Initial Long-Term Plan

National Fuel Gas Distribution Corporation

December 22, 2022

Case 22-G-0610

National Fuel®

CONTENTS

ACRONYMS AND DEFINED TERMS

Acronyms

BCA	Benefit Cost Analysis
BCR	Benefit Cost Ratio
CH4	Methane
CJWG	Climate Justice Working Group
CLCPA	Climate Leadership and Community Protection Act
CNG	Compressed Natural Gas
CO2	Carbon Dioxide
CO2e	Carbon Dioxide Equivalent
DPS	New York Department of Public Service
EIA	Energy Information Administration
ESCO	Energy Service Companies
GHG	Greenhouse Gas
GWP	Global Warming Potential
HDD	Heating Degree Days
HEAP	Home Energy Assistance Program
LDC	Local Distribution Company
LMI	Low-and Moderate Income
LNG	Liquified Natural Gas
LPP	Leak Prone Pipe
LTP	Long-Term Plan
MT	Metric Ton
N2O	Nitrous Oxide
NOAA	The National Oceanic and Atmospheric Administration
NPA	Non-Pipe Alternatives
NPV	Net Present Value
NYSERDA	New York State Energy Research & Development Authority
O&M	Operations and Maintenance
PSC	Public Service Commission
RNG	Renewable Natural Gas
SCE	Supply-Constrained Economy
SCT	Societal Cost Test
SCE	Supply Constrained Economy
TENS	Thermal Energy Networks

Defined Terms

Commission or PSC	New York Public Service Commission
National Fuel Or Company	National Fuel Gas Distribution Corporation
DPS Staff	Staff of the New York Department of Public Service

I. Introduction

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National Fuel Gas Distribution Corporation ("National Fuel" or "the Company") presents its 2022 Long-Term Plan ("LTP" or "Long-Term Plan") in response to the New York Public Service Commission's ("Commission" or "PSC") May 12, 2022, *Order Adopting Gas System Planning Process* ("Gas Planning Order"). The Gas Planning Order establishes a gas system planning process for natural gas local distribution companies ("LDCs") in New York and includes, among other things, a requirement for each LDC to file a Long-Term Plan.

Figure I-1
2022 LTP Objectives[1]

- Ensure that residents of New York can continue to meet their energy needs in the long term.
- Provide a foundation to ensure that New York continues to reduce GHG emissions in the face of climate change.
- Conduct planning consistent with the Climate Leadership and Community Protection Act ("CLCPA").
- Provide information for customers in a way that promotes effective customer planning, reduces confusion, and avoids inequities or the appearance of inequities.
- Provide information to the Commission, other government entities and agencies, and stakeholders related to the promotion of effective planning and consideration of gas alternatives, thereby reducing costs and emissions while minimizing impacts on economic development.
- Improve the Commission, NYS Department of Public Service ("DPS") Staff, and Stakeholder's ability to examine National Fuel's long-term gas plans to ensure those plans are cost-effective for ratepayers and consistent with state policies.

The Gas Planning Order provides context for the LTP, by expressing the overall objectives for the gas planning process, including a robust stakeholder engagement process to inform the development of the LTP.[2] As an initial action, National Fuel hosted a virtual informational session on November 16, 2022.[3]

The Gas Planning Order establishes several specific requirements to be addressed in the LTPs:

(1) a demand forecast that estimates the expected sources of growth and/or reduction in peak demand resulting from demand-side investments[4];

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1 Order Adopting Gas System Planning Process ("Gas Planning Order") issued on May 12, 2022, in Case No. 20-G-0131.

2 Gas Planning Order at 10.

3 National Fuel's presentation is posted at https://www.nationalfuel.com/utility/gas-planning-process/. Similar information is presented in Chapter II of this Report.

4 Gas Planning Order at 28.

(2) a supply forecast that explicitly includes the level of demand-side programs and those that prioritize developing innovative clean demand response programs[5];

(3) the methodology by which reliability will be forecast and measured[6];

(4) solutions to reliability and meeting demand, including a "no infrastructure" scenario and reasonable Non-Pipe Alternatives ("NPAs")[7] ; and

(5) an estimate of the bill impacts and net present value of costs of each alternative.[8]

As a general matter, the Commission noted that the LTP should provide necessary information to assess the potential impacts of its long-term plans and alternatives, both benefits and burdens, on disadvantaged communities[9] and ensure that the Commission, Staff, and stakeholders have the information necessary to appropriately evaluate the potential GHG emissions of the LDCs' long-term plans and alternatives[10]. The Commission also addresses the methodology to be applied when performing a benefit cost analysis ("BCA").[11]

In addition to the LTP requirements, the Commission directs the LDCs to file annual reports every May 31, which will help the Commission, DPS Staff, and stakeholders to continue to track the evolution of gas planning activities in the two years between LDC LTP filings.

National Fuel developed a list of "guiding principles" that identify the attributes that its recommended plan must satisfy. These guiding principles represent National Fuel's obligation and commitments and address the primary goals of the LTP.

National Fuel is proposing a methodology that enables a comparison of three scenarios to construct a recommended plan. In particular, the methodology (described in Chapter III) provides insights regarding the tradeoff between environmental and economic objectives, while also considering critical safety, reliability and resiliency issues.

The National Fuel LTP is presented in six chapters, plus an Executive Summary. The Executive Summary provides an overview of the LTP and a summary of the overall LTP results. This Introduction (Chapter I) includes the LTP objectives and key requirements established by the Gas Planning Order. Chapter II describes National Fuel's service territory characteristics. Chapter III explains the methodology that National Fuel employed to develop the LTP and Chapter IV presents the scenario analysis. Chapter V describes the use of the scenarios to

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5 Gas Planning Order at 30-31.

6 Gas Planning Order at 34.

7 Gas Planning Order 34-39.

8 Gas Planning Order at 45-46.

9 Gas Planning Order at 39-40.

10 Gas Planning Order at 47.

11 The Commission directs LDCs to apply the methodology established in the BCA Framework Order, Case 14-M-0101, Reforming the Energy Vision, Order Establishing the Benefit Cost Analysis Framework (issued January 21, 2016).

develop the LTP, and Chapter VI presents National Fuel's final conclusions and recommendations.

In addition, the National Fuel LTP includes the following appendices:

Appendix A – Decarbonization Action Modeling

Appendix B – Scenario Modeling

Appendix C – Benefit Cost Analysis

Appendix D – Reference Case Detail

Appendix E – “Meeting the Challenge: Scenarios for Decarbonizing New York’s Economy,” Guidehouse, February 19, 2021.

Appendix F - “Residential Weatherization Potential Study Report,” prepared for: National Fuel Gas Distribution Corporation, November 2, 2022, Cadmus

Appendix G – “Residential Home Energy Analysis,” National Fuel Gas Distribution Corp. New York Division, August 2022 Update, CJ Brown Energy

Appendix H – “2021 Residential Market Study,” National Fuel, August 5, 2021, JRB Insights

Appendix I – “Net-Zero Community Model with Networked Geothermal Heat Pumps Memorandum,” National Fuel Gas Company, November 9, 2022, Cadmus

Appendix J – “RNG Potential in NY & NFGDC Territory,” April 2020, National Fuel Gas Company

II. National Fuel's New York Service Area

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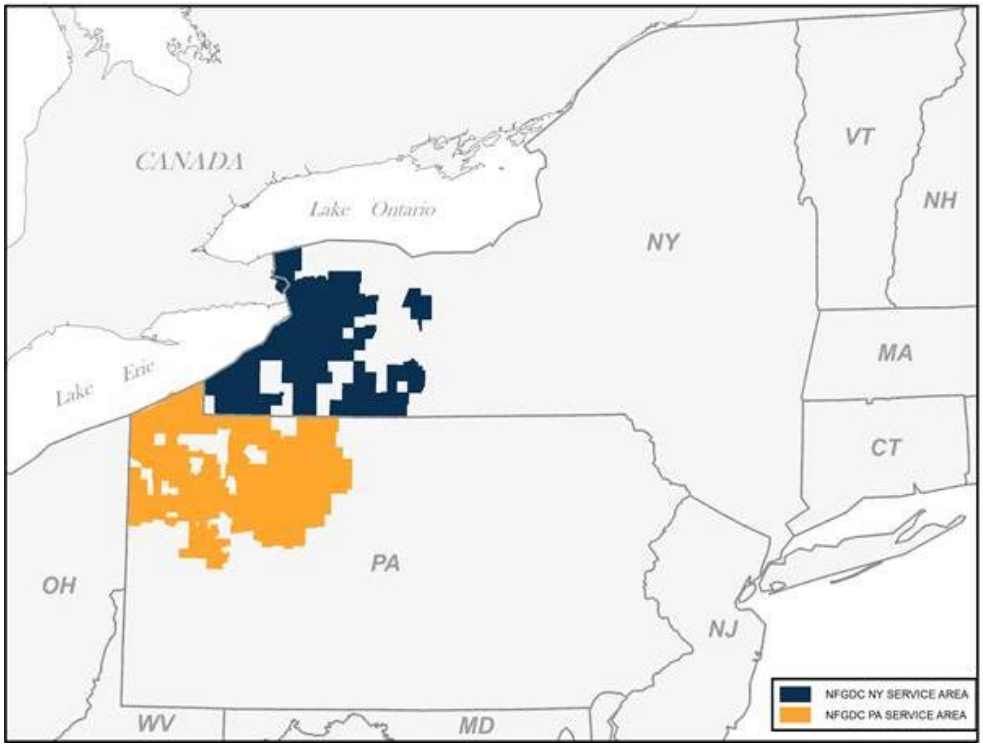
National Fuel sells or transports natural gas to over 740,000 customers through a local distribution system in western New York and northwestern Pennsylvania. Its New York service territory spans several counties and includes the cities of Buffalo, Niagara Falls, Batavia, Jamestown and Wellsville. The Company's New York customer base consists of approximately 540,000 customers across a population of more than 1.6 million people in western New York.[12] Figure II-1 presents a map of the Company's service territory.

Figure II-1
National Fuel Service Territories



National Fuel operates and maintains approximately 9,775 miles of distribution mains or pipelines in its New York service territory and has maintained an exceptional safety and reliability record, demonstrating continuous improvements. National Fuel's utility service has a 99.999% reliability rating and interruptions in service are exceedingly rare. This is significant because on the coldest day in western New York gas represents approximately 94% of a typical customer's residential energy use.

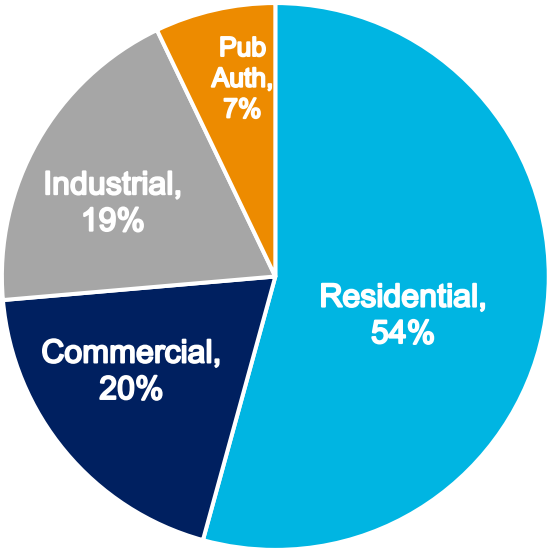
[12] Values obtained from 2020 US Census data for each community within National Fuel's service territory.

Customers and Communities

National Fuel's customers consist of a mix of residential, commercial, industrial, and public authority customers. Residential customers typically use gas to heat their homes as well as in hot water heaters, gas ranges, clothes dryers, fireplaces, grills, and pool heaters. Commercial customers are non-residential businesses selling goods or providing services. Industrial customers are businesses that manufacture or process goods or materials. Lastly, public authority customers are typically towns, cities, public schools & universities, and public housing.

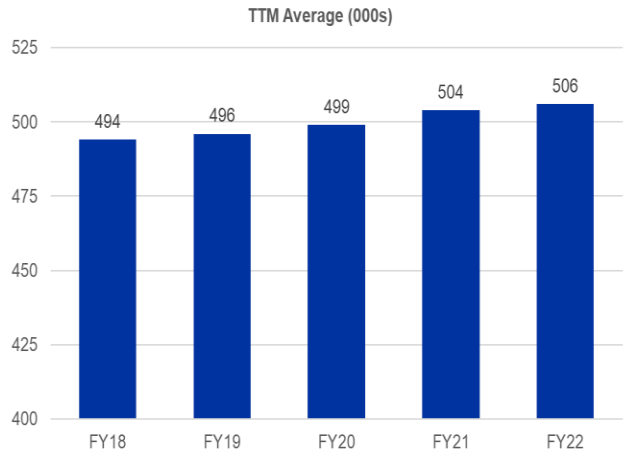
Figure II-2 presents National Fuel's usage by customer type.

Figure II-2
Percentage of Annual Customer Throughput



Residential customers make up approximately 93% of total National Fuel customers, but only use 54% of total throughput. Over the past five years, residential customer counts have grown at a compounded annual growth rate of 0.6%, with a total increase of 2.4% over the period. Figure II-3 presents historical residential customer counts; 90% of National Fuel's residential customers use gas for heating.

Figure II-3
Number of Residential Customers



TTM is a measure of data over a 12-month period in the past.

The following charts provide residential demographics. Unlike housing in downstate New York where about 36% of homes are single-family homes, that percentage is more than double at 78% in National Fuel's service territory.

Figure II-4
Housing Mix[13]

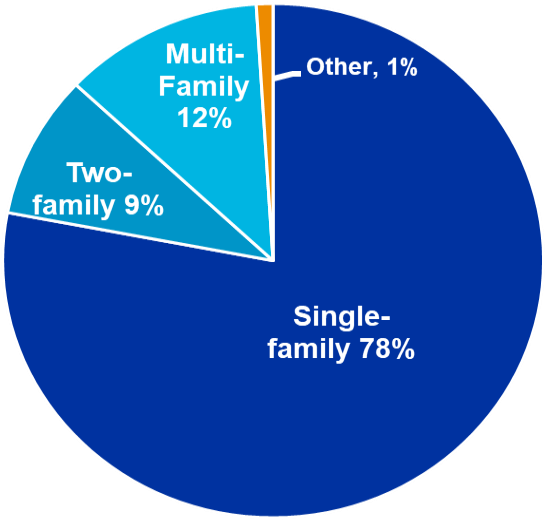


Figure II-5 demonstrates that approximately 67% of the housing stock is over 52 years old, with half of that being over 80 years old. These older homes generally possess poor building

[13] 2021 Residential Market Study performed by JRB Insights on National Fuel Residential service territory. Provided in Appendix H.

envelopes with single-pane windows, poor insulation and outdated ampere[14] services, making it more costly for these homeowners to convert their homes to electric heat.

Figure II-5
Distribution of Housing by Age[15]

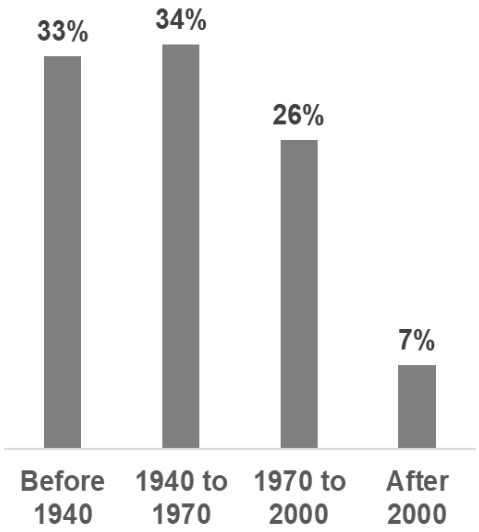


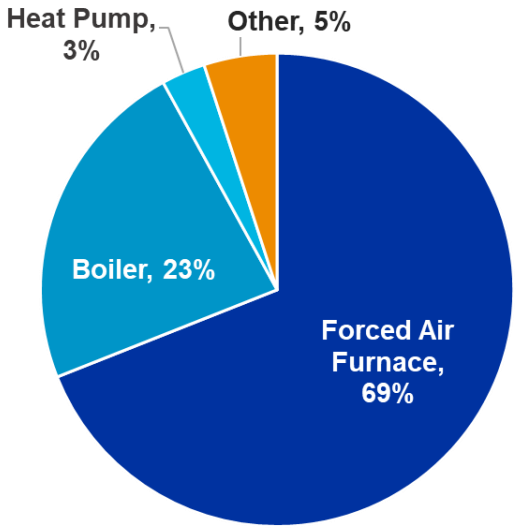
Figure II-6 shows the breakdown of heating systems in the residential homes heated by natural gas in National Fuel's service territory, with 69% of those being heated with forced air furnaces, and 23% with boilers. It is important to note that homes heated by boilers have no existing ductwork and therefore make it very difficult and costly to convert to electric heat.

