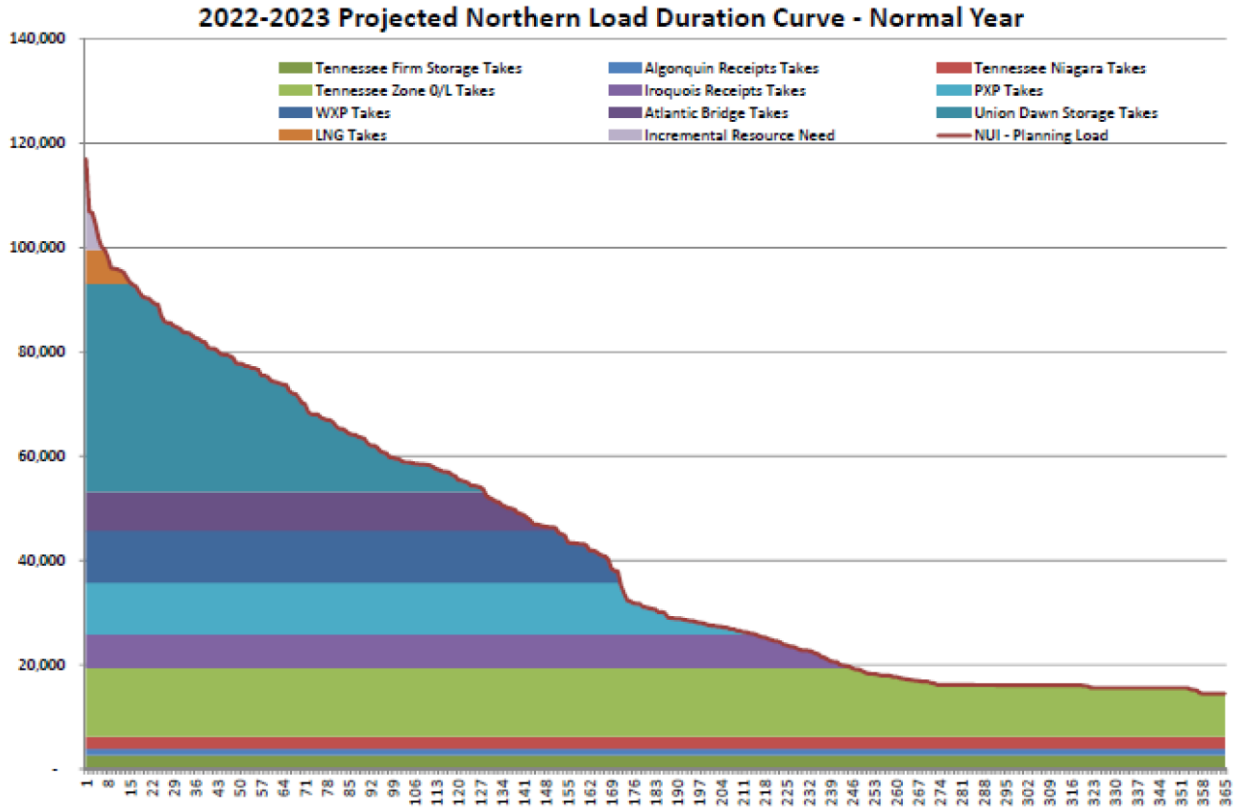
Much of this coordination takes place informally, in the course of preparation for various initiatives. The Company has two "readiness" meetings each year that inform department heads about plans that might affect them. Those gatherings engender deeper inquiry by Energy Contracts personnel into plans that might affect the gas-supply function.

5. Management should expand the scope of its resource analysis. *(Recommendation #2)*

We found the discussion in the Resource Balance (Section VII) and Incremental Resources Options (Section VIII) sections of the IRP oriented toward the peaking portion of the resource stack. We want to ensure that other parts of the Company's supply portfolio also receive attention.

We reproduce below a 365-day load duration curve (as contrasted with the 151-day durations shown in the IRP and reproduced above) that management prepared to respond to our request.

Company comments on a draft of this report noted that it does consider 365-day utilization in its supply planning, and that it provided summer-period load duration curves in the IRP. It presented winter and summer load curves were presented separately because the dispatch order changes from winter to summer. Company comments also noted that, even at 151 days of utilization, daily variability in weather can cause some non-use in winter months (warm days in November, March) and more use in shoulder summer months (cold days in April, October). Inter-seasonal variability offers another reason why Company presents seasonal load duration curves.



This more complete curve suggests the capacity of the new pipeline projects will see limited service outside of the winter season. That pipeline capacity provides 365-days-per-year capacity, but:

- PXP capacity shows use on about 215 days per year
- WXP capacity shows use on about 170 days
- Atlantic Bridge capacity shows use on about 160 days.

Local gas distribution companies outside of New England use pipeline capacity in non-winter months to fill storage. New England circumstances overall differ, because of the limited

availability of in-market storage. Pipeline capacity connecting New England with other areas is not useful for filling storage in those other areas because no supplies are available to move from New England to those other areas. Imported LNG is available in New England, but regasifying it to move it to storage in other areas would add too much to its costs.

LNG facilities effectively comprise New England's in-market storage sources. Individual local gas distribution companies own all but the LNG import terminals, making them part of each owner's state-jurisdictional assets. Some LDCs "rent" space in others' LNG facilities, but we have not found such arrangements typical.

Our concern with NUI's stated approach to its resource analysis is its focus on the peaking portion of its resource requirements. How to use the available pipeline capacity when its new projects go into service should also form a focus of its supply-planning work.

The need to address both peak requirements and pipeline capacity use require joint consideration and analysis. Capacity available in the non-winter months offer a resource that can contribute to the economic viability of an LNG facility (for example, by bringing gas from a supply point with low and stable off-peak prices to a storage facility). New England's differences between summer prices and the value of gas in winter can be significant. Substituting gas bought in the summer for gas that would have been bought in the winter would likely provide considerable economic benefit. That benefit should be considered in any analysis of a new LNG facility.

D. Recommendations

1. **Test the use of Monte Carlo distributions in the Company's weather analysis.** *(Conclusion #1)*

The Company should test the use of Monte Carlo-based weather distributions in its supply planning. Formerly complex and expensive to use, Monte Carlo software has improved considerably, and is finding increasingly broad use in utility-company supply planning.

The test of whether the Monte Carlo analysis is worth what it costs to implement and operate depends on whether it makes a difference in calculated requirements for supply for system-supply customers. This population includes transportation customers for whom the Company must provide supply capacity. It can be used to calculate normal-weather requirements and design-weather requirements. It could also be used to estimate the capacity requirements of the retail marketers to whom NUI is assigning capacity. Without testing, however, it is not possible to say how this method might affect those parameters.

The Company should look into application of Monte Carlo methods soon. It should report on its plan for testing these methods in the proceeding to consider the findings of this audit (Docket No. 2018-00300) and present its results with its summer cost-of-gas filing.

2. **Expand the scope of the Company's resource analysis.** *(Conclusion #5)*

The IRP reports that the Company has engaged a consultant to

> *… help identify Non-Pipeline Supply Resources. Possible projects include adding storage to Northern's existing LNG facility in Lewiston, exploring options to construct a new LNG facility and looking for opportunities to purchase renewable natural gas (RNG).*

The scope of that work should expand to include utilization of the available capacity on the Company's newly-added pipeline capacity.

Combining the available pipeline capacity with capacity in an LNG manufacturing and storage facility is a natural choice. Using the capacity with the Lewiston facility would require installing liquefaction; any new facility would likely include liquefaction.

Scale is an important aspect of the economics of an LNG facility, suggesting that partnering with other potential users to explore a larger facility warrants consideration. An asset manager might explore combining NUI's available pipeline capacity with someone else's LNG facility. Thus, partnering with an asset manager should also be explored.

Adequate study of possibilities such as these will likely take some time. The Company should report on its results periodically, to assure its customers and the Commission that it is taking the effort seriously. Annual reports, with one of its cost-of-gas filings, should be sufficient.

III. Gas Supply Procurement

A. Background

Effective gas supply procurement requires a structured, well-controlled, rigorously executed, and transparent set of processes, critical in ensuring supply to customers at the lowest prices consistent with reliability requirements. Key elements include clear delineation of supply requirements, establishment of risk tolerances and means for ensuring satisfaction of them, a sound and objectively executed procurement processes, promoting a robust number of offerors competing for the opportunity to supply, assessment of the reliability of offers received, and competitiveness of the delivered prices of alternatives.

Gas supply planning identifies requirements for supply, and the duration of requirements (from a few peak days per year to seasonal or year-round). Planning and executing effective procurement of supply requires a sound process for identifying accessible options that can fill each requirement. Considerations include:

- Sourcing from a sufficiently broad array of supply points to provide enough diversity to assure competitive prices and protection from disruptions
- Options configured to fit the requirement
- A sufficient number of competitors to assure competitively-determined prices.

The preceding chapter of this report examined how the Company identifies its requirements for supply, and how well it addresses its concern about its limited number of supply options. This chapter turns to the processes for selecting among available capacity options, and for securing an appropriate assembly of supply sources from among them. We applied the following criteria in evaluating gas supply procurement:

1. Clarity of objectives for purchasing and price-risk-management activities, their comprehensiveness and support for meeting customer needs reliably, yet cost effectively
2. Sufficiency of focus on liquid, transparent markets in gas procurement and price risk management
3. Robustness of the range and numbers of suppliers identified and pre-qualified to meet likely needs, including short-term and emergency conditions
4. Adequacy of information maintained for identified and pre-qualified vendors
5. Analytical rigor and objective execution of offer evaluations, including application of specific criteria, weightings, responsiveness, and supplier performance history
6. Consistency of capacity contracts consistent with appropriate quality and reliability objectives
7. Promotion of the identification and use of sufficient numbers and types of vendors to ensure a sufficient range of competitive options for meeting supply needs.

B. Findings

1. Supply Portfolio Summary

The Company's supply capacity portfolio accesses several important supply regions:

- The U. S. Gulf Coast, via long-haul capacity on the Tennessee Gas Pipeline system (TGP)

- Central and Eastern Pennsylvania, via Texas Eastern Transmission Corporation (TXE) and the Algonquin Gas Transmission system (AGT), and via short-haul capacity on TGP, and using Company storage capacity in this region
- Pipeline supplies from eastern Canada, via TGP from the Niagara import point, and via the Iroquois Gas Transmission System (IGTS) from an import point at Waddington, NY
- The Dawn, Ontario supply point, via Enbridge, the TransCanada PipeLines system (TCPL), the Trans Quebec & Maritimes system (TQM) and the Portland Natural Gas Transportation System (PNGTS).

The Company had access to most of its still-existing capacity when Unitil acquired NUI in December 2008. Since that acquisition, NUI has renewed, converted or terminated essentially all of the pipeline and storage contracts then in place. The terminations it made sought cost reduction, moving receipt points closer to the Company's distribution system, or both. The table below, modified from one included in the Company's 2015 IRP, shows the disposition of each of the contracts from that original portfolio.