[14] Ampere is the base unit of electrical current in the international system of units.

[15] 2021 Residential Market Study performed by JRB Insights on National Fuel Residential service territory. Provided in Appendix H.

Figure II-6[16]

Type of Heating Systems in National Fuel's NYS Service Territory



With the median household income for most of National Fuel's service territory, including in the cities of Niagara Falls, Jamestown, Wellsville and Buffalo, being below that of the U.S. average, and the poverty rate being higher than the U.S. average, National Fuel's service territory consists of multiple communities that have been identified as "disadvantaged" by the New York State Energy Research and Development Authority ("NYSERDA"). The CLCPA directed the Climate Justice Working Group ("CJWG") to develop a definition for disadvantaged communities, and a preliminary definition has been proposed. Until those criteria have been finalized, NYSERDA is using the following definition:

- Located within census block groups that meet the Housing and Urban Development 50% Area Median Income threshold, that are also located within the Department of Environmental Conservation Potential Environmental Justice; or
- Located within New York State Opportunity Zones.[17]

The map in Figure II-7 highlights some of the communities within National Fuel's service territory considered disadvantaged by NYSERDA's definition, with the largest number of disadvantaged customers being in metro areas.

[16] 2021 Residential Market Study performed by JRB Insights on National Fuel Residential service territory. Provided in Appendix H.

[17] https://www.nyserda.ny.gov/ny/disadvantaged-communities.

Figure II-7
Disadvantaged Communities in National Fuel's Service Territory

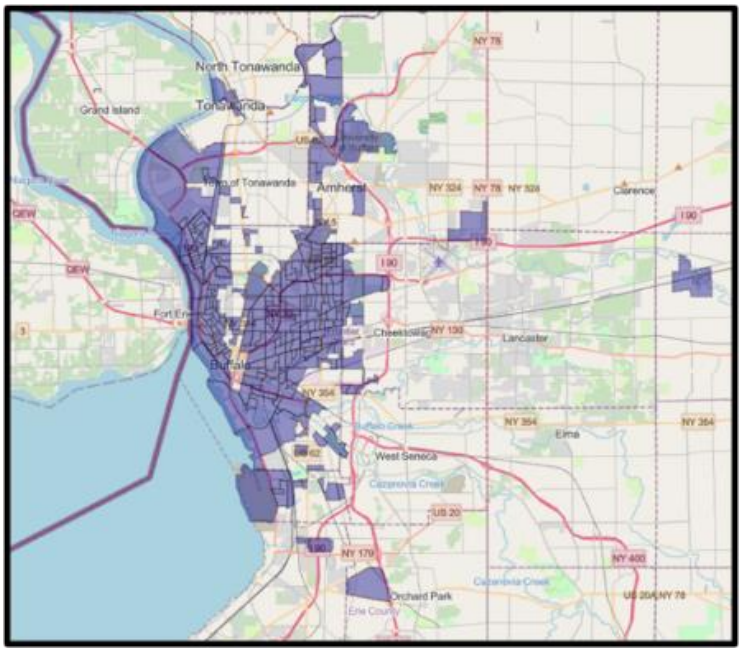


Table II-1 provides additional demographic information for National Fuel's service territory.[18] The poverty rate for the City of Buffalo is 28.3% compared to 12.5% and 11.4% for National Fuel's entire service region and the United States, respectively.

Table II-1
Demographic Data

	Buffalo-Niagara, NY		New York State	U.S.
	Buffalo Region	City		
Median Household Income	$58,358	$39,677	$75,157	$64,994
Poverty Rate	12.5%	28.3%	13.9%	11.4%

National Fuel serves approximately 76,000 customers throughout its service territory that receive bill discounts through its Statewide Low Income Program Discounts SLIP. Those discounts totaled approximately $15.5 million in fiscal year 2022. National Fuel customers also receive

[18] Median Household Income and Poverty Rates are from the U.S. Commerce Department April 2020 Census. The Unemployment Rate is from the December 2021 Bureau of Labor Statistics.

Home Energy Assistance Program ("HEAP") grants averaging between $400 and $476 per customer per year. In addition, to those two programs, National Fuel distributed approximately $3.0 million through the Emergency Rental Assistance Program ERAP in fiscal year 2022. Finally, customers benefited from approximately $22 million in Regular Arrears Supplement RAS grants. These grants were provided to eligible HEAP customers who were behind on their heating bills.

Commercial, industrial and public authority customers are a significant part of National Fuel's load, at about 45%. The number of National Fuel commercial customers has remained consistent over the past five years at around 33,000. From 2018 through 2022, the total throughput for the commercial customers ranged from 18.1 Bcf to 19.4 Bcf. Commercial customers generally include private hospitals and healthcare facilities, nursing homes, garbage disposal services, colleges and universities, Condensed Natural Gas ("CNG") stations, casinos, hydroponic greenhouses, building materials, and asphalt plants. Public authority customers generally include public elementary and secondary schools, public colleges and universities, general medical and surgical hospitals, municipal buildings, correctional facilities and other general government support.

The number of industrial customers has risen from 430 to 444 over the last five years. From 2018 through 2022, the total throughput for industrial customers ranged from 17.67 Bcf to 19.9 Bcf. National Fuel's industrial customers generally include iron and steel mills, hazardous waste disposal, flour mills and power generation. Currently, National Fuel has one interruptible transportation service customer.[19] National Fuel considers all critical care facilities such as hospitals, nursing homes, etc. similar to a firm core customer despite their greater annual consumption. National Fuel does not require firm customers to have back-up, but other healthcare regulating entities may require back-up capability. The Commission recently ordered all LDCs to send letters encouraging hospitals to fill their oil tanks, and that LDCs verify their ready state for the 2022-2023 winter.

National Fuel's Distinguishing Characteristics

National Fuel is quite different from other natural gas utilities in New York State. The Company does not currently project any pipeline capacity constraints during the 20-year LTP forecast period. Accordingly, it does not anticipate a gas moratorium in this period.[20]

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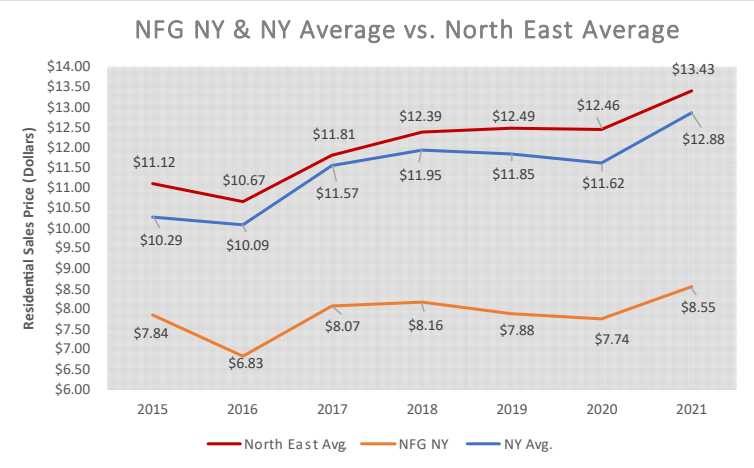
[19] National Fuel's interruptible load is approximately 566,000 Mcf/year. It's single interruptible transportation service customer has an oil tank on site and a physical inspection of the tank is conducted in order to verify the oil tank is full. In addition, National Fuel confirms annually that the customer has entered into a relationship with an oil supplier in the event the natural gas service is interrupted. The Company has not interrupted transportation service to this customer in the past five winter heating seasons.

[20] Contingent upon current forecast and an expectation that the existing gas system is maintained and not decommissioned.

Importantly, the Company has the most affordable residential gas bills in the region. Based on utility data reported by the Energy Information Administration ("EIA"), National Fuel has maintained the lowest average all-in residential retail sales rates (residential sales revenue per Mcf of throughput) amongst all gas utilities not only in New York State but in all of the Northeast United States.[21] Figure II-8 presents National Fuel NY, New York State and Northeast average gas rates.

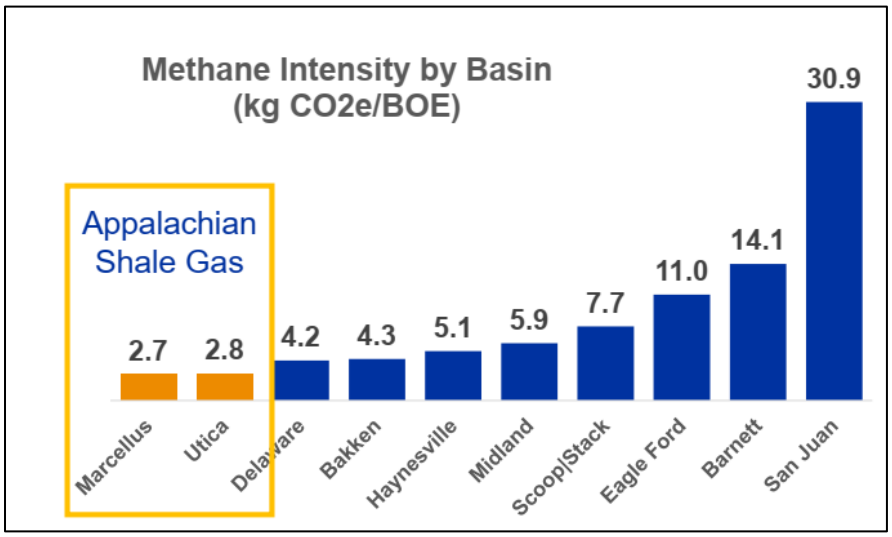
Figure II-8
National Fuel, NY and Northeast Average Gas Rates ($/Mcf)



As significant driver of the affordability of National Fuel's service is the accessibility of and proximity to supplies being produced from the Marcellus and Utica shales in the Appalachian basin. Approximately 95% of National Fuel's natural gas supply is produced from the Appalachian supply basin with the remaining 5% from New York legacy production areas. Figure II-9 presents that the methane intensity of the Marcellus and Utica shale gas is the lowest in the country. In addition, natural gas from this region is generally less expensive compared to most other regions.

[21] Based on analysis of EIA residential natural gas sales price data from calendar year 2020 (the most recent available data).

Figure II-9
Low Emission Natural Gas



National Fuel's service territory frequently experiences frigid temperatures and extreme winter weather events. The most recent example occurred in November 2022 when record-breaking heavy snowfall in portions of the service territory downed powerlines that resulted in power outages to thousands of western New York homes and businesses. Despite those power outages, National Fuel's underground natural gas system again proved its resilience to such winter events and continued providing uninterrupted service to its customers. Some of the service territory's notable low temperatures are shown in the table below. Given these temperatures, it is critical when making heating decisions (at the policy and homeowner levels) to consider that the efficiency and capacity of heat pumps may diminish as temperatures drop.

Table II-2
Notable Low Temperatures

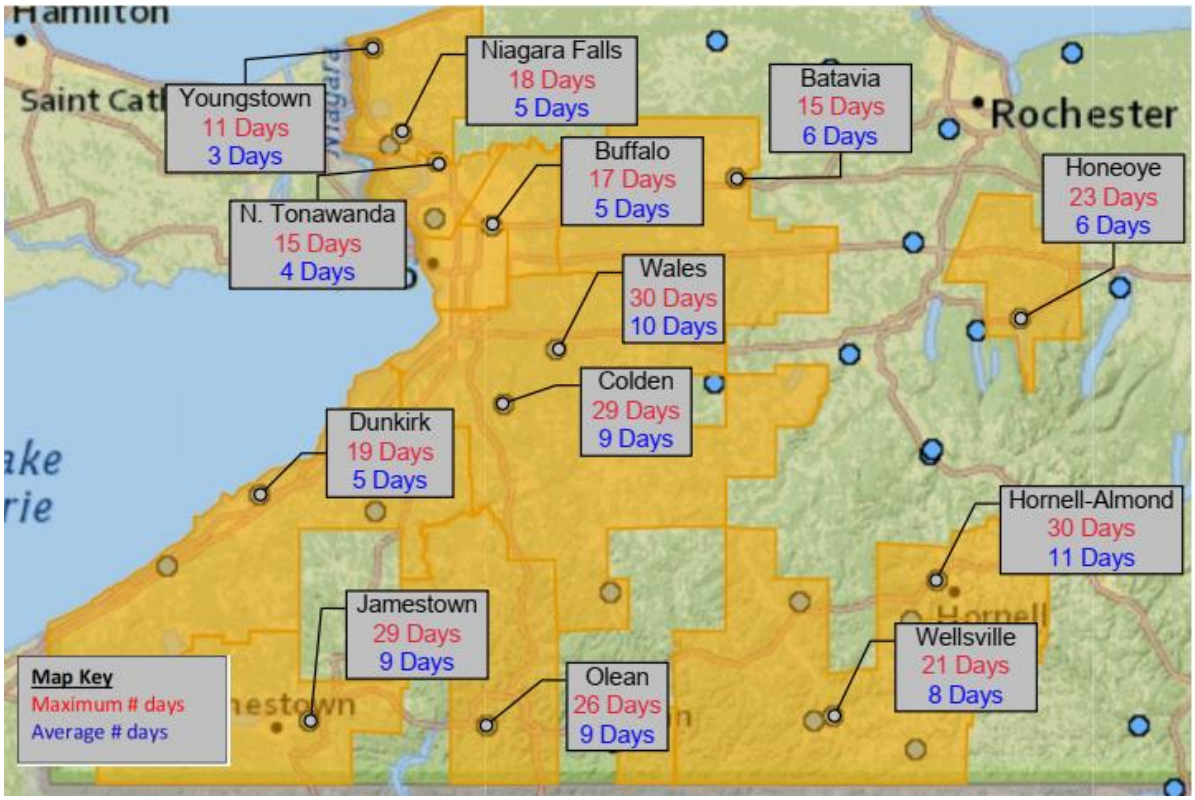
City	Date	Low Temp (ºF)
Olean	January 23, 2022	-22*
Wellsville	January 23, 2022	-19
Wellsville	February 17, 2015	-24*
Jamestown	February 17, 2015	-31*
Batavia	February 14, 2016	-15
N. Tonawanda	February 14, 2016	-15

*Record Low Temperatures

In addition, the map below further demonstrates that National Fuel's customers frequently experience very cold days for prolonged periods of time, with some cities that can experience almost 30 days in a year with average daily temperatures at or below 10 degrees.