Table VI-2: Pipeline Transportation and Underground Storage Contracts by Capacity Path					**Updates by Contract Path**
Capacity Path	**Vendor**	**Contract ID**	**Receipt Zone**	**Delivery Zone**	**Contract Disposition**
Chicago Path	Vector	FT-1-NUI-0122	Alliance	Dawn	Terminated
Chicago Path	Vector	FT-1-NUI-C0122	St. Clair (Canada)	Dawn	Terminated
Chicago Path	Union	M12205	Dawn	Parkway	Converted
Chicago Path	TransCanada	41235	Union Parkway Belt	Iroquois	Converted
Chicago Path	Iroquois	R181001	Waddington	Wright	Renewed
Chicago Path	Tennessee	95196	TGP Zone 5	TGP Zone 6	Renewed
Chicago Path	Tennessee	41099	TGP Zone 5	TGP Zone 6	Renewed
Chicago Path	Algonquin	93002F	Mendon, MA	Brockton, MA	Renewed
PNGTS Year-Round	PNGTS	1997-003	Pittsburgh	Granite	Converted
Tennessee Niagara	Tennessee	5292	TGP Zone 5	TGP Zone 6	Renewed
Tennessee Niagara	Tennessee	39735	TGP Zone 5	TGP Zone 6	Renewed
Tennessee Long-haul	Tennessee	5083	TGP Zone 0	TGP Zone 6	Renewed
Tennessee Long-haul	Tennessee	5083	TGP Zone L	TGP Zone 6	Renewed
Algonquin Long-haul	Algonquin	93201A1C	Lambertville, NJ	Taunton, MA	Renewed
Tennessee Firm Storage	Tennessee	5195	TGP TGP Zone 4	TGP TGP Zone 4	Renewed
Tennessee Firm Storage	Tennessee	5265	TGP Zone 4	TGP Zone 6	Renewed
Washington 10 Path	Washington 10	01052	W10 Withdrl Meter	Vector	Terminated
Washington 10 Path	Vector Vector	CRL-NUI-1096	Alliance	Dawn	Terminated
Washington 10 Path	TransCanada	CRL-NUI-1097	Washington 10	Dawn	Terminated
Washington 10 Path	PNGTS	33322	Union Dawn	East Hereford	Renewed
Washington 10 Path		1997-004	Pittsburgh	Granite	Converted
All Capacity Paths	Granite	14-001-FT-NN	NA	Northern	Renewed

Reviews of the original capacity portfolio as those contracts expired resulted in some modifications. In particular, the Company converted the "Chicago" path in the original portfolio to today's "Dawn Storage" path. It also relocated its largest underground storage from Washington 10 to Dawn, increased it from 3.4 Bcf to 4.0 Bcf, and increased the maximum daily withdrawal capability from 34,000 Dth to 40,000 Dth. The region around Dawn, including adjacent parts of Michigan in the U. S., includes a number of gas storage facilities. Dawn operates as well as a highly active trading point, reflecting its convergence (as the new IRP depicts) for supplies from important gas-producing regions, including the Western Canadian Sedimentary Basin and the Marcellus/Utica region in Ohio, New York, Pennsylvania and West Virginia.

NUI also accesses the markets for liquefied natural gas (LNG) to supply its LNG storage and regasification facility in Lewiston, Maine. LNG enters the region at the Canaport LNG receiving terminal in New Brunswick and at the Distrigas facility in Everett, Massachusetts. (Exelon Generation Company, LLC now owns the Distrigas facility (see Chapter II)). The NUI system also connects to the Maritimes & Northeast Pipeline system (M&NP). The offshore Nova Scotia gas-producing areas have become depleted, but revaporized LNG from the large Canaport terminal in New Brunswick can reach NUI and other U. S. markets via M&NP pipeline facilities.

The following table lists the components of the Company's supply capacity portfolio, including the pending Portland Xpress and Atlantic Bridge and the proposed Westbrook Xpress Project. The table shows that all of the Company's sources involve multiple receipts and deliveries between their sources and their arrival at NUI's distribution system.

Pipeline Transportation and Underground Storage Contracts by Capacity Path

Capacity Path	Vendor	Contract ID	Contract End Date	Receipt Zone	Delivery Zone
Iroquois Receipts	Iroquois	181003	10/31/2024	Waddington	Wright
Iroquois Receipts	Tennessee	95196	10/31/2022	TGP Zone 5	TGP Zone 6
Iroquois Receipts	Tennessee	41099	10/31/2022	TGP Zone 5	TGP Zone 6
Iroquois Receipts	Algonquin	93002F	10/31/2020	Mendon, MA	Brockton, MA
TGP Niagara	Tennessee	5292	3/31/2025	TGP Zone 5	TGP Zone 6
TGP Niagara	Tennessee	39735	3/31/2025	TGP Zone 5	TGP Zone 6
TGP Long-haul	Tennessee	5083	10/31/2023	TGP Zone 0, L	TGP Zone 6
Algonquin Receipts	Texas Eastern	800384	10/31/2024	Leidy Storage	Lambertville, NJ
Algonquin Receipts	Algonquin	93201A1C	10/31/2020	Lambertville, NJ	Taunton, MA
TGP Firm Storage	Tennessee	5195	3/31/2025	TGP Zone 4	TGP Zone 4
TGP Firm Storage	Tennessee	5265	3/31/2025	TGP Zone 4	TGP Zone 6
Dawn Storage	Enbridge	LST086	3/31/2023	Dawn Hub	Dawn Hub
Dawn Storage	Enbridge	M12256	10/31/2033	Dawn Hub	Parkway
Dawn Storage	TransCanada	57901	3/31/2033	Parkway	East Hereford
Dawn Storage	TransCanada	57055	10/31/2032	Parkway	East Hereford
Dawn Storage	PNGTS	FTN-NUI-0001	10/31/2033	Pittsburg, NH	Newington, NH
Portland Xpress	Enbridge	TBD	10/31/2040	Dawn Hub	Parkway
Portland Xpress	TransCanada	TBD	10/31/2040	Parkway	East Hereford
Portland Xpress	PNGTS	TBD	10/31/2040	Pittsburg, NH	Newington, NH
Westbrook Xpress	Enbridge	TBD	10/31/2037	Dawn Hub	Parkway
Westbrook Xpress	TransCanada	TBD	10/31/2037	Parkway	East Hereford
Westbrook Xpress	PNGTS	TBD	10/31/2037	Pittsburg, NH	Newington, NH
All Capacity Paths	Granite	16-100-FT-NN	10/31/2020	NA	Northern

The Company organizes these capacity resources into "paths." The paths connect each supply point to NUI's affiliate Granite State Gas Transmission, Inc. (GSGT). GSGT then delivers to the Company's distribution system. The table below lists the paths and their maximum daily quantities.

NUI shares all its pipeline capacity with retail marketers who serve customers on its distribution system. The table indicates the method by which NUI shares each path with the marketers:

- Capacity Release: allows the marketer to directly manage the asset
- Company-Managed: the Company manages the asset, fulfilling requests of marketers for their share of that resource.

Long-Term Resources by Capacity Path

Capacity Path	Resource Type	Max Daily Quantity	Method of Assignment	Status
Iroquois Receipts Path	Pipeline	6,434	Company-managed	Existing
Tennessee Niagara Capacity	Pipeline	2,327	Capacity Release	Existing
Tennessee Long-haul Capacity	Pipeline	13,109	Capacity Release	Existing
Algonquin Receipts Path	Pipeline	1,251	Company-managed	Existing
Tennessee Firm Storage Capacity	Storage	2,644	Capacity Release	Existing
Dawn Storage Path	Storage	39,863	Capacity Release	Existing
Lewiston On-System LNG Plant	Peaking	6,500	Company-managed	Existing
Existing Long-Term Capacity		**72,128**		**Existing**
Portland XPress Project (11/2020)	Pipeline	9,965	Capacity Release	Pending
Atlantic Bridge Capacity (11/2020)	Pipeline	7,500	Capacity Release	Pending
Pending Long-Term Capacity		**89,593**		**Pending**
Westbrook XPress Project (11/2022)	Pipeline	9,965	Capacity Release	Proposed
Proposed Long-Term Capacity		**99,558**		**Proposed**

NUI has only one receipt point on its distribution system that is not served by GSGT. That one is Lewiston, Maine, where NUI connects directly to M&NP. There is currently no upstream capacity for that point; NUI buys supply delivered there. The pending Atlantic Bridge capacity will deliver to that point, allowing NUI to look for upstream resources to serve it.

2. Capacity Contracting

Capacity contracting decisions since the Company's acquisition by Unitil have involved renewing or converting almost all capacity resources. Management viewed the portion consisting of supplies bought on a delivered basis as too large. Management has therefore sought to pursue alternatives in the period since the acquisition. Available alternatives have come in the form of pipeline connections, plus some increase in underground storage. These resources have reduced the portion of supply acquired on a delivered basis, because they have provided access to upstream supply points which are more liquid than the ones in New England. These resources include:

- The Dawn Storage Path, which went into service in April 2018, involved re-contracting of existing pipeline capacity combined with some added capacity
- The Atlantic Bridge project, which involves added capacity on the AGT system, accessing supply points in New Jersey
- The Portland Xpress project's addition to PNGTS capacity, with upstream capacity on TCPL and Enbridge, which will provide additional access to the Dawn supply point
- The Westbrook Xpress project's addition of further capacity on PNGTS and upstream pipelines TCPL and Enbridge to access Dawn.

Acquiring capacity from such projects permits year-round use, but the Company's requirements are seasonal. Nevertheless, the new IRP suggests that the lower prices and greater price stability associated with access to the more-liquid supply points favor these projects over delivered supply.

It shows expected utilization of these resources and the legacy ones under both Normal-Year and Design-Year conditions. The Company presented detailed analysis of the benefits of the Atlantic Bridge and Portland Xpress projects in proceedings to consider whether to approve them. Recently, the Commission approved a similarly detailed analysis of the Westbrook Xpress project.

Management continues to review its remaining capacity portfolio as additional contracts expire, and as particular supply problems or opportunities present themselves. Analysis includes careful quantitative comparisons of alternatives, plus application of qualitative considerations unique to each potential opportunity presented. The IRP presents a detailed discussion of the Company's resource evaluation methods.

The Energy Contracts group is responsible for assessing opportunities. It does not prepare formal decision documents, but does preserve quantitative assessments of the alternatives it considers. When decisions lead to change, the Company presents the results of all assessments, quantitative and qualitative, in its next gas-cost-adjustment filing.

3. Commodity Purchasing

NUI purchases gas supplies annually through two requests for proposals (RFPs). The first, typically issued in mid-February, seeks proposals for particular supplies and supply services, including

- Supplies provided as part of agreements to manage certain of NUI's capacity assets
- Winter-season supplies, delivered to GSGT receipt points for re-delivery to NUI
- Summer-season supplies delivered to storage-area pooling points or to injection points for storage held by NUI.

The second RFP focuses on peaking supplies. Typically issued in June, the RFP requests supplies delivered to GSGT interconnects with PNGTS or the Company's receipt point on M&NP. These supplies are to address "demand swings and peak winter days".

a. Asset Management Agreements

Operating the many capacity paths to which the Company has access would require managing relatively small amounts of capacity on multiple pipelines every day. Management therefore simplifies its daily operating challenges by aggregating each path's components into a package. It then offers the resulting path-based packages for bid under asset-management agreements (AMAs). Management selects from among the third parties offering for each package one to operate each package. This leaves to NUI the role of ensuring accurate nominations to each package's third-party asset manager for delivery of supply using that path to NUI for meeting system-supply customer needs.

Management solicits offers to manage these path-based packages under AMAs having one-year terms. The Company requires asset managers to provide supply at a relevant index price, plus variable transportation and fuel charges associated with deliveries to the specified delivery point. For paths that go through Canada, asset managers must administer all import/export filings, and pay all duties, GST taxes and any other miscellaneous charges. For each path, NUI provides the third-party managers an estimate of the amount of capacity that must be assigned to retail marketers.

The Company requires asset managers that win the right to manage the Dawn storage asset to buy the gas that remains in storage when the manager assumes responsibility for managing its operation. The manager must then fill the storage at a cost developed as though the storage capacity had been filled ratably (uniformly) at an indexed price specified by NUI. The specified prices typically use a local index, with additions for variable injection and fuel charges. Withdrawals occur when NUI nominates them, with billing for them at inventory cost when withdrawn. At the end of the storage withdrawal season NUI repurchases any remaining inventory at the final weighted average cost.

Third parties find benefit in these arrangements by: (a) selling gas to NUI at the prices their winning offerings require, and by (b) using any remaining capacity on the path (after meeting NUI and retail marketers' requirements) to serve other customers the manager may find. Thus, for example, an asset manager who finds opportunity for storage arbitrages can do so for its own account, presumably allowing it to offer NUI better compensation for use of the asset. Management generally awards management of each "path" to the third-party offering NUI the largest asset-management "fee." NUI's view of offeror capabilities and commitment to reliable service comprise factors that can cause an award not to follow raw pricing. Over the last six years (2014-2015 through 2019-2020), asset-management revenue has covered an average of 23 percent of asset demand costs (between 11 and 36 percent in any given year).

b. Delivered Supplies

Chapter II addressed expiration of the Wells Supply Contracts, whose expiration, combined with load growth since 2008, has left a considerable requirement for supplies beyond the capabilities of the legacy capacity portfolio. The pending and proposed supply projects will address a significant part of that requirement, but the Company needs additional supplies delivered to its city gate or receipt points on GSGT in the winter months.

In recent years, this requirement has been addressed in two parts:

- Contracts for delivered "base-load" supplies; *i.e.*, those delivered in the same amounts on every day of a specified period
- Contracts for delivered "peaking" supplies; *i.e.*, committing suppliers to deliver up to a maximum daily quantity of supply as the Company calls for it.

Base-load supplies are generally seasonal. Winter-period ones provide for one quantity delivered every day for the months of November through March, and a second quantity delivered every day for the months of December through February. Summer-period ones call for constant quantities every day of the specified summer months.

i. Delivered Base-Load Supplies

The Company secures delivered base-load supplies under its annual RFP, which specifies the required delivery points and the pricing structures considered acceptable by NUI. The 2019 RFP, for example, specified the last-day settlement price of the NYMEX gas contract for each month of the delivery period – November through March or December through February – plus or minus a basis differential. Bidders specified the basis differential they were willing to accept in their offers. NUI picked the supplier with the smallest basis differential.

Also in the annual RFP are small quantities of summer-period supplies. Those supplies are to be delivered to storage-area pooling points, and a storage-injection point under contract to NUI. The 2019 RFP requested:

- 1,800 Dth/day for the months of April through December, delivered to TGP's Station 313 Pool)
- 900 Dth/day for the months of April through October, delivered to NUI's storage injection meter on the 300 Leg of TGP Zone 4.

The RFP-requested pricing for both was the last-day settlement price of the NYMEX gas contract for each month of the delivery period, plus or minus a basis differential. The RFP instructed bidders to specify the basis differential they were willing to accept.

ii. Delivered Peaking Supplies

The second RFP seeks delivered peaking supplies. For the winter of 2018-2019, the Company requested as much as 40,000 Dth/day, subject to an annual maximum of 800,000 Dth. The Company sought to reserve the power to nominate up to 40,000 Dth/day, delivered to specified delivery points. Offerors specified the maximum they would commit to providing to each of the specified delivery points. Offerors had the option of proposing either fixed pricing or a stated daily index price (such as the Algonquin City Gates price), plus a fixed demand charge that would be paid in each of the months covered by the service. For indexed pricing, qualified offerors effectively competed on the basis of the demand charge. Fixed pricing required consideration of both demand and commodity components for all offers.

In late 2018, the Company issued a special RFP for a three-, four- or five-year term, rather than the one-year term of previous contracts. Termination of gas production offshore Nova Scotia has given the Company concern about the availability of supply when NUI needs it. Management sought to consider whether entering a longer-term commitment might increase supply reliability.

The special RFP used delivery and pricing specifications similar to those of prior RFPs for this type of supply:

- Sellers specified maximum daily quantity and annual contract quantity at each of six listed delivery points
- Pricing could be at the monthly Bidweek Algonquin City Gates spot-price index, or at NYMEX last-day settle for the month in which the deliveries occurred, plus a fixed demand charge covering the entire period to be covered by the supplier's offer.

[redacted]

4. Supplier Competition

The New England market has seen multiple competitors propose additions to delivery capacity, but most projects have stalled or been abandoned. NUI has looked at each, and is participating in the pipeline projects that have survived, to meet its objective of reducing dependence on delivered supplies.

Competition to provide commodity supply has been reasonably robust, but some competitors have disappeared as market risks intensify. The New England market presents comparatively high risks for suppliers because of price volatility and constrained pipeline capacity. Those with supply available at an upstream point, but who cannot get it to a customer because of a pipeline issue, may need to secure additional supply in the market where delivery must occur, potentially facing potentially ruinous price or default risk.

a. The Annual RFP

Providing asset-management service or delivered supply to NUI requires financial resources and management skills. The following table shows how many firms competed to supply each of those services in response to NUI's last five annual RFPs. Not every competitor bid on every path. The table shows by path the lowest and highest bidder numbers. Similarly, for delivered supply not every supplier bid on delivering to every point; the table shows the range of competitors for any point.

Annual AMA and Base-Load Supply Bidder Numbers

	4/1/2015-3/31/2016	4/1/2016-3/31/2017	4/1/2017-3/31/2018	4/1/2018-3/31/2019	4/1/2019-3/31/2020
Asset Management	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Delivered Base-Load Supply	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

One of the AMA opportunities involves NUI's long-haul capacity on the TGP system. That capacity accesses supply points in the U. S. Gulf Coast, near the upstream end of the TGP system, and delivers to the southern end of GSGT's pipeline system, and to GSGT at a NUI city gate in New Hampshire, both near TGP's downstream end. That AMA routinely draws the [redacted] The AMA for NUI's TGP capacity from the Niagara import point to its receipt points routinely draws the [redacted] The AMA for the Dawn Storage path (previously the Washington 10 Storage path) draws by far the largest asset-management fees, as it offers many optimization opportunities.

The competition for winter base-load supply routinely draws [redacted] Competition varies for the other delivered-supply opportunities offered in the annual RFP.

b. The Peaking RFP

The competition for delivered peaking supplies is conducted separately. The annual RFP is issued in mid-February, with contracts awarded in March. The RFP for delivered peaking service is issued in late June or early July, with the service to begin November 1. The service is provided from November 1 through the following March 31.

The peaking-service RFP traditionally provided for day-ahead nominations for the service, with a must-take provision for the nominated quantity. Beginning with the 2016 RFP (for the service period November 1, 2016 through March 31, 2017), NUI requested offers requiring day-ahead nominations, and offers allowing intra-day nominations. The following table shows the number of offers that the Company received for each type of service.

Numbers of Offers Received for Delivered Peaking Supply

	11/1/2015-3/31/2016	11/1/2016-3/31/2017	11/1/2017-3/31/2018	11/1/2018-3/31/2019
Day-Ahead Nominations	[redacted]	[redacted]	[redacted]	[redacted]
Intra-Day Nominations	[redacted]	[redacted]	[redacted]	[redacted]

As noted earlier, the Company in late 2018 issued an RFP for a multi-year delivered peaking service. [redacted]

c. Supplier Qualification

The Company requires that prospective sellers of gas or asset-management services enter into a NAESB (North American Energy Standards Board) Base Contract for Sale and Purchase of Natural Gas with it in order to do business. The Company evaluates the financial stability of any firm that wants to bid, but requests collateral rather than rejecting a possible supplier if it is concerned about the supplier's finances. For suppliers, NUI considers the physical assets that would be used to fulfill a contract. For asset managers, NUI considers a proposer's operational experience and technical capabilities. The Company says that it is willing to discuss a relationship with interested suppliers; its focus in any such discussion is to ensure that a prospective supplier understands and accepts the obligations that would come with a supply relationship with NUI. New suppliers are given relatively small opportunities to perform as tests of their suitability for a supply relationship with NUI.

As indicated in the table below, three new suppliers have been added in the last three years.

5. Supply Contracts

All of the Company's U.S. pipeline and storage capacity is on (or in) facilities regulated by the U.S. Federal Energy Regulatory Commission (FERC) Those facilities offer their services under FERC-approved tariffs, and NUI's contracts for its share of those facilities are service agreements issued pursuant to those tariffs. The only exception is the Company's LNG storage and regasification facility, which it owns. The Canadian Energy Regulator (formerly the National Energy Board) or the Ontario Energy Board regulate pipeline and storage capacity in Canada. Rates for pipeline transportation service are regulated, but rates for storage are market-based.

As noted, the Company uses the NAESB Base Contract for Sale and Purchase of Natural Gas as the basis for its relationships with all suppliers of asset-management services and natural gas. The Company uses its RFPs, and the confirmations issued when it accepts an offer for services or supply, to add specific details to govern the relationship. Those added specifics are often quite detailed as they include detailed operating provisions.

Company personnel review each year's performance under all contracts. RFPs and transaction confirmations for the succeeding year are modified to improve performance if possible. The principal objective of each year's modifications is to reduce operational risks to the Company and its customers.

6. Suppliers

The table below lists the Company's suppliers for 2016, 2017 and 2018. The list is in order of most supply to least for 2018.

Suppliers of Natural Gas to NUI (Dth)

Supplier	2016	2017	2018
[redacted]			

7. Documentation

For decisions about capacity commitments, internal evaluations, which primarily take the form of spreadsheets comparing cost provisions of available alternatives, are annotated and saved. Details of both quantitative and qualitative evaluations are presented to the Maine and New Hampshire Public Utility Commissions in requests for approval of contractual commitments.

For decisions about commodity, the Company saves all of its RFPs, all of the responses that it receives, and all of its bid evaluations as documentation for its selections of asset managers and providers of delivered supply. Day to day, spreadsheets detailing nominations under in-force contracts are saved. Any purchases or sales outside of the AMAs and delivered-supply agreements are entered into GTRAC, which is the Company's transaction-tracking system. The spreadsheets and GTRAC are structured to support the Company's twice-yearly cost-of-gas adjustment filings.

C. Conclusions

1. We found management of supply procurement a notable NUI strength.

[1] [redacted]

NUI has the benefit of a capable and experienced staff in the supply procurement function. Key personnel have deep experience in the unique circumstances of the Company's service territory, a commitment to careful analysis, and a continuing interest in evaluating performance in order to improve. Capacity options are limited, and the number of suppliers is limited for the services the Company requires, but performance in those circumstances is exceptional.

In the complex and high-risk nature of the supply environment in which the Company operates, the Company has developed supply processes well suited to that environment. Rather than try to operate a system with many small moving parts, NUI has organized its capacity portfolio into paths that connect liquid, transparent supply points to NUI's receipt points, and hires asset managers to operate each one.

For requirements that must be met with delivered supplies, the Company encourages bidders to participate by offering as much delivery-point flexibility as it can. We also believe that putting a large and diverse number of supply opportunities into one annual RFP encourages more suppliers to participate, as they can see relatively accessible opportunities to establish a relationship with NUI. We note with interest that the Company has recently attracted additional suppliers in spite of the highly-constrained and high-risk nature of the New England markets.

2. Contracting practices are effective and resulting contracts appropriate in meeting supply needs.

Analysis of the Company's results suggests that its contracting practices are highly effective. There is typically a significant spread between the highest and lowest bids. This spread indicates that the competition is extracting as much value as possible from each path.