Figure II-10

Annual Winter Days with an Average Temperature at or Below 10°F[22]



Demand and Supply

National Fuel uses a combination of historical trends and econometric regression forecasting to forecast its natural gas demand for its heat-sensitive customers (residential, commercial and public authority). The Company relies on customer surveys to estimate usage for its larger industrial and commercial customers who use natural gas for manufacturing/production processes. National Fuel produced an annual 5-year forecast, which provides values for customer counts and usage with the combination of its econometric and large volume forecasts. It develops the design peak day forecast based on this 5-year forecast.[23]

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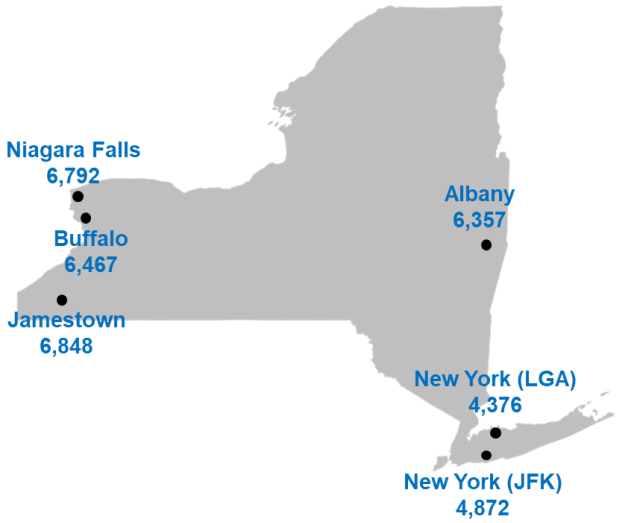
[22] These temperatures represent the 15-year (2006-2020) average for the winter period of November – March as reported by NOAA.

[23] Design peak day is an industry term that refers to the practice of capacity planning, storage capacity planning and nature gas supply planning based on customers' usage requirements on the coldest winter day expected.

National Fuel uses both dependent and independent variables for the heat-sensitive customer load where econometric forecasting is used. Its service territory typically experiences long and cold winters, although temperatures vary across the state. Therefore, weather is one of the most material independent variables in the forecast. The National Ocean and Atmospheric Administration ("NOAA") tracks average weather and Heating Degree Days ("HDD").[24] The figure below shows the most recent 30-year average HDD in upstate New York compared to downstate.

Figure II-11
HDD Days (30-Year Average)[25]



Chapter IV provides additional information on National Fuel's demand forecast.

National Fuel maintains contracts for firm transportation and storage capacity on National Fuel Gas Supply Corporation ("Supply") and on several pipelines upstream of Supply, including Eastern Gas Transmission and Storage, Inc, Empire Pipeline, Inc., Honeoye Storage Corp., Millennium Pipeline Co., Stagecoach Pipeline and Storage Co., Tennessee Gas Pipeline, LLC, and Transcontinental Gas Pipeline Co. About 95% of the Company's deliveries originate from gas supplies attached to Supply or pipelines upstream of Supply. Approximately 5% of the Company's annual deliveries to its customers are sourced from production attached directly to its system. The Company relies on Supply's transmission system as intermediate capacity to receive gas from pipelines upstream of its system and, in turn, to make redeliveries to the

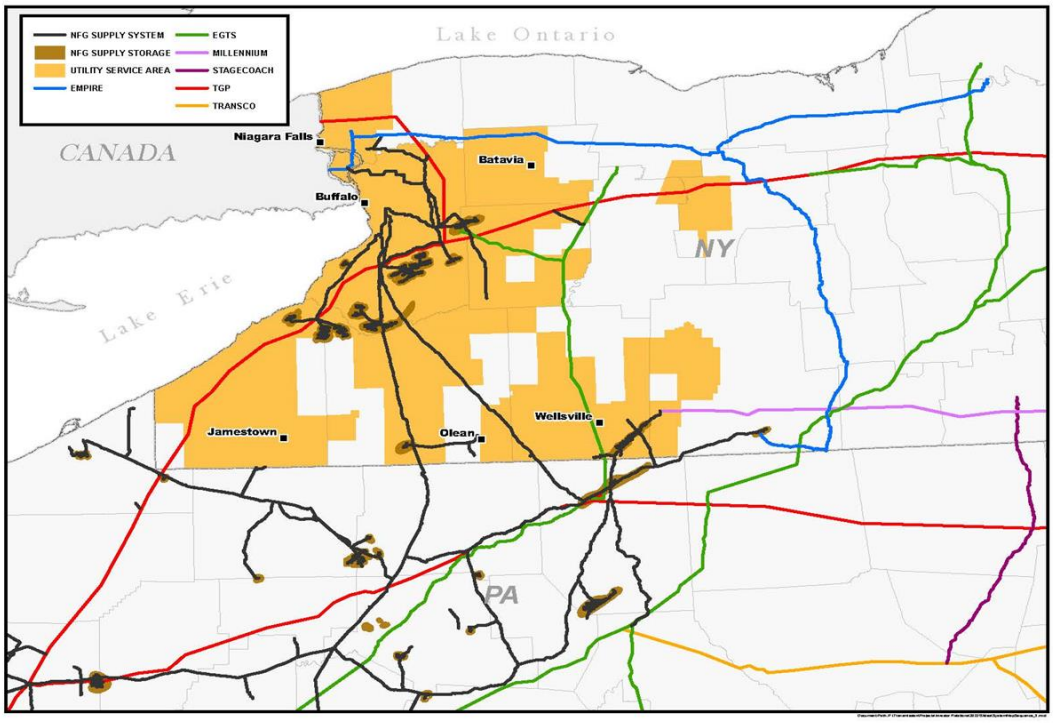
[24] A degree day is a quantitative index demonstrated to reflect demand for energy to heat or cool houses and businesses. This index is derived from daily temperature observations at nearly 200 major weather stations in the contiguous United States. A mean daily temperature (average of the daily maximum and minimum temperatures) of 65°F is the base for both heating and cooling degree day computations. Heating degree days are summations of negative differences between the mean daily temperature and the 65°F base. For example, when the temperature is 5 degrees that equates to a 60 HDD (65-5).

[25] NOAA.

Company's many non-contiguous delivery systems. The Company also relies on Supply for the transmission of the Company's gas supplies from Supply's underground storage fields dispersed in and around National Fuel's service territory. The Company uses Supply's storage and transmission facilities to receive and store gas during periods of low customer demand. Such storage gas is then redelivered to the Company's distribution system during the winter months when customer demands exceed flowing gas supplies. This usage of Supply's storage service allows the Company to maintain a high load factor on its upstream pipeline capacity, resulting in lower pipeline costs and a more favorable purchasing pattern with its suppliers that generally translates to lower costs for National Fuel's customers.

Figure II-12 presents Supply's major transmission lines and storage facilities within the Company's service territory. The Company receives gas from Supply at approximately 400 delivery points in New York and Pennsylvania. The Figure also demonstrates how Supply's facilities interconnect the Company's facilities with the network of upstream pipelines and storage facilities. The colored lines indicate the upstream pipelines' major transmission lines that the Company utilizes to serve its western New York customers.

Figure II-12
Pipeline and Storage Service



Supply Portfolio

The Company satisfies its peaking service requirement solely through traditional pipeline delivered services, specified as “NFGSC Citygate”. These citygate supply deliveries include firm supplies purchased by the Company from Appalachian producers or suppliers directly at various Supply receipt points (“Supply Citygate”).

The Company evaluates opportunities to purchase Supply Citygate supplies from reputable, proven suppliers rather than seeking upstream capacity. The Company strives to maintain the appropriate quantity of pipeline delivered peaking services with various business terms. To date, the Company’s reliance on Supply Citygate services is limited to the winter period, and accounts for approximately 10% of the Company’s design day requirements. Other than the Appalachian supply that is typically delivered year-round, the Company’s citygate supplies typically include firm gas calls ranging from 30 days to 151 days during the winter period. The Company does not rely on other forms of peaking supplies, such as Liquified Natural Gas (“LNG”) or trucked CNG delivered services.

Typical winter supply arrangements vary each winter season as the capacity asset portfolio changes. The Company ensures that firm winter seasonal pipeline and citygate supplies are available and connected to the firm capacity, and that such supplies are sufficient to meet the design day requirement.

Chapter IV provides additional information on National Fuel’s supply forecast.

Market Perspectives / Future Considerations

As discussed in the Company’s July 31, 2020 supply and demand analysis related to areas across the entire service territory, the Company believes there are no significant areas of concern or vulnerability in the distribution system.[26] Further, the Company believes ample firm capacity and supplies are available throughout its current New York franchise territory to serve projected design day, winter season and year-round demand of capacity requiring customers over the next five years. At this time, the Company believes it will continue to provide reliable and safe service throughout this forecast period with the continued utilization of the existing Company contracted firm pipeline and storage capacity, coupled with supplier-provided pipeline Supply Citygate delivered services. These circumstances may change as the Company continually optimizes its capacity asset portfolio to ensure reliability at reasonable costs as opportunities arise, particularly as existing pipeline capacity with delivery capability to the western New York region becomes available to the Federal Energy Regulatory Commission-regulated capacity market. The Company will continue to evaluate such opportunities.

[26] “Supply and Demand Analysis Related to Service Areas with Known Supply Constrain Vulnerabilities”, Case 20-G-0131, July 17, 2020 (“July 2020 Filing”).

As part of the same July 2020 Filing, National Fuel completed a review of its entire service territory that considered the potential consequences of current regulatory impacts to some of the stakeholders currently operating on the Company's systems, including the local producers transporting their production through the system, as well as Energy Service Companies ("ESCOs" or "marketers") and large industrial transportation customers that provide their own upstream capacity and associated gas supplies. While National Fuel does not consider these stakeholder issues immediate system or supply vulnerabilities, it believes there are three distinct system-wide issues that warrant recognition and consideration: (1) Continued declines in locally produced natural gas connected directly to the Company's distribution system; (2) Sudden declines or elimination of ESCO-provided capacity utilized by them to serve their customers within the Company's service territory; and (3) Non-core transportation customers, including large industrial customers, that typically provide their own capacity and supplies seeking firm sales service from the Company. Significant changes associated with these factors could potentially impact the Company's supply planning process.

Implications for Planning and the LTP

National Fuel is in a unique position having: 1) the largest gas-only distribution company in New York; 2) a location in a climate where customers frequently experience very cold days for prolonged periods of time; and 3) 90% of its 505,000 residential customers rely on natural gas for heating. These challenges make it even more crucial that the LTP reflects alternative sources of energy that meet the peak winter demands of National Fuel's service territory and ensure that its source and delivery capabilities are as reliable as today's natural gas system.

III. LTP Methodology

III. LTP Methodology

Overview

The LTP methodology guides the development of National Fuel's Long-Term Plan, which sets forth specific decarbonization actions that the Company will pursue. The methodology is designed to examine and communicate how alternative "decarbonization actions" contribute to cost-effective GHG reductions and how the most promising and efficient options might be sized and staged to make a significant contribution to New York's statewide environmental objectives in a responsible manner (i.e., maintaining safety, reliability, resilience, and affordability throughout the plan period).[27]

This examination involves a multi-dimensional approach that incorporates analyses, quantitative and feasibility assessments, consideration of customer and stakeholder perspectives, and evaluation of risks and uncertainties.

The examination starts with the current business circumstances (markets, asset base, customer programs, policies, and regulation) and produces a Long-Term Plan that achieves or makes substantial progress toward desired future outcomes as delineated by a set of Guiding Principles. "Guiding Principles" are a collection of clear, concise statements that define the goal.

National Fuel has developed an analytical model to support the development of the LTP. The model has been designed to assess alternative pathways ("scenarios") over a twenty-year period (2023-2042). A scenario consists of a combination of decarbonization actions that can be taken by National Fuel to contribute toward the realization of New York's GHG emissions targets. This quantitative model provides insights into the tradeoffs among objectives - particularly the tradeoff between GHG emissions reductions and the costs to achieve them – and considers other critical issues such as safety, reliability, resiliency and affordability.

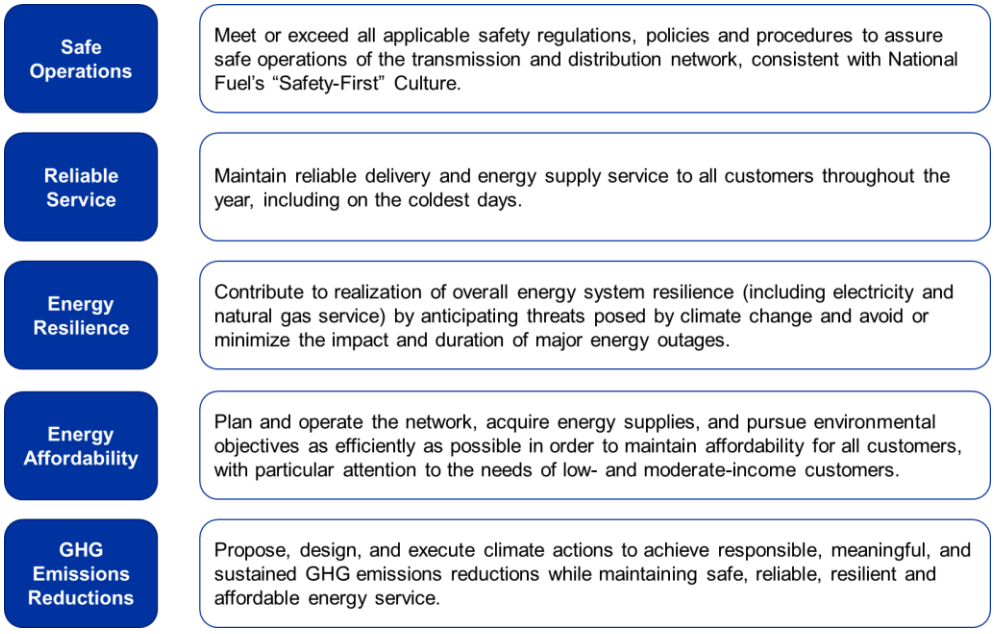
As with any model, the results are driven by assumptions that define the capability of individual decarbonization actions to produce desired results (timing, amount, and cost) as well as global assumptions that are beyond the control of National Fuel or any stakeholder, including fuel prices and inflation. All assumptions are documented in Appendices A through D. The model produces a forecast of the incremental impact of scenarios on National Fuel's revenue requirements and customer rates. Rate impacts will be calculated based on existing cost recovery ratemaking

[27] The LTP focuses on National Fuel's potential contribution to New York's clean energy targets; it does not optimize across all sectors of the economy, including electric generation, transportation and agriculture, for example. However, it does consider the potential contribution of National Fuel to electrify building heating within its service area, even though the execution and cost of this strategy will depend critically on a buildout of electric generation, transmission, and distribution infrastructure.

principles and assume that National Fuel will recover an authorized return on invested capital with a return of investment based on National Fuel's existing depreciation methodology.[28]

Development of any long-term plan begins with establishing a clear understanding of the desired outcomes. To meet its goal, the long-term plan must satisfy the overall collection of principles as well as each principle on its own. Figure III-1 presents the Guiding Principles that National Fuel used to develop and test the Long-Term Plan.

Figure III-1
National Fuel's Guiding Principles



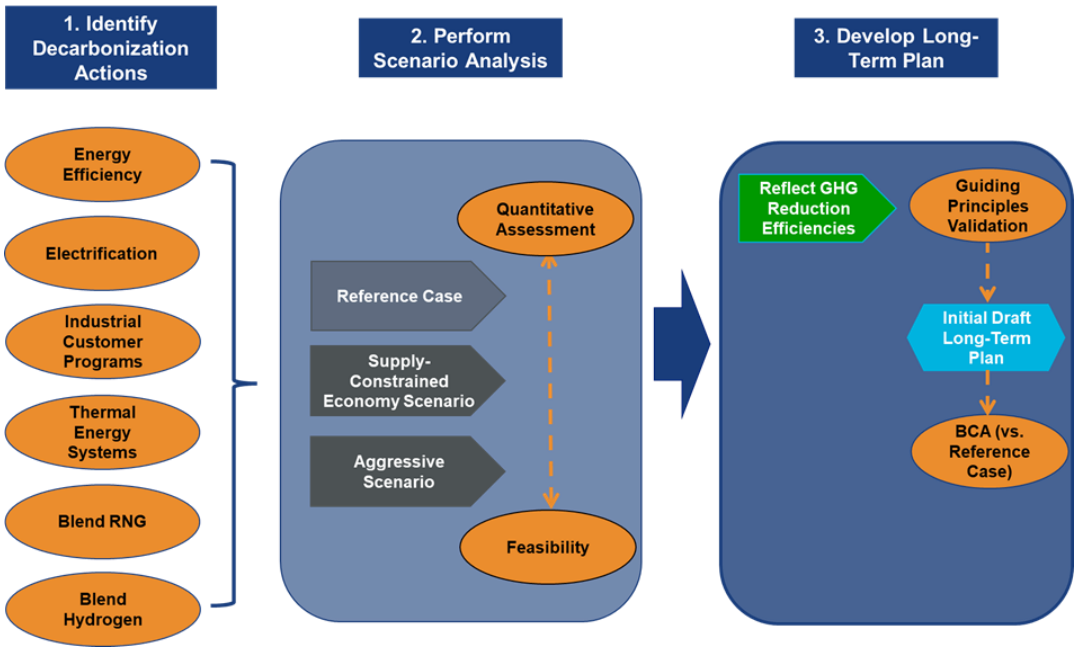
Some principles are "absolute" requirements; "safety" is perhaps the best example for regulated distribution utilities. Other principles may be expressed to acknowledge that there are inherent tradeoffs among desired outcomes. With respect to National Fuel's Long-Term Plan, the most important tradeoff is between the cost of achieving GHG emissions reductions, enhancing energy system resilience, and maintaining safe, reliable, and affordable energy service for all customers.