Each year's performance is evaluated as part of preparing for the succeeding year's competitions. Any ideas for improving that performance are incorporated into the contracts for the succeeding year.

3. The Company has clear objectives for its procurement activities.

For adding to or upgrading its capacity portfolio, the Company looks for access to deep, liquid markets. It operates its existing resources to emphasize transparency and liquidity, as well.

Service competitions are structured to support price stability. RFPs specify commodity pricing related to an available index that exhibits stability, or to the last-day-settlement price of the NYMEX contract.

4. Bid evaluations are rigorous and objective.

RFPs are carefully constructed to provide unambiguous offers. Those offers are evaluated primarily on price, with a review of supply reliability and pipeline scheduling capabilities as threshold tests for an award.

5. Maintaining a sufficient number of suppliers is increasingly difficult. *(Recommendation #1)*

NUI can find abundant competitors for the right to operate its resources that access highly-liquid supply points. On the other hand, it is difficult for suppliers to compete in the highly-constrained New England gas market. With the termination of gas production offshore Nova Scotia, some suppliers for whom that was a major source may no longer participate. Other suppliers may limit their participation in order to avoid the risks of participation.

[redacted]

D. Recommendations

1. Initiate an intensive effort to reduce dependence on [redacted] delivered peaking service. *(Conclusion #5)*

NUI's multi-year contract for delivered peaking supplies make a useful time window available to pursue alternatives. That effort should begin immediately, and should have high priority.

The effort should start on the demand side. NUI currently has no curtailment plan, and it has limited information on its customers' alternate-fuel capabilities. Regarding dual-fuel capability, the Company reports "Dual fuel capability is not incorporated into the Delivery Service Terms and Conditions or the Company's planning activities in any manner."

The delivered peaking service is costly. Because its pricing under the current and recent contracts involves large demand charges assessed over all five of the winter months, all customers are paying a high price to maintain service for customers who might be willing to get off when supply costs are high. This situation begs for a thoughtful demand-response program.

There may also be other supply-side options. The new owner of the Distrigas terminal should be approached regarding supply options. It has some pipeline capacity, and provides delivered-supply services to some customers. That terminal also delivers into both the TGP and AGT pipeline systems, however, as well as into the local distribution company (National Grid). Distrigas and its LDC customer might both be possibilities for peaking-supply options.

Other LDCs have LNG facilities that have provided storage services for customers other than the owner. Among those, Southern Connecticut Gas Company, now a subsidiary of Avangrid, once offered contract peaking services through an affiliate formed to offer such services into the interstate gas markets. The large LNG facility in Providence, RI has in times past offered LNG storage services to customers other than its owner. As NUI's requirement is relatively small, and could be divided into multiple small pieces, any number of LDCs might be able to offer a portion of its requirements.

Remote peak-period supply services in the highly constrained New England gas market will present risks. NUI has several advantages in pursuing such options:

- Its connection to multiple interstate pipeline systems through affiliate GSGT
- Its ability to displace supplies entering GSGT's system to different parts of its service territory

- A highly-skilled staff who has considerable knowledge of delivery systems and issues in the New England market, and considerable experience in operating complex delivery processes.

The Company's apparent plan [redacted] is to engage a consultant to pursue on-system LNG facilities, both expansion of the current plant in Lewiston, and a new plant in another locations. While expansion of the current plant might be competitive in cost, a new facility is likely to be very costly. The Company's analysis will not be complete until it has pursued these other demand-side and supply-side options as aggressively as it is pursuing additions to its on-system plant.

IV. Gas Supply Management

A. Background

Effective gas supply management requires operation of the supply portfolio in a manner that achieves reliable deliveries to customers at the lowest overall cost. Placing delivery capacity controlled by the company, but temporarily not required for serving the company's on-system customers into secondary markets comprises a central element of effective supply management.

We applied the following criteria in evaluating supply management:

1. Scope and focus of policies and procedures for operating the gas-supply portfolio on the cost and reliability interests of on-system customers
2. Sufficiency of the operational planning structure and execution to ensure no disadvantage to customers through operating errors or omissions or supplier or pipeline penalties
3. Control of personnel with Maine-service-area-only responsibilities over actions and decisions that could disadvantage Maine customers
4. Consistency of commodity transportation costs charged to Maine customers with operations that optimize overall costs for them
5. Comprehensive, regular, accurate verification of pipeline transportation costs and consistency with services received
6. Aggressiveness of marketing of unutilized assets in line with appropriate transaction limits, controls, and risk management.

B. Findings

NUI manages its supply on an integrated basis; *i.e.*, it uses all supply assets to serve customers in both Maine and New Hampshire.NUI faces particular challenges in managing its gas supply for a number of material reasons. First, ***multiple pipelines*** transport Company supply to a large number of delivery points:

- A gate station near Lewiston, Maine, on the Maritimes & Northeast Pipeline (M&NP) system
- Four receipt points on affiliate Granite State Gas Transmission, Inc.'s (GSGT's) system in Maine and New Hampshire, and one in Massachusetts
- A gate station at affiliate Fitchburg Gas and Electric Light Company (FG&E) in Massachusetts
- Several gate stations at former parent Bay State Gas Company in Massachusetts.

Deliveries to Bay State return to NUI through an exchange agreement under which Bay State delivers supply to NUI via GSGT at connections on the Portland Natural Gas Transportation System (PNGTS).

Second, the Company's ***fragmented service territory*** imposes locational requirements on deliveries from particular sources of supply. Third, ***retail marketers*** deliver large amounts of gas to the Company's system - - roughly 40 percent in Maine and 50 percent in New Hampshire - - to serve their customers through NUI's distribution system. These volumes coming for multiple marketers complicate management and measurement accuracy. Fourth, comparatively high

weather variability creates large swings in gas requirements, exacerbated by frequent, large daily differences between forecasted and actual weather. Fifth, the *downstream location* of the service territory on almost all of pipelines serving the Company means that, during the winter, when prompt delivery of requested gas volumes is most essential, the pipelines narrow their delivery tolerances. (Delivery tolerances refer to how close the actual quantity taken from the pipeline at the delivery point matches the quantity nominated to that point.) This means that both NUI and the retail marketers that serve customers on NUI's distribution system must take extra precautions to ensure that the supplies that they deliver to the pipelines match their customers' usage.

We found Company planning, complex under these circumstances, attentive, comprehensive, and supported by appropriate systems and processes, as we discuss below.

1. Operations Planning

The Company organizes its supply capacity portfolio by "path"- - each consisting of grouped capacity assets that move supply from where NUI buys or stores it to key delivery points:

- The M&NP gate station at Lewiston that delivers to NUI
- A gate station in Westbrook, Maine that serves both M&NP and PNGTS, and delivers to GSGT
- PNGTS gate stations at Eliot, Maine and Newington, New Hampshire that deliver to GSGT
- Tennessee Gas Pipeline (TGP) gate stations in Haverhill, Massachusetts, and Salem, New Hampshire that deliver to GSGT
- TGP gate stations that serve affiliate FG&E.

Other paths delivering to receipt points on GSGT support the exchange agreement with Bay State. Management must allocate the assets in each path, including those delivering to Bay State, between:

- Itself to serve its system-supply customers
- Marketers, for serving their end users.

Operations planning begins by using a general forecast to construct seasonal supply plans. The Energy Contracts staff assigns supply resources to particular delivery points, based on a rough estimate of loads expected at each point. This process produces baseline estimates of capacity amounts on each path required for its system-supply customers and marketers' customers.

The staff then reduces these seasonal plans to monthly plans, which further detail and align sources and deliveries. At the beginning of each month, the Company asks that each marketer validate its list of customers. Any changes from the prior month undergo examination for adjustment in the capacity management systems that support allocation of capacity resources.

The pipelines, including GSGT, use electronic bulletin boards (EBBs) to manage their systems. Users nominate the quantities that they want to pipeline to transport, the locations where they want to put gas in – receipt points – and the locations where they want to take gas out – delivery points. All users input this information every day, and may adjust it within each day. With this information, the pipelines can assess whether their systems are physically capable of accomplishing all the requested movements. When they get close to their physical limits, they will impose flow restrictions, such as narrowing delivery tolerances. Because NUI is near the

downstream ends of the major pipelines that serve it, pipeline capacity is quite limited. As a consequence, the pipelines that serve NUI operate under operational flow orders (OFOs) for most of every winter. Those orders narrow delivery tolerances to half or less of the normal levels.

2. Day-to-Day Operations

A Daily Forecast file embeds the monthly plans. This file applies a seven-day weather forecast to generate a corresponding daily forecast of supply requirements at the pipeline delivery locations that serve NUI. NUI personnel then nominate from among the available supply resources the quantities that they want delivered to each receipt location. Volumes under the exchange agreement with Bay State generally comprise a base-loaded volume, which means that they don't change every day. They change seasonally, but not every day.

Management updates the Daily Forecast file every day with new weather data. An accompanying Imbalance File shows whether actual deliveries have matched requirements, and provides up-to-date assessments of surplus or shortage in deliveries.

Affiliate pipeline GSGT provides the "backbone" of the Company's distribution system. Except for FG&E in Massachusetts, the Company's service territories almost all connect to and receive deliveries by GSGT. The service territories, however, do not have robust connections among themselves.

The five points (identified earlier in this chapter) of delivery into GSGT take more than seven times more (38) delivery points to get gas from GSGT into the various segments of NUI's service territory. The Westbrook Gate Station into GSGT lies very near the pipeline's northernmost delivery point, which serves an NUI lateral connecting to the Lewiston service territory. The lateral effectively serves as an extension of GSGT, connecting Lewiston to the other portions of the service territory. That lateral does not have sufficient capacity to meet Lewiston's demand during the winter. An M&NP delivery point and NUI's liquefied natural gas (LNG) storage and regasification facility also serve the Lewiston area.

GSGT and the lateral to Lewiston connect the Maine and New Hampshire service territories to each other. That interconnection allows operation of the system on an integrated basis; *i.e.*, the Maine and New Hampshire territories operate as one system. Limits on GSGT flow capacity, however, prohibit unlimited movement of gas from different GSGT receipt points to all its points of delivery to NUI. Accordingly, location-specific requirements must be addressed before supply can flow among receipt and delivery points.

a. Coordination with Retail Choice Program

The Company allocates shares of each of its supply-capacity paths to retail marketers in proportion to the design daily demands of each marketer's load. Allocations take place on a "slice-of-the-system" basis. Thus, each marketer gets a proportionate share of every resource. The marketers receive most resources through direct assignment, but the Company operates two:

- The Company's LNG storage and regasification facility in Lewiston, Maine
- A small TGP storage contract and the pipeline capacity for delivering the stored gas to GSGT.

These resources do not form part of the paths operated under contract with NUI by third-party asset managers. The Company manages these two asset groups in-house and provides supply from them in response to marketers' nominations. In practice, Northern can provide any supply in response to nominations by marketers for the Company-managed resources. That is, if a marketer requests Company-managed supply, Northern can fulfill the requirement with pipeline-delivered gas, rather than gas from the two Company-managed assets.

The marketers serving end users can trade their assigned "slices" among themselves, to optimize their capacity holdings as they see fit. They must, however, deliver their required amounts to specified GSGT receipt points, thus allowing the correct amount of supply to reach each of the marketers' customers. The marketers nominate their own capacity on GSGT's system. However, GSGT's meters for delivery into NUI's distribution system do not measure volumes continuously. Thus, marketers must also report their deliveries into GSGT on NUI's Centralized Supplier Interface (CSI). All marketer nominations for their Maine supply pools go to Westbrook, and nominations for New Hampshire pools go to Newington or to Haverhill. Management can verify correct volumes to be sent to the proper NUI receipt points when marketers nominate their supplies on NUI's system.

Marketers have responsibility for ensuring deliveries for their requirements, regardless of how weather and conditions may cause them to vary from nominations. NUI's Delivery Service Terms and Conditions, part of its tariff, make clear marketer responsibilities and penalties for failure to fulfill them.

b. Nominations and Dispatch

The Company's contracts for supply resources address procedures for daily resource nominations. NUI's extensive use of asset-management agreements (AMAs) make the following the primary focuses of its supply-management activities:

- Nominating quantities for delivery to GSGT, including withdrawals from storage, under each AMA
- Calling on the small quantities of supply it manages directly, when needed by the retail marketers or the Company's system-supply customers

Management must address locational requirements first. Recall that GSGT capacity limits prevent supplies received by GSGT from being delivered to any point on GSGT's system unless locational requirements are met. After addressing that constraint, the Company can select among available resources on the basis of cost.

Gas Control prepares the Daily Forecast File. Gas Control's files contain the daily forecast parameters determined in the regression models that Energy Contracts developed and maintain. These models use historical sendout information to develop relationships between EDD (weather) and sendout. Each day, Gas Control uses those models and the weather forecast for the next seven days to forecast gas requirements over that period. Weather forecast updates occur five times per day. Cold-weather nominations for supply can change up to five times per day, in accord with industry nominations cycles: timely, evening, and three intra-day cycles.

Energy Contracts carefully coordinates its nominations work with the activities of Gas Control, which performs complementary activities that include:

- Providing daily requirements estimates to the retail suppliers for the non-daily-metered customer pools (monthly-metered customers), using an automated process based on customer-specific regression analyses conducted annually by Energy Contracts, as part of the Annual TCQ Update process required by the Delivery Service Terms and Conditions
- Operating NUI's LNG facility, and ordering additional supplies during the facility's use.

3. Management of Available Capacity

The Company uses contracts for supplies delivered to GSGT or its city gates and delivered peaking supplies as a substantial part of its supply resources. Therefore, NUI does not have the sizeable amount of upstream pipeline capacity that some other gas distributors have available for secondary-market activities. It places most of its available capacity into the path-based asset-management agreements discussed earlier. Company RFPs for asset-management services provide estimates of the amounts of its pipeline capacity required to serve its load and of the amounts required to be assigned to retail marketers. Prospective asset managers consider their ability to make economic use of any unused capacity that they estimate will be available to them when pricing their bids in competing for the right to manage a particular asset.

NUI tends to over-nominate in winter, to ensure that its customers get enough supply, and to avoid pipeline imbalance penalties. When deliveries appear to exceed requirements, the Company adjusts by reducing storage withdrawals in the first half of the winter, and engages in off-system sales in the second half.

In the past, the Company released during the summer season some pipeline capacity under its management. More recently, it has placed that capacity into one of its asset-management agreements, in an effort to recover more of the costs of the capacity through increased asset-management fees and to increase reliability.

4. Procedures and Documentation

Gas supply operations operate smoothly and confidently. All participants know their roles and responsibilities well, but no written procedures exist. The Energy Contracts staff has developed a series of spreadsheets that record various aspects of the supply-management process. The staff updates these spreadsheets daily, and retains each day's sheets for documentation purposes. The spreadsheets are structured to capture all information required for cost-of-gas filings with the Commission.

C. Conclusions

1. We found NUI gas supply management a notable strength.

Company personnel have developed systems and processes to deal with the complexities of the Company's gas-supply resources and service territories. Close coordination between Energy Contracts and Gas Control during cold-weather days results in highly-effective performance in a difficult operating environment.

The nature of the Company's service territories and the physical aspects of gas supply rule out effective operation of the Maine and New Hampshire Divisions on a segregated basis. We found

it clear that the interests of on-system customers serve as the predominant drivers for supply operations in all of its service territories. Management routinely addresses the allocation of administrative costs among them to its three state jurisdictions -- Maine, Massachusetts and New Hampshire. FG&E has its own supply portfolio, but NUI allocates its gas costs between Maine and New Hampshire. Those Commissions and the Company's customers have ample opportunities to satisfy themselves regarding the rules that produce those allocations, and the results that they produce.

Physical aspects of the service territories and gas delivery systems limit choices in dispatch. After satisfying locational requirements, the Company employs economic dispatch. These processes result in the lowest possible costs to each group of customers.

The Company effectively employs its path-based, asset-management agreements to place capacity sometimes not needed. Offering the asset-management opportunity to multiple bidders encourages the extraction of maximum value for on-system customers. Those marketers who can find the most effective off-system use for capacity they manage presumably reflect the margins they gain when competing for asset-management roles.

2. **Preferable short-term forecasting tools may exist; they warrant examination.** *(Recommendation #1)*

The Company uses regression models developed in-house for short-term load forecasting (embedded in the Daily Forecast File). This approach improves on traditional methods for performing this function. Nevertheless, industry best practice for this application supplements these models with a tool known as "deep neural networks". NUI may be able to enhance its short-term forecasts, and thus improve its dispatch, by using this technique. A description of the technique and its application to short-term natural gas forecasting, is presented in a recent journal article in *Energies* by Gregory D. Merkel, Richard J. Povinelli and Ronald H. Brown. (Published: 2 August 2018).

3. **The lack of written procedures risks operational continuity, should NUI experience a loss of key skills which, while now sufficient, do not exist in reasonably large number.** *(Recommendation #2)*

The Energy Contracts and Gas Control staffs have developed efficient and effective processes for gas-supply management. That detailed knowledge of those processes is concentrated in a small group of individuals, however, presents a risk of discontinuity.

Written procedures would reduce that risk by capturing a significant share of their expertise. The potential loss of highly experienced incumbents, due to retirement, accidents or illness, or departure from the Company, should be addressed.

The solution to these concerns is to develop written procedures for daily nominations and dispatch. Much of the substance of such procedures has been developed in responding to data requests in the course of this audit. The task that remains is to complete them, and then re-format them into steps that can be followed by other persons, and by auditors.

D. Recommendations

1. **Explore the application of neural network methods to the Company's short-term requirements forecasting.** *(Conclusion #2)*

As noted above, these methods now comprise industry best practice for this function. The Company should explore their application to its Daily Load Forecast. Improved forecasts should improve dispatch, hopefully lowering the requirement for same-day and intra-day adjustments.

Evaluation of such applications can take place in short time order. We recommend that the Company report on its progress in the proceeding to consider the findings of this audit (Docket No. 2018-00300).

2. **Prepare written procedures to guide the nominations and dispatch functions.** *(Conclusion #3)*

Much of the substance of required and appropriate procedures has been developed in responding to data requests in the course of this examination. What remains is to complete them and revise them into a procedures format. We regard this recommendation as a priority. The Company should initiate this effort with dispatch, and report on its progress in the proceeding to consider the findings of this audit (Docket No. 2018-00300).

V. Measurement and Balancing

A. Background

Sound measurement methods and practices support accurate determination of total gas costs. Effective balancing minimizes penalties from delivering pipelines, and supports the appropriate distribution of gas costs among customers. We evaluated measurement and balancing under the following criteria:

1. Application of metering and testing programs conforming to industry standards and to the Company's unique circumstances
2. Design and execution of metering strategies to isolate deliveries to various customer classes and Company uses
3. Design and execution of a balancing strategy and practices appropriate for each customer class.

B. Findings

1. Management Strategies and Processes

NUI receives almost all of its gas supplies via pipeline. Affiliate Granite State Gas Transmission, Inc. (GSGT) receives most of the field purchases and storage and delivered supplies, redelivering them to NUI. The Lewiston, Maine areas comprises the principal exception; NUI receives gas there from the Maritimes & Northeast Pipeline (M&NP) directly into its distribution system. The Company also operates a small liquefied natural gas (LNG) facility in Lewiston, which receives its supplies by truck, and then delivers the regasified product into the distribution system. As discussed in Chapter IV, the Company can also supply the Lewiston, Maine area through a lateral on NUI's system, but this lateral does not have sufficient capacity to meet locational demands during the winter.

NUI delivers some of the gas that it buys for transport on its capacity on the Tennessee Gas Pipeline system (TGP) and Iroquois Gas Transmission System (IGTS) and all of the gas that it buys for delivery on its Algonquin Gas Transmission system (AGT) capacity to Bay State Gas Company receipt points in Lawrence, Agawam and Taunton in Massachusetts. Bay State, in return, delivers gas on capacity that it holds on the Portland Natural Gas Transmission System (PNGTS) to GSGT receipt points at Westbrook and Eliot, Maine, and Newington, New Hampshire, for redelivery to NUI. Bay State contracts for capacity on GSGT, which it uses to deliver to NUI. An exchange agreement negotiated as part of the sale of NUI to Unitil covers these deliveries. This exchange agreement provides access for NUI to supplies sourced on TGP and on AGT, to which NUI has no physical connection.

The overall measurement scheme uses pipeline measurement of their own deliveries into GSGT, or into NUI's distribution system in the case of M&NP delivering into Lewiston. GSGT measures its deliveries into NUI's system. NUI, in turn, measures its deliveries to its customers.

At year-end 2018, the Company's Maine Division had 34,119 active meters. Most of those (almost 33,000) consisted of diaphragm-type meters, which the Company uses for residential and small commercial and industrial (C&I) customers. The Company employs rotary meters for larger C&I customers, and turbine meters for the largest C&Is. NUI had only six turbine meters in operation

at the end of 2018. The Company filed descriptions of how each meter type operates, and of the circumstances in which each is deployed, with its initial response in Docket No. 2018-00331, *Inquiry into Meter Testing and Standards of Local Distribution Companies*.

The interstate pipelines calibrate their meters at least annually. GSGT inspects its turbine and rotary meters monthly to verify their operation, and it calibrates its flow computers annually. NUI tests meters before installation, and calibrates its largest ones quarterly. Field audits conducted each year sample the non-instrumented rotary and diaphragm meters. The audits seek to validate proper operation of the reading indexes and the automated meter reading (AMR) devices. The practice is to examine two percent of small-diaphragm meters and 25 percent of large diaphragm ones each year.

NUI's billing system identifies anomalies in billings, such as measurements showing no usage at customer locations known to be active. Upon detecting anomalies, technicians visit the meter to examine the circumstances. NUI also tests meters on customer request.

NUI has identified certain meter types with known problems, replacing them as practical. Management also has a practice of retiring certain meter types to reduce the number of types in inventory. Otherwise, NUI retires meters more than 20 years old.

NUI requires its meter manufacturers to provide test data for new meters purchased. The Company sends meters removed for testing to a testing facility in Pennsylvania. Testing applies a protocol established by Unitil. In the 10 years that Unitil has owned the Company, the Maine Division has received test results for 13,358 purchased meters, and for 1,910 meters removed for testing.

The Company generally follows manuals published by the American Gas Association (AGA) to guide meter accuracy and testing standards and protocols. Management observed that the three jurisdictions in which it operates have different requirements regarding metering standards.