Development of the Long-Term Plan

The development of National Fuel's LTP reflects a three-step methodology, as presented in Figure III-2.

[28] Gas Planning Order, at 60.

Figure III-2
Development of National Fuel's Long-Term Plan



Step 1. Identify Decarbonization Actions

Decarbonization actions include enhancements to existing energy efficiency programs, electrification of building space heating and cooling loads and other household gas appliances, geothermal district heating, and a reconfiguration of National Fuel's supply portfolio to rely on less-carbon intensive fuel sources such as Renewable Natural Gas ("RNG") and hydrogen. There are also actions to decarbonize industrial loads.

As noted in Table III-1, most of the decarbonization actions are sufficiently advanced to enable modeling of estimated costs (capital and Operations & Maintenance ("O&M")) and GHG emissions reductions. The targeted network retirement is difficult to project but remains an option if it is economically superior and does not adversely impact safety or reliability.

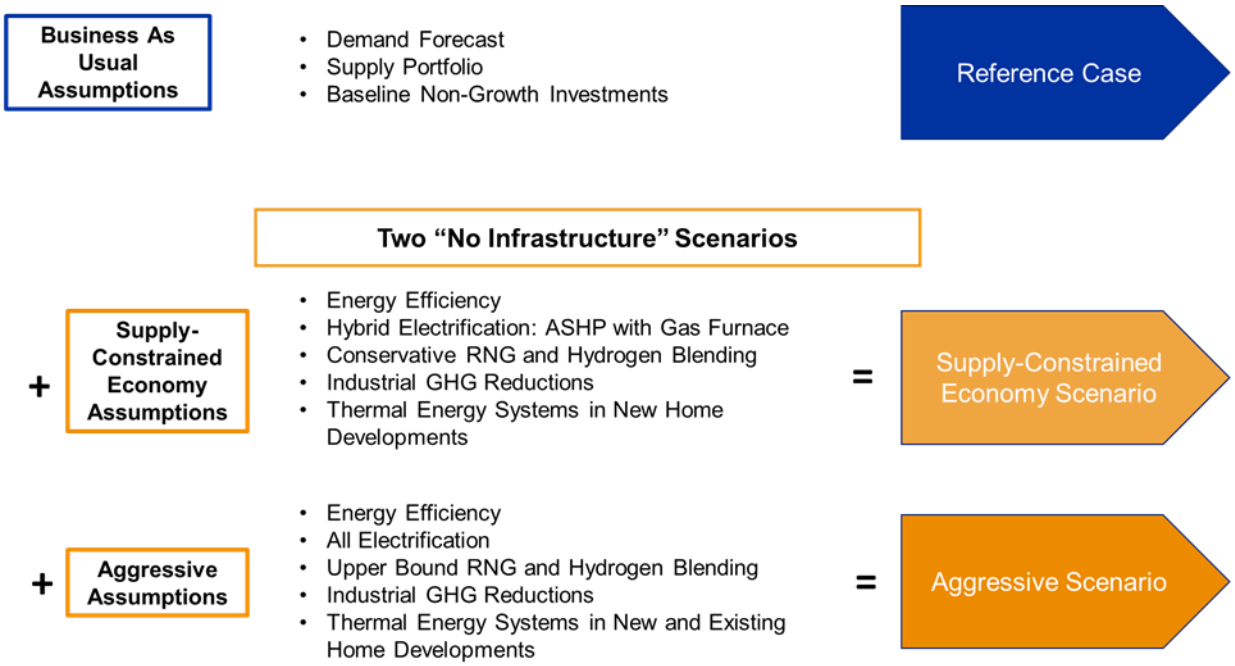
Table III-1
Decarbonization Actions

	Potential Actions	Description	Modeled?[29]
1	**Scale Gas Energy Efficiency**	Existing appliance rebate programs in the Reference Case; scaling up of new weatherization and behavioral programs in scenarios.	Yes: Supply Constrained Economy ("SCE") and Aggressive scenarios.
2	**Building Electrification**	Electrification of residential space heating/cooling load with hybrid heating systems (standard or cold climate air source heat pumps with natural gas furnace backup.) Electrification of other residential household gas appliances. Electrification of space heating/cooling load for small commercial, large multi-family, and university/college segments.	Yes. Several technology cases with distinctions between the SCE and Aggressive scenarios.
3	**Industrial Customer Decarbonization Actions**	Electrification of space heating and targeted energy efficiency measures. Potential direct use of hydrogen by industrials is not included in the LTP.	Yes: SCE and Aggressive scenarios.
4	**Renewable Natural Gas**	Interconnection (or injection) and integration of locally produced RNG supplies into system supply.	Yes: SCE and Aggressive scenarios.
5	**Hydrogen**	Production of hydrogen and interconnected to the distribution network for delivery of blended supply to customers.	Yes: Based on forecast on H2 production timing, cost, and target blending %.
6	**Thermal Energy Networks**	Development of an interconnected geothermal network to serve heating and cooling of a collection of homes and businesses.	Yes: SCE and Aggressive scenarios based on National Fuel's contemplated pilot programs.
7	**Targeted Network Abandonment**	Building electrification and thermal energy networks have the potential for customer conversions that enable National Fuel to economically retire network segments while maintaining safety and reliability, particularly if they are scheduled for replacement	No. Approach to Targeted Segment Abandonment addressed in Chapter V.

Step 2. Perform Scenario Analysis

Scenario analyses inform the LTP by assessing potential actions that National Fuel can take that will have an impact on GHG emissions, including carbon dioxide ("CO2"), methane ("CH4"), and nitrous oxide("N2O") emissions. National Fuel developed and evaluated three scenarios that inform its Recommended LTP. The three scenarios are a Reference Case and two alternative scenarios: a "Supply-Constrained Economy ("SCE") Scenario" and an "Aggressive Scenario." Each scenario is comprised of specified levels of each of the six decarbonization actions that are modeled. All three scenarios are designed to be feasible. The development of the Reference Case and two alternative scenarios is depicted in Figure III-3.

Figure III-3
Reference Case and Alternative Scenarios



- The **Reference Case** is a representation of the National Fuel market and business profile as described in Chapter II along with a forecast of supply and demand that reflects National Fuel's existing customer programs and outlook for key drivers that are external to National Fuel. These drivers include a demographic and economic outlook, natural gas and electricity prices, and assumptions regarding the availability of end-use technologies.

[29] The scenarios are described in greater detail below.

- The **SCE Scenario** reflects labor and resource constraints that are experienced under normal economic conditions that limit energy equipment manufacturing, building construction and utility infrastructure development.
- The **Aggressive Scenario** reflects an optimistic view with respect to customer interest in electrification options and the ability of the national, regional, and local economy to deliver labor, technologies, customer equipment and infrastructure to enable decarbonization of New York's economy.

The two alternative scenarios are not restricted by the cost impacts associated with individual decarbonization actions or an overall scenario. These cost impacts include the impact on National Fuel's gas customers from an increase in rates, customer investments to install equipment, or the costs that will be incurred to meet the incremental demand for electricity. Cost impacts and the relative efficiency of the decarbonization actions in achieving GHG emissions reductions are considered in developing National Fuel's LTP. This tradeoff will help National Fuel, Staff, the Commission and other stakeholders evaluate the consequences of adjusting the timing or level of commitment of individual decarbonization actions and the overall portfolio of such actions.

National Fuel includes planned and anticipated investments to improve customer service, interconnect and integrate RNG and hydrogen supplies, maintain service reliability, enhance network resilience, and execute its pipe replacement program in all scenarios. However, National Fuel's circumstances do not call for any new capacity related capital investments to meet demand growth or address moratoria concerns under the Reference Case or the two alternative scenarios. Thus, both the SCE Scenario and Aggressive Scenario qualify as "No Infrastructure" scenarios for purposes of compliance with the Gas Planning Order.[30]

Each scenario produces results from the quantitative metrics identified later in this Chapter as well as an assessment of considerations that are difficult to quantify, yet important inputs to development of the LTP. A BCA will be performed for the LTP by comparing incremental benefits and costs relative to the Reference Case and applying the Societal Cost Test ("SCT").[31]

The scenario assessment has two distinct elements:

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[30] The Gas Planning Order states in relevant part that, "We require that LDCs shall be expected to include a "no infrastructure" scenario in their long-term plans. However, we will allow an LDC to assert that a no infrastructure scenario is not feasible for a particular project, or portion of its long-term plan. We expect Staff, the selected consultant, and stakeholders to vigorously test such assertions and the entirety of the LDCs' long-term plans." [p. 35-36].

[31] As confirmed in the May 12, 2022 Gas Planning Order, the BCA should comply with the Commission's BCA Framework Order, Case 14-M-0101, Reforming the Energy Vision, Order Establishing the Benefit Cost Analysis Framework (issued January 21, 2016).

a. Quantitative Assessment: the primary focus of the quantitative assessment is assessing the trade-off between reductions in GHG emissions and cost impacts. The quantitative outcomes produced by the model include:

- Annual changes in total throughput;
- Annual reductions in GHG emissions;
- Annual natural gas bill impacts for residential customers that do not participate in electrification options; and
- Annual and net present value ("NPV") of Decarbonization Policy Costs[32].

The costs that are analogous to gas supply costs (e.g., RNG and hydrogen) should be recovered through National Fuel's rates. Decarbonization Policy Costs track costs that are attributable to the LTP that may not be recovered through National Fuel customer bills. These costs are a direct result of National Fuel's decarbonization actions but will be recovered as determined by policy makers. National Fuel's plan estimates these costs but does not presume how they may be recovered. They include the incremental costs incurred by participating residential, commercial and industrial customers to install new equipment, minus the replacement cost of any retired (or new) gas and air conditioning equipment, minus gas cost savings enabled by the investments, plus change in participants' electricity bills attributable to the use of electrified end-uses. The electricity prices used to determine participant net operating costs reflect costs that will be incurred by electric utilities to serve incremental loads from hybrid or whole-building electrification. It is also likely that investments will be required to maintain energy system resilience as the economy decarbonizes. The impact of electricity price increases on other base load end-uses, e.g., refrigeration and lighting, is not included as a component of Decarbonization Policy Costs.

b. Feasibility: The economy-wide transformation from fossil fuels to electricity will face resource and development challenges related to the ability to build new electric infrastructure, design and produce commercially viable enabling energy technologies, and convert heating and cooling systems in existing buildings. The electric infrastructure investments include customer-sided investments as well as electric transmission and distribution investments, smart grid investments, and investments in resilience. Each of these challenges will create a strain on the ability to attract and develop a trained workforce to work in manufacturing, building trades, and utility operations and maintenance. Transformation of the industrial sector must consider the additional pressure of operating in a competitive business environment. Most large industrial customers face intense competition for capital from other

[32] Decarbonization Policy Costs are defined below and in Section V.

plants in the same corporation and competition for customers from competitors located in other states and around the globe.

Step 3. Development of the Long-Term Plan

The Scenario Assessment provides the insights necessary to develop a Long-Term Plan that achieves a reasonable balance between GHG emissions reductions and the cost of achieving them. National Fuel's two no-infrastructure scenarios were designed with this principal criterion in mind by defining the Aggressive Scenario to be an upper bound of implementation feasibility. The SCE Scenario also reflects the need to take actions in the near-term that make meaningful progress toward New York's climate goals but takes a more practical view with respect to the ability to address implementation challenges.

The Company's LTP was developed using a bottom-up approach where per unit costs (e.g., incremental equipment cost and incremental energy bills per participating customer or incremental cost per unit of RNG or hydrogen) and benefits (e.g., decreased emissions per participating customer, decreased emissions per unit of RNG or hydrogen) were estimated for each decarbonization action. It was then determined how much of each decarbonization action was included in the LTP based on its feasibility, relative cost, and the specific characteristics of National Fuel's system, service territory, customer base, and market.

Having refined the Long-Term Plan, National Fuel returned to the Guiding Principles (Figure III-1) to confirm that each and every principle was being met. Finally, National Fuel performed a BCA of the Long-Term Plan relative to the Reference Case.

IV. Scenarios

IV. Scenarios

As described in Chapter III, National Fuel developed and evaluated three scenarios that inform its LTP. The three scenarios are a Reference Case and two alternative scenarios: a SCE Scenario and an Aggressive Scenario. Each scenario is comprised of specified levels of each of the six decarbonization actions that are modeled. All three scenarios are designed to be feasible, without consideration of costs that will be incurred to achieve them.

Reference Case Scenario

The Reference Case is a representation of the National Fuel market and business profile as described in Chapter II along with a forecast of supply and demand that reflects existing customer programs and a forecast of key factors that are external to National Fuel. These factors include a demographic and economic outlook, natural gas prices, and assumptions regarding the availability of end-use technologies. Most importantly for the purposes of evaluating potential incremental decarbonization actions, the Reference Case does not include the impact of CLCPA actions that have not yet been planned or implemented and it assumes that none of the identified National Fuel decarbonization actions have been implemented.[33]

Reference Case Demand Forecast

National Fuel's Reference Case begins with a long-term demand forecast for the residential, commercial, public authority, and industrial customer class throughput (i.e., sales and transportation) based on its business-as-usual forecast methodology.[34] Forecasts of residential, commercial, and public authority accounts and use per account were developed using regression models which are a function of one or more economic variables. The residential demand forecast was adjusted to account for the projected effects of National Fuel's existing energy efficiency programs that focus on rebates to customers for installing highly efficient appliances. Residential demand comprises approximately half of total demand.

Large industrial demand was forecast on a customer-by-customer basis based on information provided by account representatives. The small industrial demand forecast was held constant.[35]

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[33] The Reference Case forecast addresses total distribution system demand, supply and GHG emissions (i.e., that associated with retail sales customers plus transportation customers) since National Fuel's distribution system is built and used to deliver gas to both retail sales and transportation customers, regardless of what entity is responsible for procuring the natural gas.

[34] See Appendix D for detailed Reference Case demand forecast assumptions and results.

[35] Forecasts only include firm demand (i.e., National Fuel's one interruptible customer is excluded from the demand forecast).

As shown in Table IV-1, National Fuel's reference case demand is expected to grow at a rate of 0.6% per year over the 20-year LTP period, led by growth in the commercial sector, both in absolute percentage terms.

Table IV-1
Reference Case Annual Demand Forecast by Sector (MCF)

	FY 2023	FY 2027	FY 2032	FY 2037	FY 2042	FY2023-FY2042 CAGR
Residential	53,852,740	54,684,434	55,747,874	56,246,639	57,044,398	0.3%
Commercial	19,867,974	21,197,705	23,104,851	24,924,198	27,026,348	1.6%
Industrial	18,710,749	18,908,011	19,186,445	19,334,531	19,551,385	0.2%
Public Authority	7,761,309	8,076,379	8,525,801	8,907,532	9,354,655	1.0%
Company Use	110,793	110,793	110,793	110,793	110,793	0.0%
Shrinkage	1,755,414	1,802,208	1,866,934	1,916,776	1,979,148	0.6%
Total	**102,058,979**	**104,779,530**	**108,542,698**	**111,440,469**	**115,066,727**	0.6%

National Fuel's total Reference Case demand growth is attributable to increases in the number of customer accounts as well as growth in use per account. As shown in Table IV-2 and Table IV-3, National Fuel's customer accounts and use per account are each expected to grow at a rate of 0.3% over the LTP period.