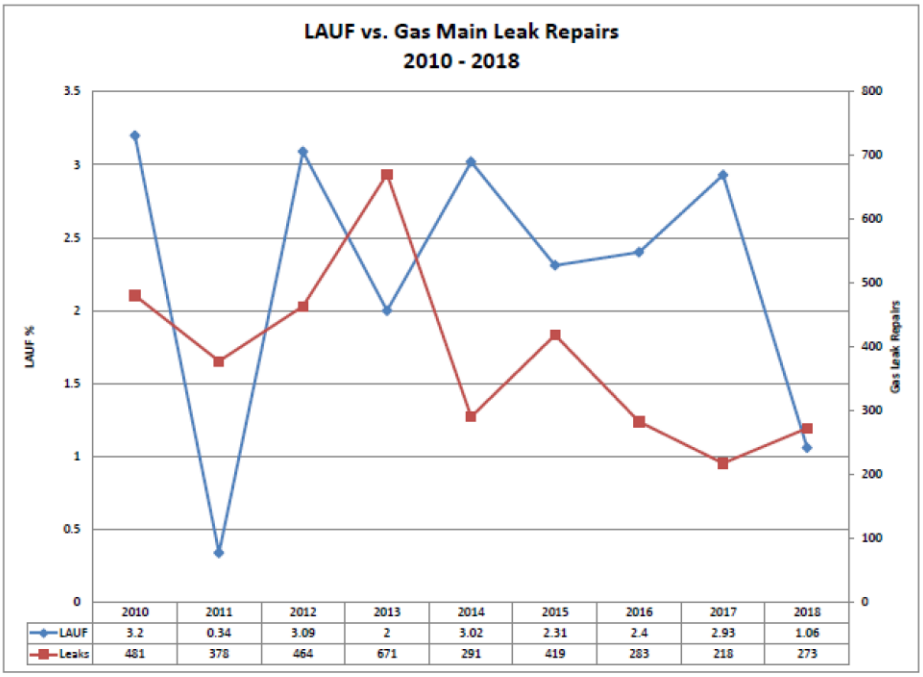
2. Lost and Unaccounted for Gas

A variety of factors produce Lost and Unaccounted for Gas (LAUF); *e.g.*, meter accuracy, timing differences between billing measurements at upstream points and individual customer meters, company usage, measurement accuracy of LNG inventory, boil-off gas, theft, pipe leaks, and accounting differences. NUI's measures to reduce LAUF include:

- It measures Company use for domestic heat and hot water at various facilities and for vaporization and heaters at its LNG facility and district regulator stations, and deducts the measured quantities from LAUF calculations
- It installs correctors that compensate for variances in pressure and temperature for commercial and industrial customers
- It checks customer service regulators and adjusts them upon installation and routine meter changes, to ensure accurate delivery pressures, and, in turn, measurement
- It conducts an aggressive leak repair program.

The Company reports that most leaks occur along the cast-iron portions of its distribution system. Management plots leaks on maps, to serve as a factor in planning the cast-iron replacement program. NUI has completed that replacement program in New Hampshire, now finding no leaks

there. While logic suggests that repairing leaks would reduce LAUF, management has found no clear correlation between leak repairs and LAUF (see the graph below), which reflects the fact that a factors beyond leaks materially influence LAUF.



NUI has organized its cast-iron replacement program by geographic areas. During work in an active area, the Company usually replaces meters as well, and upgrades service lines as necessary or appropriate.

As do most gas distribution companies, NUI calculates its annual LAUF percentage by summing monthly calculations from July of the previous year through June of the reporting year. The Company calculates LAUF separately for its Maine and New Hampshire Divisions, and for subsidiary Fitchburg Gas and Electric Light Company (FG&E) in Massachusetts.

The next table, taken from the Company's PHMSA F7100.1-1 Annual Report for the Maine Division, shows the Company's LAUF calculation for the years 2014 through 2018. NUI often appears to receive more gas than it delivers (positive LAUF) in winter, but then appears to deliver more than it receives in the spring (negative LAUF). Cycle billing produces this pattern, characteristic of most gas LDCs. For this reason, reported LAUF usually employs a 12-month calculation period.

Northern Utilities, Inc.
Maine Division
Lost and Unaccounted For, Company use, and Therm Factor Data

12 Months Ending June	Month	Total - ME City-Gate (MCF)	Therm Factor	Total - ME City-Gate (Dth)	Total System Billed Sales (Dth)	Company Use (Dth)	Lost and Unaccounted For (Dth)	Lost and Unaccounted For (%)
2014	Jul-13	360,798	1.0170	366,931	361,116	37	5,778	1.60%
2014	Aug-13	373,504	1.0126	378,210	366,661	8	11,541	3.15%
2014	Sep-13	399,136	1.0281	410,352	378,996	14	31,342	8.27%
2014	Oct-13	575,408	1.0386	597,619	485,235	34	112,350	23.15%
2014	Nov-13	1,004,257	1.0272	1,031,573	843,493	173	187,907	22.28%
2014	Dec-13	1,454,069	1.0317	1,500,163	1,286,509	337	213,317	16.58%
2014	Jan-14	1,581,927	1.0386	1,642,989	1,587,741	2,465	52,783	3.32%
2014	Feb-14	1,354,980	1.0356	1,403,217	1,450,516	1,170	(48,469)	-3.34%
2014	Mar-14	1,373,442	1.0300	1,414,645	1,408,731	1,306	4,608	0.33%
2014	Apr-14	821,018	1.0312	846,634	1,008,764	933	(163,063)	-16.16%
2014	May-14	500,294	1.0371	518,855	619,888	373	(101,406)	-16.36%
2014	Jun-14	373,847	1.0438	390,221	427,439	86	(37,304)	-8.73%
2015	Jul-14	355,102	1.0396	369,164	370,442	33	(1,311)	-0.35%
2015	Aug-14	359,916	1.0408	374,600	353,033	26	21,541	6.10%
2015	Sep-14	411,741	1.0179	419,111	385,511	26	33,574	8.71%
2015	Oct-14	582,481	1.0170	592,383	514,552	112	77,719	15.10%
2015	Nov-14	1,025,629	1.0272	1,053,526	827,326	448	225,752	27.29%
2015	Dec-14	1,256,340	1.0356	1,301,066	1,222,092	976	77,998	6.38%
2015	Jan-15	1,634,539	1.0403	1,700,410	1,525,468	1,237	173,705	11.39%
2015	Feb-15	1,634,909	1.0406	1,701,286	1,710,367	2,860	(11,941)	-0.70%
2015	Mar-15	1,379,495	1.0347	1,427,364	1,499,295	2,179	(74,109)	-4.94%
2015	Apr-15	854,091	1.0266	876,810	1,052,591	1,059	(176,840)	-16.80%
2015	May-15	498,638	1.0251	511,154	590,016	245	(79,108)	-13.41%
2015	Jun-15	438,073	1.0224	447,886	462,683	80	(14,877)	-3.22%

12 Months Ending June	Month	Total - ME City-Gate (MCF)	Therm Factor	Total - ME City-Gate (Dth)	Total System Billed Sales (Dth)	Company Use (Dth)	Lost and Unaccounted For (Dth)	Lost and Unaccounted For (%)
2016	Jul-15	392,545	1.0228	401,495	398,252	28	3,216	0.81%
2016	Aug-15	387,281	1.0208	395,336	382,252	14	13,070	3.42%
2016	Sep-15	395,272	1.0212	403,652	387,311	37	16,304	4.21%
2016	Oct-15	679,374	1.0308	700,299	557,542	89	142,668	25.59%
2016	Nov-15	902,671	1.0280	927,946	778,166	381	149,398	19.20%
2016	Dec-15	1,080,621	1.0313	1,114,444	1,061,183	1,103	52,158	4.92%
2016	Jan-16	1,444,975	1.0395	1,502,052	1,363,726	1,435	136,891	10.04%
2016	Feb-16	1,280,645	1.0417	1,334,048	1,397,147	1,836	(64,935)	-4.65%
2016	Mar-16	1,104,015	1.0322	1,139,565	1,226,006	1,558	(87,999)	-7.18%
2016	Apr-16	880,207	1.0289	905,645	954,764	1,270	(50,389)	-5.28%
2016	May-16	586,114	1.0234	599,830	666,178	574	(66,921)	-10.05%
2016	Jun-16	423,131	1.0260	434,132	464,054	71	(29,993)	-6.46%
2017	Jul-16	383,017	1.0192	390,371	375,734	28	14,610	3.89%
2017	Aug-16	393,016	1.0195	400,680	404,659	26	(4,005)	-0.99%
2017	Sep-16	413,879	1.0176	421,163	393,396	29	27,739	7.05%
2017	Oct-16	658,449	1.0199	671,552	547,913	198	123,441	22.53%
2017	Nov-16	934,347	1.0215	954,435	846,936	718	106,780	12.61%
2017	Dec-16	1,435,585	1.0311	1,480,231	1,214,257	1,192	264,782	21.81%
2017	Jan-17	1,402,244	1.0337	1,449,500	1,438,474	1,601	9,426	0.66%
2017	Feb-17	1,251,854	1.0442	1,307,186	1,361,604	1,580	(55,998)	-4.11%
2017	Mar-17	1,401,927	1.0344	1,450,153	1,347,498	1,528	101,127	7.50%
2017	Apr-17	812,508	1.0258	833,470	1,034,142	1,212	(201,884)	-19.52%
2017	May-17	614,371	1.0245	629,423	702,918	640	(74,135)	-10.55%
2017	Jun-17	426,811	1.0253	437,609	444,976	380	(7,747)	-1.74%
2018	Jul-17	393,491	1.0220	402,147	445,002	27	(42,882)	-9.64%
2018	Aug-17	400,454	1.0227	409,545	397,745	27	11,774	2.96%
2018	Sep-17	403,092	1.0223	412,081	401,100	39	10,942	2.73%
2018	Oct-17	502,147	1.0249	514,651	489,750	141	24,760	5.06%
2018	Nov-17	1,046,849	1.0337	1,082,128	814,852	657	266,620	32.72%
2018	Dec-17	1,592,327	1.0360	1,649,651	1,378,493	1,182	269,975	19.58%
2018	Jan-18	1,677,857	1.0410	1,746,649	1,797,898	2,559	(53,808)	-2.99%
2018	Feb-18	1,228,124	1.0356	1,271,845	1,407,008	1,974	(137,137)	-9.75%
2018	Mar-18	1,265,450	1.0363	1,311,386	1,295,226	1,677	14,483	1.12%
2018	Apr-18	974,101	1.0346	1,007,805	1,101,347	1,234	(94,776)	-8.61%
2018	May-18	514,209	1.0266	527,887	659,106	752	(131,971)	-20.02%
2018	Jun-18	429,087	1.0326	443,076	466,445	118	(23,487)	-5.04%
2014		10,172,678	1.0323	10,501,409	10,225,089	6,937	269,384	**2.57%**
2015		10,430,953	1.0330	10,774,760	10,513,377	9,280	252,104	**2.34%**
2016		9,556,852	1.0316	9,858,444	9,636,580	8,396	213,468	**2.17%**
2017		10,128,007	1.0294	10,425,773	10,112,507	9,131	304,135	**2.92%**
2018		10,427,188	1.0337	10,778,851	10,653,973	10,386	114,492	**1.06%**

3. Balancing

Balancing consists of getting deliveries into the distribution system to match deliveries out of it. Effective balancing promotes: (a) getting the correct gas costs to each customer or class of customers, and (b) avoiding imbalance penalties. Balancing poses special challenges for NUI, because: (a) its service territory experiences large changes in weather, which, in turn, results in large changes in gas requirements, and (b) retail marketers supply a large portion of NUI's load. The marketers bring supplies for their customers to NUI which must then deliver those supplies to marketer customers. The next table shows, for a sample winter month (January 2018), the influence of both factors. It shows the magnitude of the load supplied by marketers, as much as one-third on some days, and it shows the impact of weather changes. Notice Column 6, which shows for that month a forecast variance range of minus 24 percent to plus 29 percent.

Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 15	Col 16
			Col 4- Col 3	(Col 4 / Col 3) - 1			Col 8 - Col 7	(Col 8 / Col7) -1		
Gas Day	Forecast Average ME/NH EDD	Actual Average ME/NH EDD	Forecast EDD Variance (EDD)	Forecast EDD Variance (Percentage)	Forecasted Northern System Sendout (Dth)	Actual Northern System Sendout (Dth)	Forecast Sendout Variance (Dth)	Forecast Sendout Variance (Percentage)	Total System Supply	Imbalance (Dth)
1/1/2018	68.0	70.3	2.3	3%	143,319	137,700	-5,619	-4%	141,034	3,334
1/2/2018	58.0	58.7	0.7	1%	124,097	131,944	7,847	6%	128,527	-3,417
1/3/2018	50.0	49.7	-0.3	-1%	109,124	112,367	3,243	3%	110,380	-1,987
1/4/2018	51.5	51.4	-0.1	0%	110,822	105,102	-5,720	-5%	115,428	10,326
1/5/2018	72.0	71.5	-0.5	-1%	144,456	138,437	-6,019	-4%	145,472	7,035
1/6/2018	75.5	75.0	-0.5	-1%	146,632	143,516	-3,116	-2%	149,039	5,523
1/7/2018	57.5	56.2	-1.4	-2%	120,565	120,460	-105	0%	132,258	11,798
1/8/2018	41.0	39.7	-1.4	-3%	96,749	100,426	3,678	4%	104,717	4,291
1/9/2018	44.5	39.8	-4.8	-11%	96,602	90,918	-5,684	-6%	92,993	2,075
1/10/2018	37.5	34.7	-2.8	-7%	89,094	85,159	-3,935	-4%	77,398	-7,761
1/11/2018	24.5	22.0	-2.6	-10%	71,332	65,508	-5,824	-8%	64,983	-525
1/12/2018	20.5	15.6	-4.9	-24%	59,691	50,784	-8,906	-15%	56,321	5,537
1/13/2018	50.5	48.4	-2.2	-4%	90,542	91,172	630	1%	91,917	745
1/14/2018	57.5	56.8	-0.7	-1%	114,825	116,497	1,672	1%	120,118	3,621
1/15/2018	53.5	52.8	-0.7	-1%	115,179	119,964	4,786	4%	119,654	-310
1/16/2018	40.0	38.8	-1.3	-3%	93,172	94,830	1,658	2%	93,500	-1,330
1/17/2018	42.0	41.7	-0.3	-1%	93,964	94,994	1,030	1%	98,057	3,063
1/18/2018	44.5	44.9	0.3	1%	99,262	95,161	-4,101	-4%	92,782	-2,379
1/19/2018	38.5	37.0	-1.6	-4%	88,611	84,789	-3,822	-4%	84,510	-279
1/20/2018	30.0	28.8	-1.3	-4%	67,172	71,443	4,271	6%	68,287	-3,156
1/21/2018	32.5	31.1	-1.5	-4%	73,485	71,656	-1,829	-2%	79,185	7,529
1/22/2018	33.0	42.7	9.7	29%	80,509	95,592	15,083	19%	83,898	-11,694
1/23/2018	27.0	33.8	6.8	25%	71,362	84,713	13,351	19%	67,275	-17,438
1/24/2018	46.5	46.2	-0.3	-1%	97,494	100,221	2,727	3%	101,875	1,654
1/25/2018	55.0	52.5	-2.6	-5%	116,912	112,865	-4,047	-3%	108,780	-4,085
1/26/2018	44.0	42.8	-1.2	-3%	98,311	98,791	480	0%	84,235	-14,556
1/27/2018	26.5	22.3	-4.3	-16%	63,862	63,186	-676	-1%	67,641	4,455
1/28/2018	32.5	28.1	-4.5	-14%	72,875	72,224	-651	-1%	72,566	342
1/29/2018	44.5	44.0	-0.5	-1%	95,659	95,525	-134	0%	94,640	-885
1/30/2018	48.0	49.5	1.5	3%	102,212	110,823	8,611	8%	107,877	-2,946
1/31/2018	41.0	40.3	-0.7	-2%	94,744	93,817	-926	-1%	99,101	5,284

NUI's location at or near the downstream ends of the gas pipelines that serve it compounds the problem. As a consequence of NUI's location, service interruptions almost anywhere on any of the four upstream pipelines that serve NUI adversely affect it. All four operate under flow restrictions for much of every winter. The four are TGP, M&NP, PNGTS and AGT, the latter

through the exchange agreement with Bay State. "Upstream" refers primarily to upstream of GSGT, which delivers to NUI; however, the Union Gas system, TransCanada PipeLines (TCPL) and Trans Quebec & Maritimes (TQM) are upstream of PNGTS, and deliveries to PNGTS can be affected by interruptions on those systems. TCPL and IGTS are upstream of some of the Company's TGP capacity.

NUI's service territory consists of several areas in Maine and New Hampshire - - areas minimally or not at all connected to each other. GSGT serves as the link among them, except for the area around Lewiston, which M&NP facilities serve directly. This configuration imposes some locational needs on which sources can go to which portions of the territory, but NUI manages balancing by considering the system as an integrated whole.

Balancing starts with annual resource acquisition, which results in asset-management agreements and commodity-supply contracts tailored to the Company's load forecast. Monthly plans assign portions of the Company's pipeline capacity to retail marketers and asset managers, then Energy Contracts develops detailed plans for the Company's own load. Energy Contracts and Gas Control then manage supply resources for the Company-supplied load day-to-day. That process begins with an Imbalance file that shows daily and cumulative balances for the current month. If the Company is short at a point, it orders extra supplies for the next day.

Retail marketers have responsibility for their own load forecasts for Daily Metered customer pools; Northern estimates daily demand for marketers' Non-Daily Metered customer pools. Northern communicates its estimates to the marketers daily. Retail marketers have responsibility to get enough supply to NUI's city gates to meet their customers' requirements. The marketers nominate into GTRAC, NUI's system for matching marketer deliveries from GSGT to the Company's system, to their customers' consumption. NUI's Delivery Service Terms and Conditions provide that any flow restrictions, such as upstream imbalance warnings or operational flow orders (OFOs), are passed along to the marketers. Any penalties caused by marketer imbalances are passed along to the offender.

The Company generally manages intra-day balancing, which might occur due to changes in the weather or supply problems from a particular source, with adjustments to storage withdrawals for the first half of the winter, then with off-system sales in the second half. The Company's contracts for peaking supply and its on-system LNG facility are additional resources for addressing imbalances if necessary.

C. Conclusions

1. Metering and testing programs generally conform to prevailing industry practice.

In interviews and in response to our data requests, the Company emphasizes that its metering and measurement practices conform to the regulations of the three states in which it operates (Maine, Massachusetts and New Hampshire). We found its practices generally conforming to prevailing industry practice.

We understand that the metering and testing programs of all of the gas LDCs operating in Maine, and the relationship of those programs to industry practice, are being explored in Docket No. 2018-

00331. NUI is participating actively in this proceeding, and anticipates additional protocols to ensure meter accuracy.

2. The Company's metering strategies are effective in isolating usage by customers and the Company.

NUI's distribution system consists of multiple groups of customers that are not connected to each other, but are connected to GSGT. GSGT has a relatively large number (38) of delivery points into NUI's system, each of which is metered. That large number of metering points, most of which are serving defined groups of customers, provides a lot of disaggregated data on customer usage.

The Company is also careful to measure its own usage. Taken together, this large amount of measurement data relative to the number of users provides confidence that usage information is accurate.

3. NUI's systems, practices and processes for balancing are a strength.

NUI's location, system configuration and supply resources present significant challenges for balancing. NUI has made significant investments of time and talent to address these challenges. The Company's objective in making this investment has been to facilitate balancing by all, rather than collecting penalties.

D. Recommendations

Liberty has no recommendations in this area.

VI. Price Risk Management

A. Background

Price-risk management programs, including physical and financial hedging, can comprise an important element in effective gas-supply procurement and management. We evaluated this subject using the following criteria:

1. Focus and clarity of objectives
2. Correlation between hedging instruments selected and attainment of program objectives
3. Sufficiency of policies and procedures in reflecting knowledgeable assessment of program risks, and careful design of elements to control risks
4. Completeness and effectiveness of administration of controls
5. Frequency and scope of program results review and modifications made to improve results.

NUI operated a financial hedging program when Unitil acquired the Company in 2008. NUI refocused the program, and operated it subject to periodic review by the Commission until 2017. Early in that year, the Company petitioned the Commission to allow it to suspend the program for one year, allowing option contracts held at that time to expire, followed by determining the best course going forward. The Company also noted that it was replacing one of its gas storage contracts with a larger one that would result in an increase in the volume of gas with physically hedged pricing for the 2018-2019 Winter Period.

The next year, the Company requested that the Commission allow it to terminate the financial hedging program. The Commission approved the Company's request, stating "the current hedging program benefits do not appear to warrant the ongoing cost …." The Commission went on to say

> *The Commission would propose that Northern include in its integrated resource planning filing an in depth discussion of its price risk management objectives and a description of actions it has taken, or will take, to reduce customers' exposure to gas price volatility from year to year, including whether or not use of financial instruments may be warranted.*

In this chapter, we provide a brief history of the Company's financial-hedging program, and then review the Company's approach to inventory strategy as it relates to providing a physical hedge.

B. Findings

1. The Initial Hedging Program

At the time that Unitil acquired the Company, NUI was operating a hedging program that was initially approved in 2003. That program's portfolio approach employed both physical and financial hedging to fix the prices of 70 percent of its winter supply requirements and 40 percent of its needs for May and October. The financial portion of the program used futures contracts.

When Unitil assumed control of the program, it added more structure to the financial-hedging component. Forty percent of futures contracts purchased to hedge NUI's non-storage pipeline supplies were bought pursuant to a time-based strategy: equal amounts were purchased in each of the 12 months of the year prior to the year being hedged. Up to another 30 percent of non-storage

supplies could be bought with "price-triggered" hedges: purchases structured to acquire an additional 10 percent of non-pipeline supplies when certain price targets were reached. Taken together, the time-based and price-triggered hedges could result in 70 percent of non-storage supplies being hedged.

a. 2010 Program Changes

The price-based part of the program produced repeated losses, due to generally falling NYMEX prices. In its order approving NUI's 2007-2008 Winter Period CGF rates, the Commission required NUI to file a detailed evaluation of the effectiveness of the hedging program since its inception. That proceeding began with testimony from witnesses for NiSource, which owned the Company before Unitil acquired it.

The evaluation was filed after Unitil acquired the Company. In its April 2009 Annual Report on Financial Hedging Activity for November 2008 through April 2009, NUI reported that the program had not provided as much price stability as originally expected. In August, NUI filed a proposed program redesign, with three primary changes:

1. The introduction of a price ceiling above which purchases of futures contracts would be deferred until prices fell below the ceiling
2. The complete elimination of the price-based component of the existing program
3. A process that provided for sales of futures contracts that appreciated above a specified percentage.