Table IV-2
Reference Case Account Forecast by Sector (# Accounts)

	FY 2023	FY 2027	FY 2032	FY 2037	FY 2042	FY2023-FY2042 CAGR)
Residential	506,539	514,695	522,402	530,224	538,164	0.3%
Commercial	33,268	33,633	34,094	34,561	35,035	0.3%
Industrial	447	440	431	421	412	-0.4%
Public Authority	2,436	2,507	2,597	2,690	2,787	0.7%
Total	**542,690**	**551,276**	**559,524**	**567,897**	**576,397**	**0.3%**

Table IV-3
Reference Case Use per Account Forecast by Sector (MCF/Account)

MCF/Account	FY 2023	FY 2027	FY 2032	FY 2037	FY 2042	FY2023-FY2042 CAGR)
Residential	106	106	107	106	106	0.0%
Commercial	597	630	678	721	771	1.4%
Industrial	41,851	42,965	44,555	45,885	47,419	0.7%
Public Authority	3,186	3,221	3,283	3,311	3,357	0.3%
Total	**188**	**190**	**194**	**196**	**200**	**0.3%**

Design day demand reflects the impact of cold weather and serves as the basis for planning infrastructure and procuring supplies to reliably serve customers on the coldest days of the year, assuming 74 HDD which is equivalent to an average temperature of -9 degrees F.[36] Design Day demand is forecasted to grow at an average rate of 0.4% per year, from 1,026,958 Dth/day in FY 2023 to 1,106,564 Dth/day in FY 2042.

Reference Case Supply Forecast and Supply/Demand Balance

National Fuel's gas supply portfolio consists of flowing supplies (contracted upstream pipeline supplies), storage withdrawals, and winter peaking city gate delivered services. Each of these supplies are contracted on a firm basis and must be contracted in advance of the winter to ensure they are available to the Company during cold winter days. Firm pipeline and storage are typically contracted over a longer term, with contract terms that typically range from five to twenty years or longer. In contrast, contracts for winter peaking citygate delivered services can be as short as one winter season. National Fuel pays fixed demand (or reservation) charges to reserve specific amounts of pipeline, storage, and citygate delivery capacity. In addition, National Fuel pays variable commodity charges based on the amount of these services it uses on a daily basis to serve its customers. The Company does not currently include any LNG, CNG, local production, or RNG in its gas supply portfolio and does not anticipate adding these supplies to its portfolio over the next 20-years in the Reference Case.[37] All gas supply-related costs are passed through to customers on a dollar-for-dollar basis (i.e., National Fuel does not make a profit on the cost of gas supplies).

Transportation customers do not purchase gas supply from the Company and National Fuel is not obligated to plan to provide these customers with supply service. purchase natural gas for the delivery to transportation customers via the Company's distribution system. National Fuel receives ESCO gas at its citygate and delivers it to its transportation customers. Some large industrial transportation customers procure their own gas supplies and provide them to National Fuel for ultimate delivery to the industrial plant.

Design day levels of flowing supplies, storage withdrawals and supplies delivered by marketers for transportation customers are forecast to remain constant during the 20-year Reference Case forecast, while delivered citygate supplies are projected to increase over this period from 93,432 Dth/day in 2022/23 to 158,432 Dth/day in 2041/42, as illustrated in Figure IV-1.

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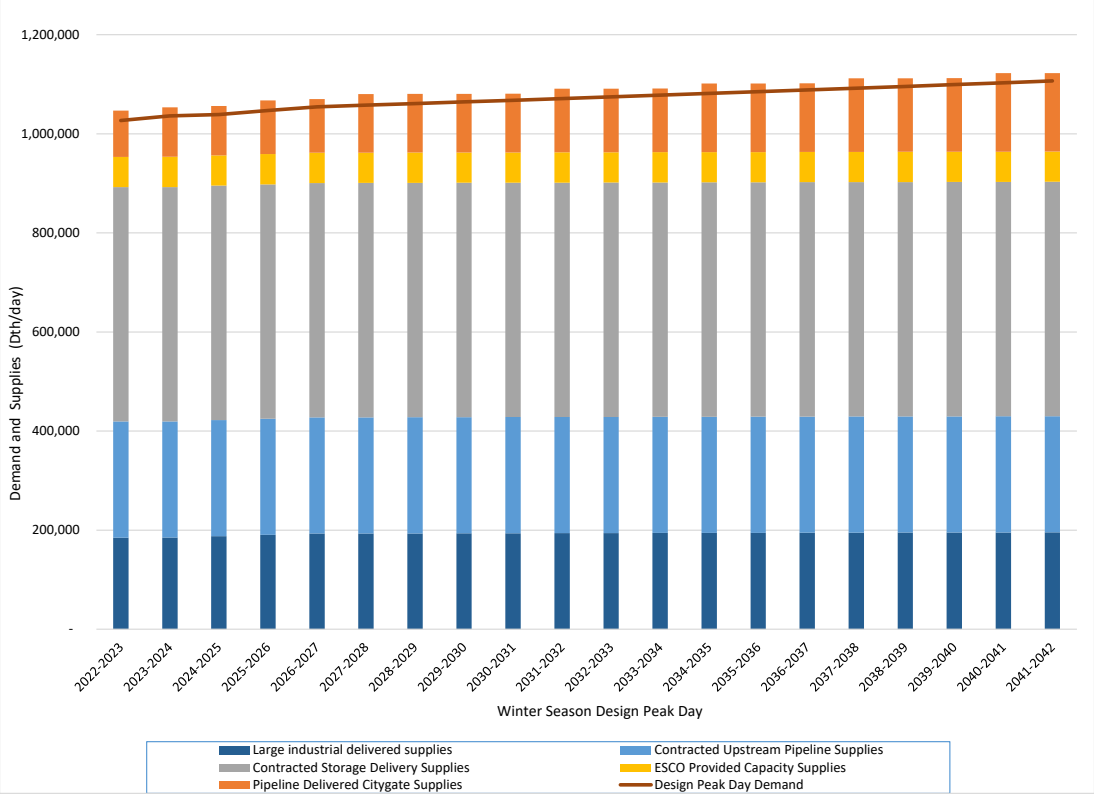
[36] See page 54 of the November 16 Stakeholder Presentation for information on the design day demand forecast of 74 HDDs.

[37] There are small quantities of local natural gas production (approximately 11,000-12,000 Mcf/day in recent years) as well as some small RNG production (approximately 2,500 Mcf/day) that is purchased by marketers and delivered directly to National Fuel's distribution system on behalf of transportation customers.

Figure IV-1
Reference Case Design Day Demand and Capacity by Source (Dth/day)



National Fuel projects sufficient supplies to serve design day demand in the Reference Case without needing to build additional upstream infrastructure, as also shown in Figure IV-1. In the last year of the forecast period (2042), delivered city gate supplies represent approximately 14% of total design day capacity. Given the shorter contract periods, the Company has the flexibility to adjust its contracts for delivered city gate supplies if design day demand forecasts change in the future.

Vulnerable Locations and Risk Factors

A vulnerable location is a portion of the system where gas may not be able to be delivered safely or reliably within the next five years. National Fuel reported in its July 2020 Filing, that it did not have any vulnerable locations. This remains the case today as National Fuel, pursuant to the Gas Planning Order, has updated its assessment of "vulnerable locations." Furthermore, the Company does not anticipate the need to propose a moratorium on new connections during the LTP period.

National Fuel has identified three risk factors that do not impact the LTP but may impact future LTPs related to the supplies and capacity used by ESCOs to serve transportation customers. National Fuel will continue to monitor these situations and will develop a plan to address them should the need arise.

A. **Decline or Elimination of Local Production**: As noted above, ESCOs purchase small amounts of local production for delivery to transportation customers on the Company's system. Local production has been declining over the last decade, and declines are expected to continue. While the overall amount of local production that is delivered to the Company's system is minimal, and the reduction in local production is gradual, reductions in supply injections near where the production wells are located could lead to lower operating pressure areas on the distribution system on a design day that would need to be addressed.

B. **Transportation Customers Seeking Sales Service Requiring Firm Capacity**: ESCOs must hold pipeline capacity rights to serve non-core transportation customer loads. If these transportation customers convert to sales service provided by National Fuel, ESCOs are not required to transfer their associated firm capacity entitlements to National Fuel. As a consequence, the Company could be required to procure additional capacity to serve these customers. At this point in time, National Fuel believes that the amount of capacity that could be necessary under these circumstances is unlikely to exceed what would likely be available in the market, but circumstances could change in the future.

C. **Decline or Elimination of ESCO Capacity:** The Company is required to provide ESCOs with an allocation of its firm capacity rights to serve core customers electing to receive transportation service from an ESCO rather than sales service from the Company. [38] An exception to this "mandatory capacity assignment" program allows authorized ESCOs to secure their own capacity to serve core customers. The Company relies on ESCOs to utilize their demonstrated capacity to make deliveries on behalf of these customers.

   The Company considers the loss of the ESCO capacity secured for these purposes as a notable potential system-wide vulnerability. Low natural gas commodity prices and significant changes to the Commission-approved capacity assignment program may prove challenging to some marketers. This appears to have resulted in and may continue to result in their exit from the program. ESCOs that provide their own capacity to serve customers connected to the system are not obligated to transfer their associated capacity rights to the Company. For example, an ESCO with demonstrated capacity may transfer its core customers (customers that require firm capacity) to another ESCO or return them to the Company. The transferring ESCO is not obligated to transfer the demonstrated

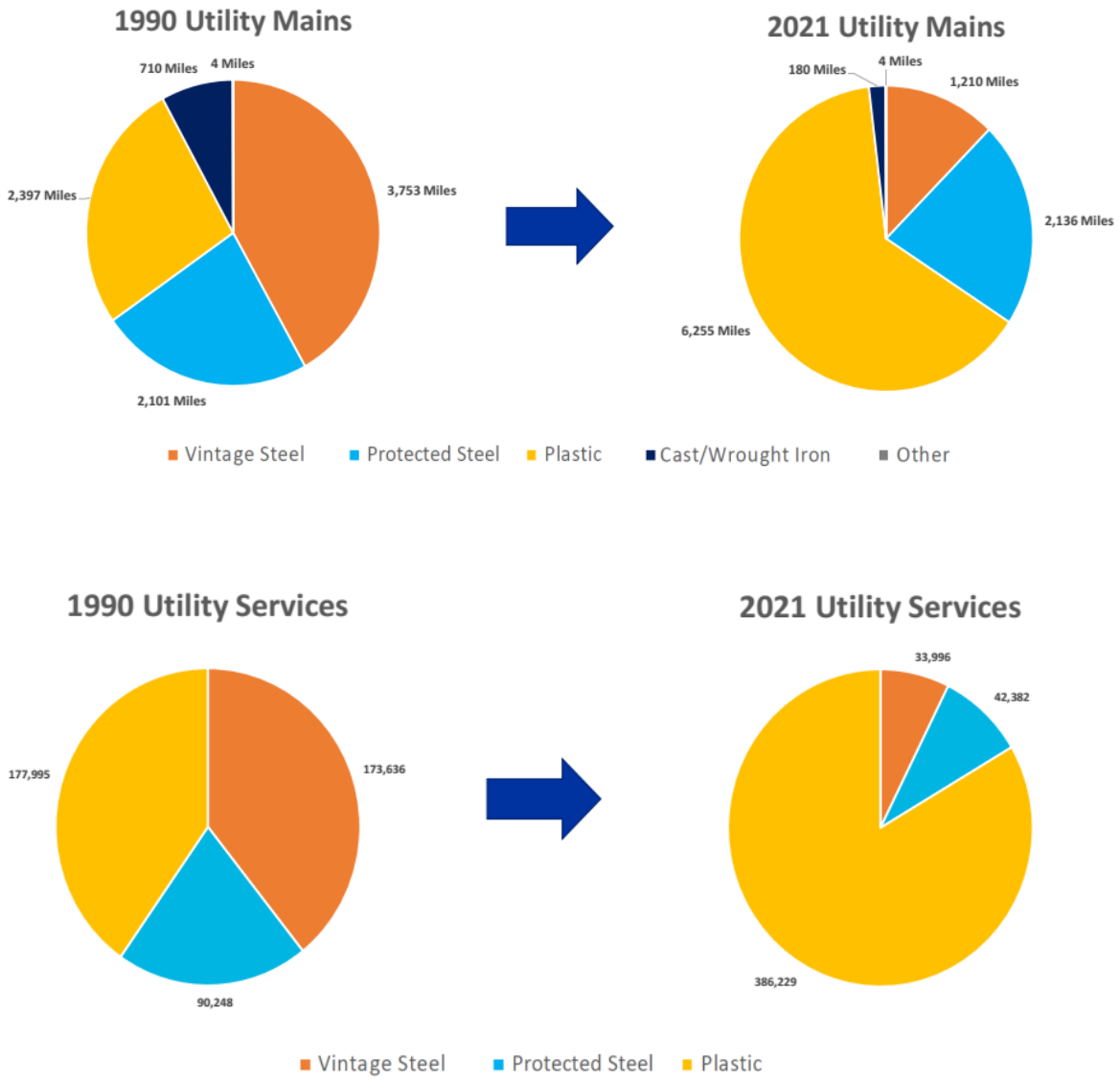
[38] The Company's "core customers" include all sales customers and critical transportation customers. "Critical transportation customers" include those transportation customers that use 5,000 Mcf or less per year and those that use more than 5,000 Mcf per year to serve human needs, such as hospitals.

capacity to the receiving ESCO or the Company as part of that transaction. Thus, the ESCO may elect to terminate its capacity contracts with the upstream pipeline or storage service provider or release the capacity to another party. In either instance, the Company must acquire new capacity to either serve the customers, or to release capacity to the new ESCO supplier. The Company believes ample capacity is available if the remaining ESCOs with grandfathered capacity entitlement rights elect to exit the New York retail choice program and the Company must fulfill its obligation to serve those core customers and/or provide capacity to the replacement ESCOs over the next 5 years.

Capital Investment Plan

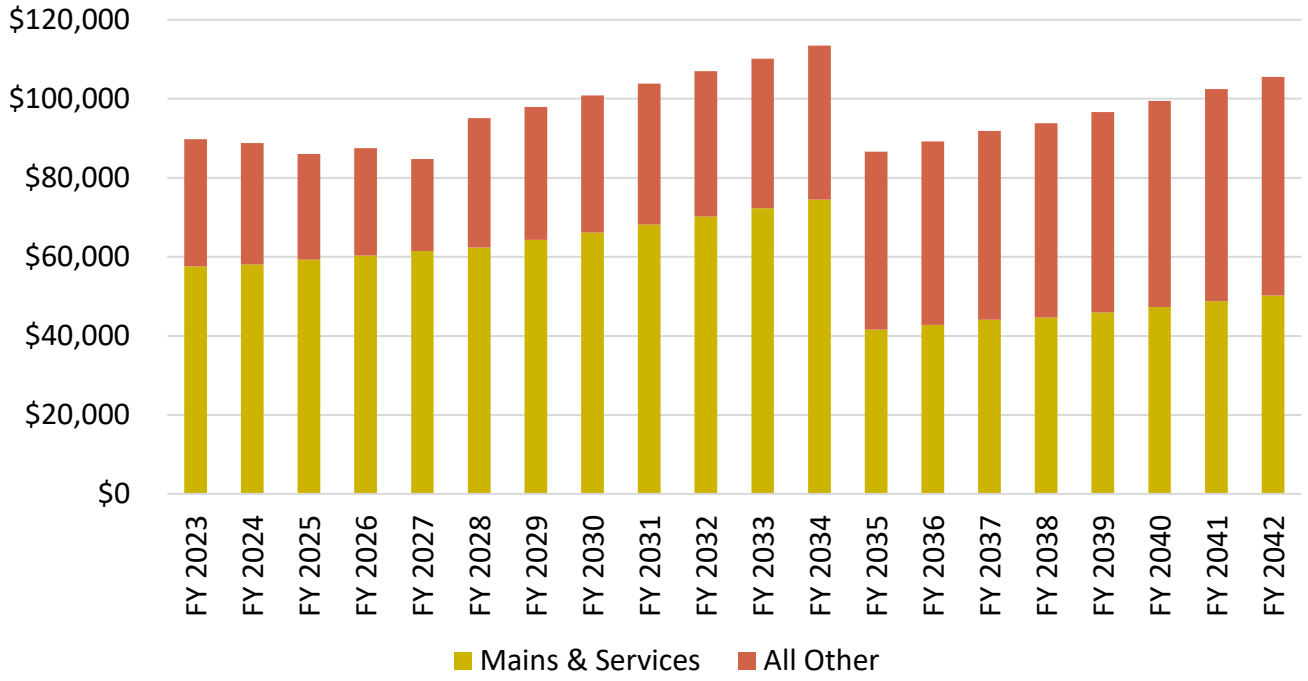
In recent years, National Fuel's capital expenditures have been dominated by its Leak Prone Pipe ("LPP") replacement program. National Fuel has been investing in replacing leak-prone pipes (mains and services) for several decades, resulting in a significant reduction in cast/wrought iron and vintage steel pipes, as illustrated in Figure IV-2. These investments have significantly reduced leaks and enhanced system safety. The Company, pursuant to Commission guidance, is required to replace all leak-prone pipes by 2035. This will require continuing the current pace of replacing approximately 110 miles of pipe per year. The modernization effort will continue after 2035 with the replacement of vintage plastic materials, although these replacements are projected at a slower pace.

Figure IV-2
Composition of Mains and Services 1990 and 2021



As presented in Figure IV-3, capital expenditures are projected to continue to be driven by the Company's leak-prone pipe replacement program, increasing from a total of approximately $90 million in FY 2023 to approximately $113 million in FY 2034, driven by anticipated inflation. Annual capital expenditures are projected to decrease in FY 2035 after National Fuel's remaining bare steel and wrought iron mains and services have been replaced.

Figure IV-3
Reference Case Capital Forecast ($000)



Reference Case GHG Emissions

GHG emissions are estimated for the entire supply and delivery chain from gas production through gas consumption for all National Fuel customers to provide a comprehensive understanding of the emissions associated with National Fuel's Reference Case supply and demand. National Fuel reports direct (Scope 1) and indirect (Scope 2 and Scope 3) GHG emissions.

- **Scope 1** emissions include emissions that are created by sources that are owned and controlled by National Fuel. This includes emissions associated with the Company's mains, services, customer meters as well as those from National Fuel's vehicle fleets and buildings.
- Indirect, **Scope 2** emissions include emissions associated with electricity purchased to operate National Fuel's business.

- Indirect, **Scope 3** emissions include those related to producing and transporting gas to National Fuel's distribution system, as well as emissions associated with the combustion of natural gas by National Fuel's end-use customers.[39]

Reference Case GHG emissions were projected by applying appropriate emission factors to National Fuel's Reference Case forecasted system characteristics, number of accounts, supply, and demand.[40] Annual emissions were calculated for CO2, CH4, and N2O. Total CO2 equivalent ("CO2e") emissions were calculated by converting CH4 and N2O emissions to CO2e assuming a 20-year global warming potential ("GWP").[41]

As presented in Table IV-4, over 90% of National Fuel's Reference Case CO2e emissions are associated with Scope 3. Over time, Scope 1 emissions are projected to decline as National Fuel continues to replace its leak-prone mains and services. Similarly, Scope 2 emissions are projected to decline overtime accounting for changes in electric generation mix. Reference Case Scope 3 emissions are projected to increase as demand increases.

Table IV-4
Reference Case FY 2023 and 2042 CO2e Emissions

	CO2e (MT) FY 2023	CO2e (MT) FY 2042
Scope 1	605,155	331,828
Scope 2	847	464
Scope 3		
End User	5,509,176	6,211,338
Gas Supply and Upstream Transport	2,277,550	2,568,293
Scope 3 Total	7,786,726	8,779,631
Total Emissions	**8,392,728**	**9,111,922**

[39] There is some discussion about whether gas utilities must account for Scope 3 emissions associated with gas purchased for and used by transportation customers. National Fuel has included all Scope 3 emissions for transportation customers, which results in significantly increasing the GHG emissions included in this report.

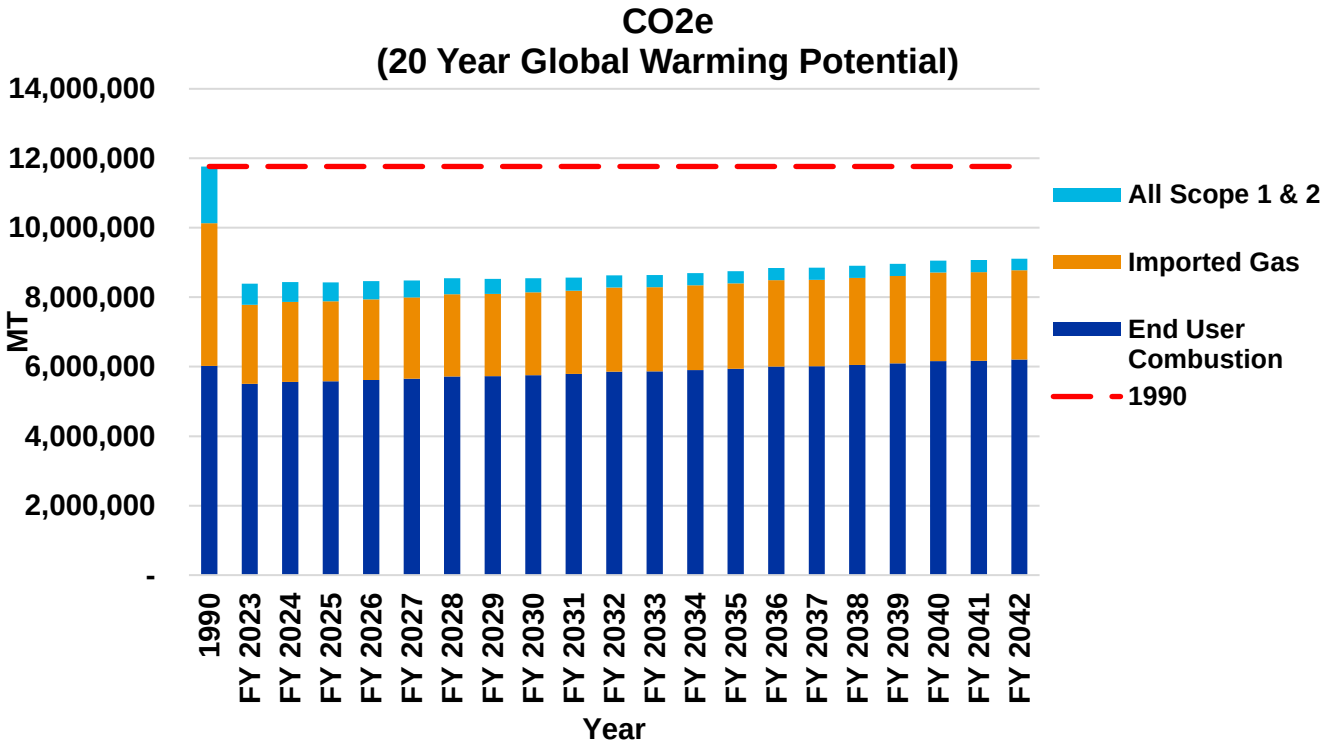
[40] The same emissions factors are applied to the changes in system characteristics, number of accounts, supply, and demand to calculate GHG emissions reductions resulting from various decarbonization actions.

[41] The GWP allows comparisons of the global warming impacts of different gases that have different effects on the Earth's warming (e.g., CO2, CH4, and N2O). Two factors include the ability to absorb energy ("radiative efficiency"), and how long they stay in the atmosphere ("lifetime"). Specifically, GWP is a measure of how much energy the emissions of 1 ton of a gas will absorb relative to the emissions of 1 ton of CO2 over a specific period of time. Many sources report CO2e using a 100-year GWP, so care should be used when comparing the GHG emissions numbers in this report with other sources. National Fuel reported CO2e emissions using the 20-year GWP as defined in the CLCPA. (ECL § 75-0101(2)) The 20-year GWP AR5 values are 1 for CO2, 84 for CH4 and 265 for N20. As an illustrative example, a measure with GHG emissions of 1 Metric Ton ("MT") of CO2, 1 MT of CH4, and 1 MT of N20, would result in an C02e value of 350 MT, which is equal to 1 x 1 MT CO2 + 84 x 1 MT CH4 + 265 x 1 MT N20.

As shown in Figure IV-4, National Fuel's CO2e emissions are primarily comprised of emissions created from end user combustion of natural gas, followed by emissions associated with production and transportation of gas. End user combustion accounts for 66% of CO2e emissions in FY 2023 and 68% in FY 2042.

Figure IV-4 presents the Reference Case forecast of GHG emissions reductions as well as the 1990 level of CO2e emissions which serves as the baseline for emission reductions reporting.

Figure IV-4
Reference Case Annual CO2e Emissions by Major Emissions Category



The approximate 30% decline from 1990 to FY 2023 primarily relates to reductions in methane emissions driven by the Company's pipeline replacement and system modernization programs and a substantial shift to procuring gas supplies from the Marcellus and Utica shales.

Alternative Scenarios

The two alternative scenarios are comprised of varying levels of the decarbonization actions identified in Chapter III (Table III-1). Each of these decarbonization actions is described in more detail below, followed by a table that defines how they are applied to develop the SCE Scenario and Aggressive Scenario.

1. **Scale Gas Energy Efficiency:** National Fuel is exploring introducing two new energy efficiency programs targeted to the residential class to supplement its existing energy efficiency programs. The new programs would include a weatherization program and a behavioral program that will consist of providing home energy reports to customers. The weatherization program is based on the results of a recent energy efficiency potential study[42] and the home energy report program is based on similar programs implemented at other utilities. The analytical model allows the Company to assess alternative customer adoption levels, resulting reductions in gas use, and associated program budgets.

2. **Building Electrification:** The analytical model incorporates a robust approach to electrification of space heating loads for residential, small commercial, public authority (universities) and large residential (housing authority) customers, in addition to electrification of other gas appliances (water heating, dryer and cooking ranges). The approach evaluates several electrification options and assumes replacement occurs at the end of life of equipment given average equipment lives. For residential (single and multi-family) heating, National Fuel analyzed the different costs and impacts associated with electrifying (1) older homes (80+ years old) compared to newer homes, (2) furnaces as compared to boilers, and (3) full electrification compared to hybrid heating. Similarly, National Fuel considered the different costs and impacts associated with electrifying furnaces compared to boilers for small commercial customers. The model allows the Company to examine several electrification options and select the most promising options for inclusion in the two alternative scenarios.

3. **Industrial Customer Clean Actions:** As noted above, there are competitive challenges related to achieving GHG emissions reductions for National Fuel's large industrial customers.[43] The analytical model considers the potential for electrification of space heating loads and performing energy efficiency on process loads but defers consideration of direct use of hydrogen and RNG by industrial customers until a future LTP.

4. **RNG:** RNG is biogas that has been converted into pipeline-quality gas and is considered a "drop in" replacement for natural gas. Using RNG as a substitute for natural gas captures the GHGs from the biogas feed source that would otherwise have been emitted to the atmosphere. Supply, timing, and cost assumptions for development of RNG are based on recent New York State studies.[44]

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[42] "Residential Weatherization Potential Study Report". Cadmus prepared for National Fuel November 2, 2022. Also provided in Appendix I.

[43] "National Fuel Gas Corporate Informational Filing" submitted on June 15, 2022 in Case Nos. 20-G-0131 and 22-M-0149 includes a detailed discussion of the opportunities and challenges facing National Fuel's industrial customers as they explore actions that they can take to reduce emissions.

[44] "Potential of Renewable Natural Gas in New York State", ICF April 2022. NYSERDA Report Number 21-34, p 44. "RNG Potential in NY & NFGDC Territory", National Fuel Gas Company, April 2020.

5. **Hydrogen:** Blending hydrogen into natural gas for redelivery to customers reduces GHG emissions. The potential blending of hydrogen for delivery through existing distribution networks and fueling end-use equipment is the focus of numerous pilot programs. A key assumption for modeling purposes is the proportion of natural gas that can be safely replaced by hydrogen.[45]

6. **Thermal Energy Network ("TEN"):** National Fuel and other New York investor-owned utilities are proposing TEN pilot programs within their respective service areas. National Fuel is proposing to develop a geothermal pilot project that will serve 11 residential buildings and a 100,000 square foot workforce training facility located within a disadvantaged community (as defined by the CLCPA) in Buffalo, New York. The economics and feasibility of networked geothermal projects are extremely site-specific. National Fuel has modeled the development of generic project design in order to include network geothermal in the quantitative analyses. The Company is committed to implementing the geothermal pilot or pilots that are approved in Case No. 22-M-0429. These pilots, and others that are being planned and implemented in New York, other states, and other countries, will inform the network geothermal assumptions in the Company's next 2025 LTP filing.

7. **Targeted Network Retirement:** Targeted network retirement, as a concept, refers to an economic decision that will be considered if and when either (a) a geothermal district heating project is developed, or (2) a defined segment of National Fuel's distribution system is targeted for conversion from natural gas service to all-electric service. Under either scenario, it will be determined whether it is prudent to suspend segments of the natural gas distribution network from an energy resilience perspective and if so, whether customers along the segment are receptive to conversion and whether it is the preferred economic solution based on a BCA or other analysis. This decision will be based on project-specific circumstances. Nonetheless, National Fuel has included targeted network retirement as an option that may be analyzed under favorable circumstances and as part of a non-pipes alternative process (see discussion in Chapter V).

Table IV-5 presents the assumed decarbonizations action assumptions for each of the three scenarios.

[45] The total amount of hydrogen that can be safely blended into a specific gas distribution system will require significant system-specific analysis to determine the make-up and condition of the existing pipelines and other equipment that may be affected by the introduction of hydrogen.

Table IV-5
Decarbonization Actions by Scenario

	Decarbonization Action	Reference Case	Supply-Constrained Economy Scenario	Aggressive Scenario
1	**Scale Gas Energy Efficiency**	Continue existing appliance rebate program	• Continue Reference Case EE • Residential Weatherization Standard Income and LMI: 2024 start, 75% of The Cadmus Group, Inc.(“Cadmus”) max achievable savings; All measures • Residential home energy reports: 2024 start, 50% customer participation	• Continue Reference Case EE • Residential Weatherization Standard Income and LMI: 2024 start, 100% of Cadmus max achievable savings; All measures • Residential home energy reports: 2024 start, 100% customer participation
2	**Building Electrification Residential**	None	• 2025 start; % conversions at appliance end-of-life ramping up over time to max of 50%; 24% of furnaces converted to hybrid heating systems by 2042, electrify hot water, dryer, range; exclude old homes	• 2025 start; % conversions at appliance end-of-life ramping up over time* to max of 100%; 48% of furnaces and 42% of boilers converted to full electrification by 2042; electrify hot water, dryer, range; include old homes
3	**Building Electrification** **Small Commercial**	None	• 2025 start; % furnace conversions at appliance end-of-life ramping up over time* to max of 50%; 23% of furnaces converted to full electric ASHP by 2042	• 2025 start; % furnace and boiler conversions at appliance end-of-life ramping up over time* to max of 100%; 45% of furnaces and 40% of boilers converted to full electrification ASHP by 2042.
4	**Building Electrification** **University and Public Housing**	None	• 2025 start; % furnace/heater[46] conversions at appliance end-of-life ramping up over time* to max of 50%; 24% of furnace /heater heating load converted to full electrification ASAP by 2042.	•2025 start; % of furnace/heater and boiler conversions at appliance end-of-life ramping up over time* to max of 100%; 47% of furnaces/heaters and 42% of boilers heating Load converted to full electrification ASHP by 2042.