NUI updated its program redesign in February 2010. To the three changes listed above, it added

> *… adoption of a portfolio approach to hedging whereby Northern would combine its physically hedged supplies with its financial hedges to begin each peak season with approximately 70 percent of the supply requirements available under a fixed-price. The remaining supply (approximately 30%) would be purchased at market prices throughout the peak period*

The Company also proposed to modify the hedging plan schedule. Rather than buy hedges over the 12 months prior to the start of each six-month cost-of-gas period, the Company proposed to submit a hedging plan once a year, providing a 12-month purchasing schedule with an 18-month window to implement the plan. Each plan filing would outline a three-year schedule of projected hedging activity that would include a three-year projection of sendout requirements, the peak-season resources expected to provide fixed pricing (storage and fixed-price contracts), and the financial hedging volumes required to meet the fixed-price supply quantity target. Hedging activity would continue into the delivery season if necessary to: (a) make purchases postponed due to limits imposed by the price ceiling, and (b) sell appreciated contracts under the appreciation rule.

The Commission approved NUI's proposals.

b. 2013 Program Changes

Two years later, in the spring of 2012, the Commission noted the price stability and low prices in the markets for natural gas, and directed NUI to propose changes to the hedging program. The Company worked with a brokerage firm to develop a new approach to hedging, which involved protecting against price "spikes", rather than trying to reduce price volatility.

Protection against price spikes could be achieved by purchasing options, particularly "call" options, which give the holder the right to buy at a specified price, irrespective of what was happening to market prices. In this way, the Company could effectively "cap" the prices that it would pay for gas, while preserving the opportunity for lower prices if market prices went down. This approach also had the advantage of requiring much smaller cash outlays than buying futures contracts.

NUI's proposals retained the 70-percent target, which it had inherited from NiSource. That target would apply to winter-season commodity requirements, rather than all 12 months, and it would be attained using both physical and financial hedges. By that time, physical storage provided approximately 50 percent of winter-season requirements, leaving only 20 percent to be hedged financially. Northern picked a type of option that suited its use in the financial segment of the Company's hedging program. The financial hedges would be "out-of-the-money" call options, *i.e.*, options providing the right to purchase at a specified price (the "strike" price) that was above the current price.

NUI proposed to continue to submit annual hedging plans with its off-peak cost-of-gas (CGF) filings. The plans would include calculations to determine the number of call options to be purchased for the current hedging period and the two succeeding ones, which would provide a three-year projection of expected hedging activity.

The Commission approved the revised program.

c. 2016 Program Changes

In the hedging plan for the 2017/2018 period (submitted in February 2016), NUI proposed an increased hedging budget in order to set the strike prices for the call options closer to futures contract prices. The options purchased in previous hedging plans had been too far "out of the money", and thus had expired without any benefit to the Company's gas costs. The Company had analyzed recent experience and current market conditions, and recommended paying more for options in order that the strike prices might be set closer to levels suggested by current futures contracts.

The Commission approved the Company's proposal for one year, but required the Company to file an evaluation of actual results of this program compared with what would have happened if the budget had not been increased.

d. Program Suspension and Termination

The following year, NUI reported that the options contracts under the old budget had indeed expired worthless, but it appeared that the ones with strike prices closer to futures prices were also going to expire worthless, due to the general stability of prices. NUI recommended that the program be suspended for a year, and then decide how to proceed.

NUI also reported that it had replaced an expiring storage contract with a larger contract, thereby increasing the proportion of its supplies covered by a physical hedge (buying gas at summer prices to be consumed the following winter).

The Commission approved suspension of the program, but directed further discussions to consider whether changes to the program should be made. By the next year (2018), all parties were largely agreed that, in the current period of stable gas prices, the benefits of the financial hedging program were not worth its costs. The Commission approved NUI's proposal to terminate the financial hedging program, but ordered

> *The Commission would propose that Northern include in its integrated resource planning filing an in depth discussion of its price risk management objectives and a description of actions it has taken, or will take, to reduce customers' exposure to gas price volatility from year to year, including whether or not use of financial instruments may be warranted.*

2. Alternative Methods of Price Risk Management

The Company has been sensitive to the high level of price volatility in the Northeast gas markets, and interested parties' and the Commission's interest in protecting its customers from the effects of that volatility. The Company's preferred approach to addressing that volatility has been by way of its physical procurement strategies, however. In particular,

- The Company's most-recent replacement of an expiring storage contract increased the storage quantity by 15 percent
- The Company structures its delivered supply and LNG contracts to be priced with respect to a monthly index, rather than daily ones
- Longer term, it is adding pipeline capacity that will connect its service territory with supply points that are more liquid and have more stable – and lower – pricing.

On the latter point, pipeline-capacity additions include participation in the Portland Express Project, the Atlantic Bridge Project and Phase III of the Westbrook Xpress Project. If the first two successfully enter service, the Company's proposed addition of capacity through the Westbrook Xpress Phase III Project will reduce its purchases of delivered supply to only about one percent of its total annual supplies.

3. Program Management

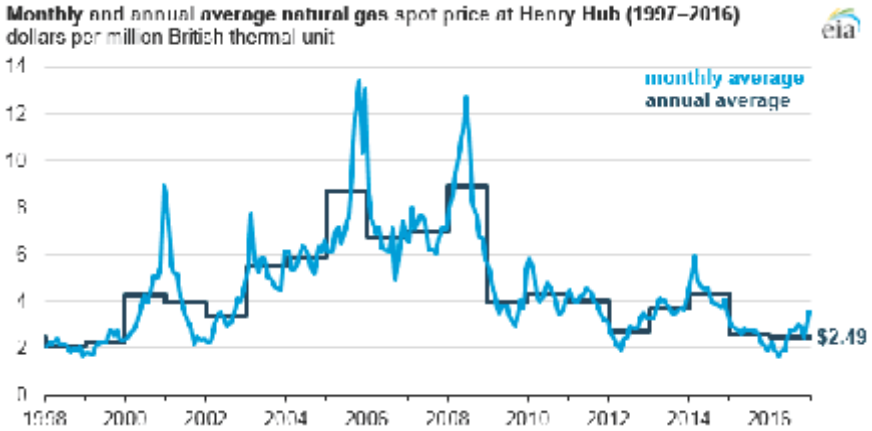
NUI had formal procedures governing operation of its financial hedging program, but the program's small size allowed it to be conducted and managed without a separate structure. The Company's Chief Financial Officer first, and then the Director of Energy Contracts, sent written instructions to execute trades to a broker who had worked with NiSource initially, and then continued working with NUI after Unitil acquired the Company. Both the Energy Contracts group and the Company's Treasury Department received daily and monthly statements of the Company's positions. Prior to converting to options contracts, Energy Contracts calculated margin-call exposure associated with futures contracts daily, and then submitted it to the Finance Department daily. Energy Contracts coordinated payment requests for margin account funding with the Director of Finance. A Senior Treasury Analyst contacted the broker for any requests to withdraw excess margin funds. The Company filed a Summary Transaction Report with the two PUCs each month.

C. Conclusions

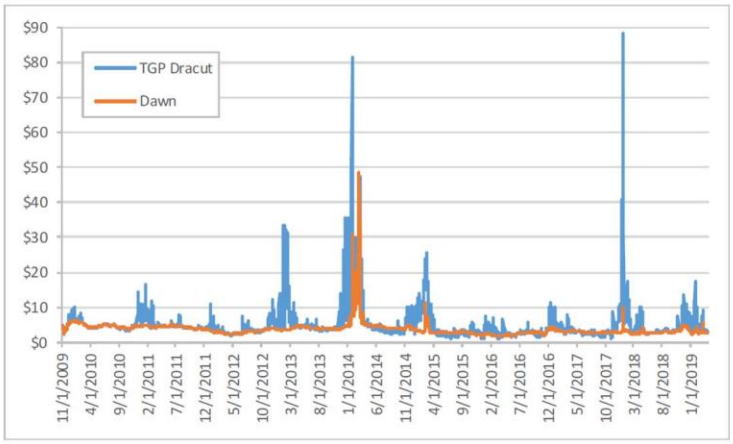
1. The objectives of NUI's hedging program have changed over the period that Unitil has owned the Company.

The stated objective of the hedging program has always been to protect NUI's customers from the consequences of natural gas price volatility. In late 2008 and early 2009, when Unitil took the program over from NiSource, the focus was volatility in the Henry Hub price. The hedging program that Unitil took over used gas futures contracts to reduce the consequences of that volatility. Gas futures contracts provide the right to buy a stated quantity at a stated price for a selected month at the Henry Hub location.

Unitil's principal change to the program, substituting call options on futures contracts for the contracts, was an effort to address the same objective – volatility in the Henry Hub price – at less cost, and with less requirement for credit support. While the level of Henry Hub prices has fluctuated somewhat since 2008, the general trend has been toward less volatility. The following chart, taken from a recent report by the U. S. Department of Energy's Energy Information Administration (EIA), illustrates this trend.



Over the same period, volatility in daily prices in the New England region has increased. The reasons for this increased volatility are well known -- increased demand for gas without corresponding increases in gas-supply capacity. The chart below, taken from NUI's recently-filed Integrated Resource Plan, illustrates this trend, using the daily spot price at TGP's Dracut location.



NUI has substituted increased physical hedging and particular contracting strategies for financial hedging, but the objective is clear: to "insulate customers from the volatility of *daily* index prices". (Emphasis added). As the Company has also stated.

> *As feasible Northern structures its Delivered Supply and LNG contracts to be indexed to monthly rather than daily prices, in order to insulate customers from daily index pricing, which can become extreme particularly on very cold days when delivered peaking supplies are needed.*

2. NUI's selection of hedging "instruments" reflects core strengths of its operations.

We noted earlier NUI's strengths in: (a) knowledge of the gas-supply infrastructure in its region, (b) knowledge of the operational risks of that infrastructure, (c) structuring its supply contracts and asset-management agreements to reduce risk, and (d) effective operation of its gas-supply resources. The Company's focus on storage and contracting strategies for reducing its customers' exposure to gas-price volatility reflects those strengths. The Company has no other particular use for expertise in financial derivatives, and chooses not to acquire it for the sole purpose of gas-price hedging.

3. Controls, policies and procedures have reflected the Company's approach to hedging.

During the period of financial hedging, the Company established controls, policies and procedures that reflected the limited scope of the hedging activity. The activity was conducted by the Director of Energy Contracts, in cooperation and coordination with Treasury and Finance. With the move to increased physical hedging and supply contracting, Energy Contracts' normal processes of analysis and approval are considered sufficient. As noted in the chapter on Organization, Staffing and Controls, those processes have been in place, if somewhat informal. Liberty has recommended that additional structure be added to those functions.

4. Company personnel have reviewed program results regularly, and have recommended changes as market trends and program results have developed.

NUI began examining the results of the financial-hedging program as soon as it took the program over from NiSource, and made several recommendations for program improvements before recommending that it be terminated. The Commission remarked favorably on NUI's program

evaluations and recommendations for improvement multiple times over the period that the financial-hedging program operated.[2]

NUI's supply-contracting evaluations and decisions over the period have been driven primarily by considerations of supply security and reduced operational risk. The role of those decisions in protecting the Company's customers from price volatility has increasingly entered those deliberations, however, as the potential benefits to price stability have been realized. Price risk management has now been recognized as a feature of the Company's physical procurement strategies.[3]

D. Recommendations

Liberty has no recommendations in this area.

[2] See, *e.g.*, Order, dated April 28, 2017, in Docket No. 2017-00028, *NORTHERN UTILITIES, INC. d/b/a UNITIL, Proposed Cost of Gas Factor for May 2017 - October 2017*, at page 7, and Order, issued in Docket No. 2016-00025, *NORTHERN UTILITIES, INC. d/b/a UNITIL, Proposed Cost of Gas Factor for May 2016 – October 2016*, on April 29, 2016, at page 6.
[3] See, *e.g., 2019 Integrated Resource Plan*, at page VI-115.