[46] Includes unit heaters, infra-red heaters, make-up air heaters and rooftop heaters.

	Decarbonization Action	Reference Case	Supply-Constrained Economy Scenario	Aggressive Scenario
5	**Renewable Natural Gas**	None	• ICF's Achievable Deployment Scenario, excluding thermal gasification	• ICF's Optimistic Growth Scenario, excluding thermal gasification
6	**Hydrogen**	None	• 2030 start, increase 0.5%/year, max at 5%	• 2028 start, increase 0.5%/year, increasing to 1%/yr in 2038, max at 10%
7	**Industrial Customer Clean Actions**	None	• Energy Efficiency of Process Load: 2024 start; 0.5%/year process load reduction; 5% process load reduction by 2042 • Electrify space heating: 2025 start; % furnace/heater conversions at appliance end-of-life ramping up over time* to max of 50%; 24% of furnace/heater heating load converted to full electrification ASAP by 2042.	• Energy Efficiency of Process Load: 2024 start; 0.5%/year process load reduction; 10% process load reduction by 2042 (consistent with Guidehouse limit) • Electrify space heating: 2025 start; % of furnace/heater and boiler space heating (non-processing) conversions at appliance end-of-life ramping up over time* to max of 100%; 47% of furnaces/heaters and 42% of boilers heating load converted to full electrification ASHP by 2042.
8	**Thermal Energy Networks**	Pilot Program. Eleven home Neighborhood and Northland Campus Community Center in Buffalo, NY.	• One new 50-home network geothermal development project a year starting in 2027.	• One new 50-home network geothermal development project a year starting in 2027. • One existing 50-home neighborhood network geothermal project a year starting in 2027.
9	**Targeted Network Retirement**	None	Same as Reference Case (discuss opportunities and challenges in report; not modeled)	
10	**Leak Prone Pipe Replacement**	Continue existing program	Same as Reference Case.	

* Use Cadmus max achievable shape as "ramp up over time"

The results of the scenario analyses and how they are used to define National Fuel's LTP is discussed in Chapter V.

V. Long-Term Plan

V. Long-Term Plan

Approach to Long-Term Plan Development

The scenario analysis described above provides the insights necessary to develop a Long-Term Plan that achieves a reasonable balance between GHG emissions reductions and the cost of achieving them, while preserving reliability of the energy system. National Fuel's objective is to develop a Long-Term Plan that satisfies the overall collection of Guiding Principles as well as each Guiding Principle on its own, recognizing that there are tradeoffs among desired outcomes. The most important tradeoff is between achieving GHG emissions reductions and maintaining safe, reliable, resilient and affordable energy for all customers and competitive energy prices for industrial customers. The LTP model provides three key outputs that enable consideration of these tradeoffs:

(a) **Reduction in GHG Emissions** - Annual GHG emissions reductions, including CO2, CH4, and N2O are calculated for each decarbonization action and summarized into a measure of CO2e using a 20-year GWP. These GHG emissions reductions are primarily a result of reduced natural gas use (offset by emissions associated with increased electric use) from blending RNG and hydrogen into gas supplies.

(b) **National Fuel Gas Bill Impacts** - Incremental costs that are likely to be recovered through the gas rates paid by National Fuel's customers will increase National Fuel's revenue requirement and/or cost of gas. These costs are primarily comprised of incremental supply costs from the blending of RNG and hydrogen. Gas rate impacts also include effects on billing determinants (positive or negative) from changes in throughput attributable to decarbonization actions (e.g., energy efficiency or electrification). The impacts to National Fuel's residential gas rates are estimated by a rate calculation model that reflects the impact of each scenario on both revenue requirements (numerator) and throughput (denominator). It is assumed that the existing ratemaking principles continue through the forecast period (i.e., National Fuel has not postulated any changes to cost allocation principles or rate design). Bill impacts are calculated for a typical residential heating customer that has not participated in electrification (a "non-participant"), which is assumed to use 106 Mcf/year.

(c) **Decarbonization Policy Costs** – Decarbonization Policy Costs are costs that are incurred as a result of decarbonization but subject to recovery that will be determined by regulators or legislators. They are comprised of three components: (1) customer incremental equipment installation costs minus replacement cost of retired (or new) equipment, (2) participating customer gas cost savings (i.e., negative costs) that result from reduced reliance on natural gas for heating and other end-uses, and (3) incremental net change in participants' electric bills attributable to National Fuel's decarbonization actions. Furthermore, the contribution of electric costs to the estimate of Decarbonization Policy Costs reflects only the increased costs of heating and cooling by participating

customers. It does not reflect the impact of higher electric prices on other electric loads by participating or non-participating customers (e.g., refrigerators and lights). Electric prices reflect costs that may be incurred by electric utilities that overlap with National Fuel's service area to accommodate increases in electric load from electrification. As described in Appendix B, the electric prices are preliminary estimates based on projected investments by electric utilities to serve incremental loads and integrate renewable and distributed resources. It is conceivable that these electric prices could be significantly higher after electric utilities perform the necessary planning studies that consider the impact on their systems.

The ultimate demarcation of which costs are recovered through gas bills, and which are Decarbonization Policy Costs that will be recovered from other sources will be determined by policy makers. It is conceivable that the Decarbonization Policy Costs may be funded through a combination of tax policies, utility program incentives, rate subsidies, transfer payments and other mechanisms that supplement funds contributed by participants and any other private sources. These issues have not yet been resolved and National Fuel has not made any assumptions with respect to the mechanism(s) that will be used to recover Decarbonization Policy Costs.

Scenario Results

Estimates of GHG emission reductions, gas bills, and Decarbonization Policy Costs are generated by the LTP model based on technology-specific assumptions, the start date, maximum annual participation rate, and ramp rate of each decarbonization action. Table V-1 presents results for these metrics for the two alternative scenarios. The Aggressive Scenario produces double the GHG emissions reduction as compared to the SCE Scenario (52% reduction compared to 26% reduction in 2042 versus Reference Case levels) due to higher levels of activity in all decarbonization actions. However, the Aggressive Scenario has a much greater 2042 gas bill Increase for customers that do not participate in electrification compared to the SCE Scenario (121% vs. 33%) due to a combination of a more substantial decline in throughput and higher levels of RNG and hydrogen blending compared to the SCE Scenario.

Table V-1
Incremental GHG Emissions and Cost Impacts

	2042 Annual GHG	2042 Non-Participant Gas Bill	Installation Costs NPV	Gas Costs NPV	Elec. Costs NPV	Total Decarb Policy Costs NPV
Reference Case: Baseline (*)	**9,112**	**$134**	$0	$0	$0	**$0**
Increment Relative to the Reference Case						
SCE Scenario	**-26%**	**33%**	$1,446	$(578)	$593	**$1,462**
Aggressive Scenario	**-52%**	**121%**	$4,237	$(2,206)	$2,795	**$4,826**

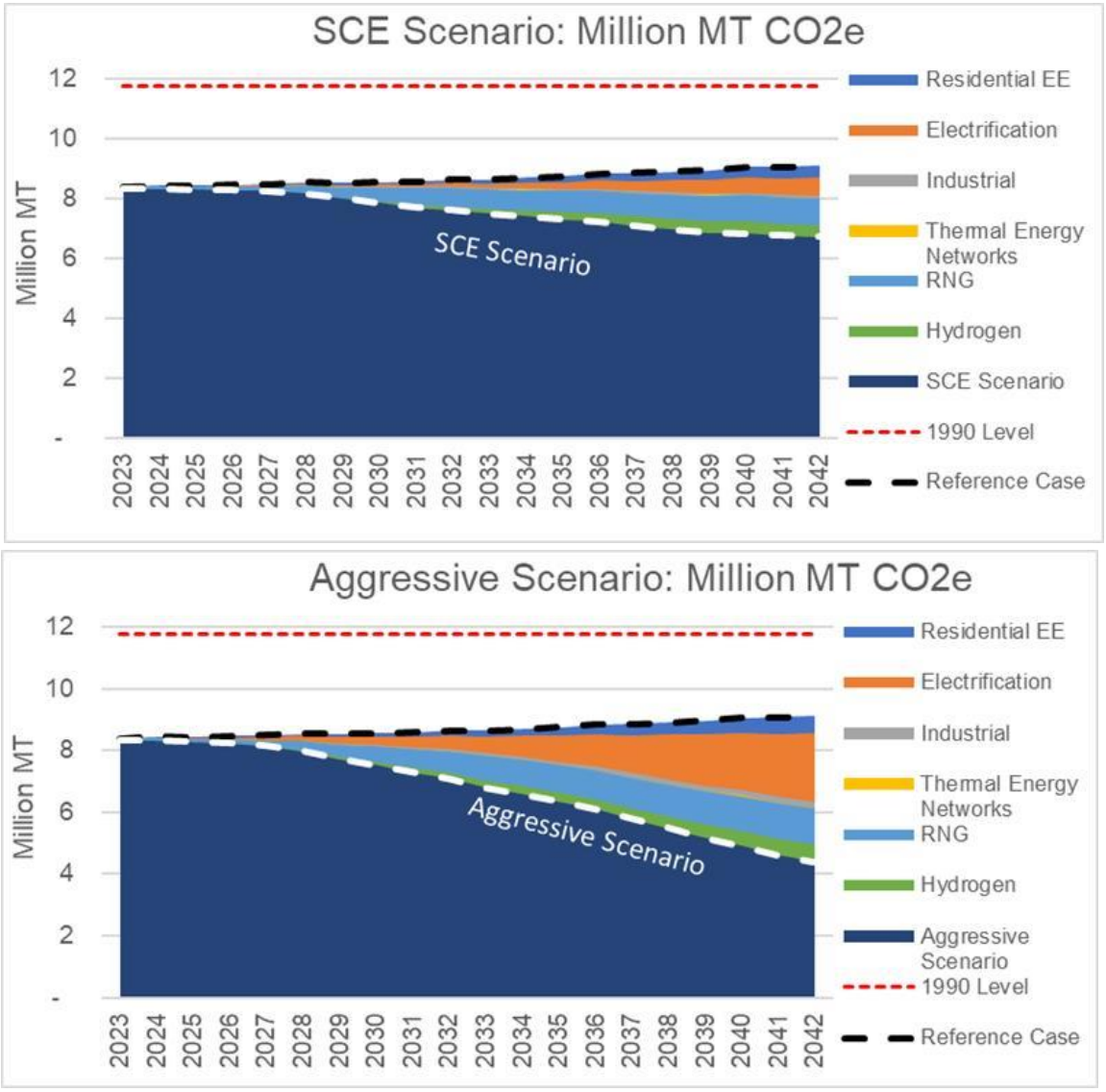
(*) Reference Case Units: GHG in Thousand MT CO2e; Gas Bill – Typical Monthly Residential Heating Customer Bill using 106 Mcf per year; Decarbonization Policy Costs - $M

Also as shown in Table V-1, the NPV Decarbonization Policy Costs for the Aggressive Case are $4.8 billion, which is comprised of $4.2 billion installation cost at customer premises, minus $2.2 billion in reduced (or eliminated) gas bills for participating customers, plus $2.8 billion in increased electric costs for participating customers. The NPV Decarbonization Policy Costs for the SCE Scenario are significantly less, at $1.5 billion. The higher Decarbonization Policy Costs in the Aggressive Scenario are primarily due to higher upfront and operating costs associated with all-electrification compared to hybrid heating systems for residential customers.

Overall, the Aggressive Scenario results in bill impacts and Decarbonization Policy Costs that are nearly four times higher than SCE Scenario, while realizing only twice the reductions in GHG emissions compared to the Reference Case in 2042.

Figure V-1 presents the contributions to GHG emission reductions by decarbonization action for the SCE and Aggressive Scenarios, respectively. The dashed black line represents the projected GHG emissions under the Reference Case, and the dashed white line represents the projected total GHG emissions under the alternative scenario. Each colored wedge between the black and white dashed lines represents the GHG emissions decrease associated with a particular decarbonization action. As shown in Figure V-1, both the SCE Scenario and the Aggressive Scenario have modest impacts on GHG emissions in the early years, with increased impacts in the later years as programs ramp up and impacts accumulate over time. The largest difference in GHG emissions reductions between the two alternative scenarios is related to building electrification (orange wedge). While the all-electrification option in the Aggressive Scenario results in greater contributions to GHG emission reductions as compared to the use of hybrid heating systems for residential customers in the SCE Scenario, this distinction also drives the increase in costs between the two scenarios, which will be discussed in more detail later in this chapter.

Figure V -1
Scenario Contributions to GHG Emissions Reductions



Insights from the Scenario Analysis

The scenario analysis provides the insights necessary to develop a Long-Term Plan that achieves a reasonable balance among GHG emissions reductions, the cost of achieving them, and risk to the reliability of the energy system. The modeling results indicate that there will be upward pressure on National Fuel's rates and the Decarbonization Policy Costs under any likely scenario that achieves material GHG emissions reductions. This is consistent with an expectation that achieving New York's climate goals will require significant investments in the energy sector. National Fuel, for its part, proposes to pursue decarbonization actions in a responsible manner, while striving to maintain affordable outcomes throughout the twenty-year

LTP period and beyond. National Fuel is also of the view that the transformation must begin immediately, while maintaining safety, reliability and resiliency of the energy system are also absolute requirements. National Fuel has applied the following strategy in an effort to achieve substantial GHG emissions reductions while maintaining safety, reliability, resiliency and affordability:

1) Assess the relative efficiency of individual decarbonization actions in contributing to GHG emissions reductions (i.e., cost required per unit of GHG emissions reductions), as there is meaningful variation among the decarbonization actions with respect to their economic efficiency in reducing GHG emissions. These efficiencies are calculated by the LTP model and expressed as $/MT CO2e reduction, with both numerator and denominator expressed as NPV values. The total costs are the sum of the incremental impact on National Fuel's revenue requirements (relative to the Reference Case) plus the Decarbonization Policy Costs. Starting with the Aggressive Scenario, the Company scaled down and deferred the least efficient decarbonization actions. With respect to the energy efficiency (weatherization) and electrification decarbonization actions, National Fuel selected the most efficient near-term technology options by customer segment.
2) Refine the plan by considering feasibility implications. These include practical constraints that restrict the number of household heating conversions per year or the buildout of the electric sector infrastructure, for example. They also include an assessment of whether an unproven technology or business model will be viable by 2025, prior to the development of National Fuel's next plan.
3) Validate that the plan is consistent with the Guiding Principles including maintaining safe, reliable, resilient, and affordable energy system, adjusting the plan if necessary.

There are several insights from the Scenario Analysis that inform National Fuel's Long-Term Plan:

- RNG is a major contributor to GHG emissions reductions in both scenarios and is relatively efficient in terms of cost per GHG emission reduction. Animal manure and food waste RNG fuel feedstocks could contribute to for significant GHG emission reductions due to negative life-cycle carbon intensities. Thermal gasification is not as market ready as anaerobic digestion-based feed stocks.
- Electrification is a major contributor to GHG emissions reductions in both scenarios due to the large amount of gas load converted to electric load. Residential electrification is significantly more cost-efficient in the SCE Scenario (which assumes hybrid heating systems) than in the Aggressive Scenario (which assumes an all-electric home with cold climate heat pumps). Full electrification of residential customers in the Aggressive Scenario has among the highest cost per GHG emission reduction of all decarbonization actions modeled. Electrical upgrades for 80+ year old houses make electrification significantly more expensive compared to conversion of newer homes.

- Residential energy efficiency (Weatherization programs) are less efficient programs as a whole and are making a modest contribution to the reduction in GHG emissions. However, weatherization does deliver sustainable GHG emissions reductions and energy bill reductions and there are material differences in the efficiencies of specific weatherization measures. Replacing windows, duct sealing, and attic insulation are less cost effective compared to other weatherization measures. In addition, weatherization of LMI customers is substantially more efficient than for other customers. Targeting weatherization to LMI customers will contribute to equity goals established by the CLCPA. Home energy reports are the most efficient Decarbonization Action but have a limited impact on overall GHG emissions reductions.
- Industrial sector energy efficiency and electrification measures begin to address challenges associated with a hard-to-decarbonize sector and are relatively efficient. It will be important to consider the impact that energy efficiency and electrification measures will have on industrial customer operations due to the role that these customers play in the overall economy.
- Although network geothermal projects are slightly more cost efficient for new housing developments as compared to existing neighborhood projects, the economics are poor for both options at this time and a modest approach is appropriate for the LTP.
- Hydrogen blending is also relatively efficient, however its overall GHG emissions reduction is dependent upon determining the appropriate hydrogen blending levels.

These insights, along with overall cost considerations, were used to determine the specific levels and timing of each Decarbonization Action included in National Fuel's LTP.

National Fuel's Long-Term Plan

The goal of the Company's LTP is to realize meaningful GHG emissions reductions at a reasonable overall plan cost while maintaining safety, reliability, resilience, and affordability throughout the plan period. The Company's LTP was developed using a bottom-up approach where per unit costs (e.g., incremental equipment cost and incremental energy bills per participating customer or incremental cost per unit of RNG or hydrogen) and benefits (e.g., decreased emissions per participating customer, decreased emissions per unit of RNG or hydrogen) were estimated for each decarbonization action. Insights from the Scenario Analysis were used to determined how much of each decarbonization action was included in the LTP based on its feasibility, relative cost efficiencies, and the specific characteristics of National Fuel's system, service territory, customer base, and market. An effort was made to be as aggressive as possible as long as the relative cost efficiency of the action was in line with or lower than alternatives and National Fuel was confident that it would be able to execute the plan. The resulting LTP, organized by each decarbonization action, is presented in Table V-2.

Where necessary, the Company will seek appropriate Regulatory approval(s) for implementation of these initiatives.

Table V-2
Long-Term Plan – Decarbonization Actions

	Decarbonization Action	National Fuel's Long-Term Plan
1	Scale Gas Energy Efficiency	**Overall Approach: Same as Aggressive Scenario but eliminate the least efficient weatherization measures to reduce costs. Also, focus weatherization investments on LMI customers.** • Continue Reference Case EE • Residential Weatherization, Standard Income: 2024 start, 100% of Cadmus max achievable savings; Excludes Attic Insulation, Windows and Duct Sealing • Residential Weatherization, LMI: 2024 start, 100% of Cadmus max achievable savings; Excludes Duct Sealing • Residential home energy reports: 100% customer participation; 2024 start
2	Building Electrification	**Overall Approach: Focus on electrifying non-boiler based heating systems due to the significant increased cost of electrifying systems heated by boilers. Residential customers convert to hybrid heating system due to the cost premium and comfort challenges associated with cold-climate heat pumps.** • Residential: 2025 start; 48% of furnaces converted to hybrid by 2042; includes electrification of water heaters, dryers and ranges ramp up over time; exclude old homes and boilers; conversions occur at end-of-life. • Small commercial: 2025 start; ramp up over time; furnaces at end-of-life converted to full electrification; 45% of furnaces converted to by 2042 • University: 2025 start; ramp up over time; furnaces at end-of-life converted to full electrification ASHP; 47% of furnace and heater heating load converted by 2042 • Public Housing: 2025 start; ramp up over time; furnaces at end-of-life converted to full electrification ASHP; 47% of furnace and heater heating load converted by 2042
3	Industrial Customer Clean Actions	**Overall Approach: Electrify non-boiler based heating systems due to the significant increased cost of electrifying systems heated by boilers. Include energy efficiency at Aggressive Scenario level.** • Energy Efficiency of Process Load: 2024 start; 0.5%/year process load reduction; 10% process load reduction by 2042 • Electrify space heating: 2025 start; 47% of furnace and heater space heating load converted to full electrification ASHP by 2042[47]; ramp up over time
4	Thermal Energy Networks	**Overall Approach: Same as SCE Scenario** • One 50-home geothermal project per year to replace natural gas in a new sub-division starting in 2027. • No existing neighborhood projects.

[47] Includes unit heaters, infra-red heaters, make-up air heaters and rooftop heaters.

	Decarbonization Action	National Fuel's Long-Term Plan
5	Renewable Natural Gas	**Overall Approach: Same as Aggressive Scenario** • Promote regional anaerobic digestion projects that produce RNG from landfills, animal manure, food waste, and wastewater facility operations and deliver those volumes to the Company's system as soon as possible per ICF's Optimistic Growth Scenario, excluding thermal gasification
6	Hydrogen	**Overall Approach: Same as SCE Scenario due to uncertainty about higher levels of hydrogen blending and required development time of hydrogen projects.** • 2030 start, increase 0.5%/year, max at 5%

The start dates are determined based on the likely time necessary to obtain regulatory approvals, design and implement programs or projects, and in some cases to allow for more information about utility scale operations to become available. Energy efficiency weatherization and electrification participation are assumed to follow a ramp up curve provided in the Cadmus weatherization study.

National Fuel's LTP will make significant strides toward achieving its decarbonization goals. The LTP is projected to reduce emissions by 37% by the end of the 20-year horizon (2042) compared to Reference Case levels, and by 51% from 1990 levels as shown In Figure V-2. The emissions reductions start modestly and increase over time as constraints on deploying technology are resolved. Emissions reductions are projected to continue after 2042, through 2050 and beyond.

The largest emissions reductions in 2042 result from adding RNG to the gas supply mix and from electrification primarily with hybrid heating systems.

Figure V-2
LTP Contributions to GHG Emissions Reductions

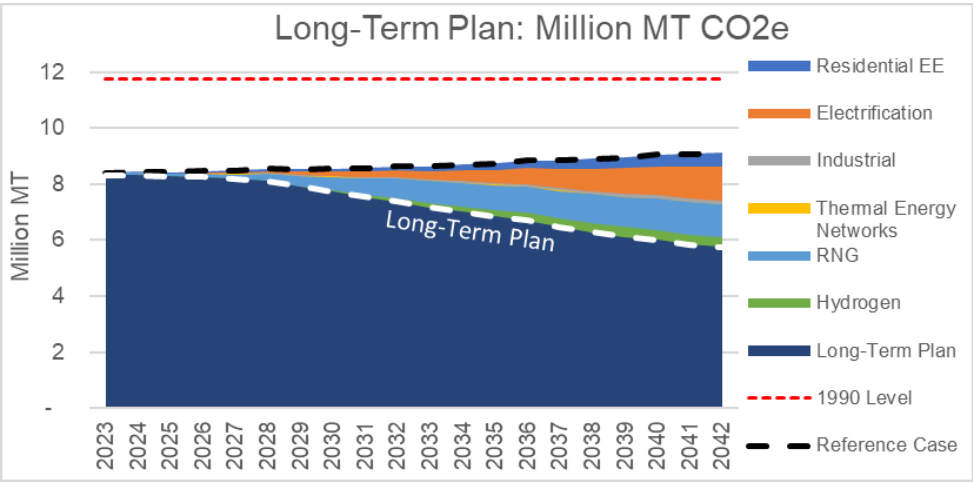


Table V-3 details the relative cost efficiency, 2042 GHG emissions reduction, NPV impact on National Fuel's revenue requirement, and NPV Decarbonization Policy Costs for each decarbonization action in National Fuel's Long-Term Plan. The incremental cost of equipment at the customer premises, incremental gas supply costs for RNG and hydrogen, and incremental energy bills for participating customers associated with the LTP as a whole are estimated to total approximately $3.0 billion on a net present value basis over the next 20 years.

Table V-3
LTP Decarbonization Actions and GHG Emission Reduction Efficiency

	Long-Term Plan		
	$/MT CO2e	2042 Annual CO2e (000's MT)	Total Cost NPV ($M)
Reference Case	n/a	9,112	n/a
Decarbonization Actions			
Energy Efficiency, Home Energy Reports	$ (105)	(40)	$ (40)
Weatherization Standard Income	$67	(107)	$19
Weatherization LMI	$602	(345)	$558
Electrification, Residential	$372	(1,038)	$953
Electrification, Small Commercial	$223	(168)	$90
Electrification, University & College	$460	(1)	$ 1
Electrification, Large Multi-Family	$497	(2)	$ 3
Industrial Heating Electrification	$87	(25)	$ 5
Industrial Process Energy Efficiency	$187	(96)	$73
Network Geothermal	$972	(8)	$26
Renewable Natural Gas	$213	(1,183)	$ 1,136
Hydrogen Blending	$180	(343)	$200
Scenario Total	$263	5,755	
Change from Ref Case	n/a	(3,357)	$3,025
% Change from Ref Case		-37%	

As shown in Table V-3, energy efficiency (home energy reports – with a green font) is the most efficient decarbonization action included in National Fuel's LTP at a cost of -$105/MT CO2e reduced, however total GHG reductions are limited. Installing thermal energy networks (geothermal) is the least efficient decarbonization action (meriting a red font) included in National Fuels LTP at a cost of $972/MT CO2e reduced and energy efficiency (LMI weatherization) is the second least efficient decarbonization action at $602/MT CO2e reduced. National Fuel believes that including less efficient measures in the LMI weatherization program in the LTP is warranted given the need to pay particular attention to the effects that decarbonization will have on LMI customers.

Comparison to the SCE and Aggressive Scenarios

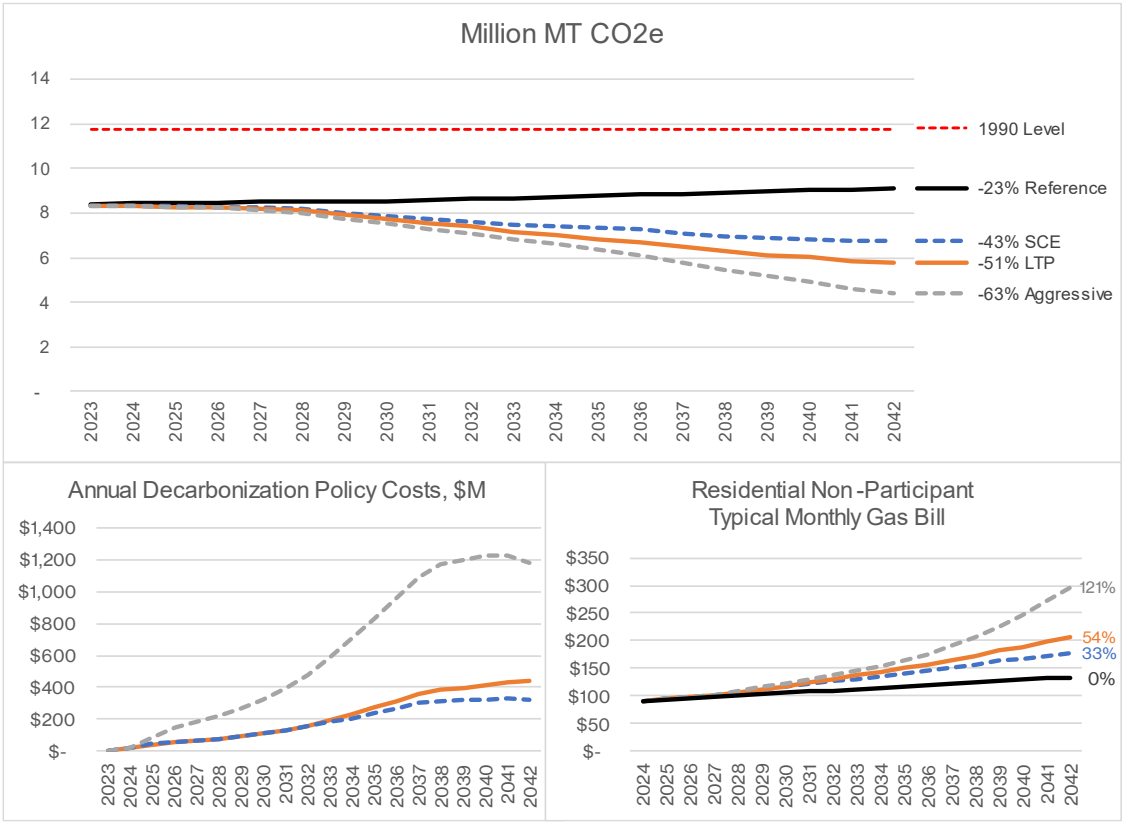
The LTP performs well with regard to total cost, reliability, resiliency, and affordability when compared against the Aggressive Scenario. The primary difference between the LTP and the Aggressive Scenario is that the Aggressive Scenario assumes residential customers convert to full electrification of all major home appliances whereas the LTP assumes residential customers convert to a hybrid heating system, along with the electrification of all other non-heating appliances including water heating, cooking, and clothes drying. As shown in Table V-4, the LTP is substantially more cost-effective compared to an Aggressive Scenario. The LTP produces significant reductions in GHG emissions (3.36 million metric ton reduction of CO2e emissions in 2042) at a total NPV cost of $3.0 billion. The Aggressive Scenario produces somewhat higher reductions In GHG emissions (4.73 million metric ton reduction of CO2e emissions in 2042), but at a cost that is more than double the LTP at $6.3 billion. This is primarily due to the relatively lower upfront and ongoing operating costs of converting residential customers to a hybrid gas/electric heating solution in the LTP compared to conversion to an all-electric/cold climate heat pump solution in the Aggressive Scenario. The residential natural gas bill for non-participants in 2042 is also substantially lower in the LTP than in the Aggressive Scenario ($206 per month compared to $295 per month).

Table V-4
GHG and Cost Metrics

	Long-Term Plan		Aggressive Scenario	
Change from Reference Case	**2042 CO2e (000's MT)**	**Total Cost NPV ($M)**	**2042 CO2e (000's MT)**	**Total Cost NPV ($M)**
	(3,357)	$ 3,025	(4,726)	$6,257
Residential Typical Monthly Natural Gas Bill	**2024**	$91	**2024**	$91
	2042	$206	**2042**	$295

Figure V-3 presents the same information on an annual basis in line diagrams that illustrate the GHG and cost impacts among the Reference Case, Aggressive Scenario, and LTP.

Figure V-3
GHG Emission Reductions and Cost Impacts



Key Strategies

While six decarbonization actions were modeled, the major features of National Fuel's LTP can be summarized into three key strategies that are consistent with its decarbonization strategy.

1. **Enhance Energy Efficiency Measures:** Reducing overall energy use through energy efficiency is an important feature of many decarbonization strategies. The Cadmus study identified several weatherization measures as well as the estimated cost and gas usage reduction associated with each measure. Cadmus also identified that LMI customers would likely have greater gas savings for most weatherization measures due to the characteristics of LMI housing. It was assumed that the maximum achievable potential estimated by Cadmus was achieved across all weatherization measures and across standard and LMI customers in the Aggressive Scenario. The weatherization program in the Aggressive Scenario cost approximately $1.0 billion on an NPV basis and reduced 2042 emissions by 518 thousand metric tons CO2e. The LTP is able to achieve similar 2042 emissions reductions of 452 thousand metric tons CO2e at a cost of $577 million by eliminating several of the least cost-effective weatherization measures for standard

income customers. National Fuel proposes to include windows, a relatively expensive measure, in its weatherization program exclusively for LMI customers.

The LTP also includes an aggressive behavioral energy efficiency program whereby home energy reports are sent to all residential customers. While the savings associated with home energy reports can be limited, the program is very low cost compared to the other decarbonization measures studied, so it is included in the LTP at the most aggressive levels possible.

2. **Promote Hybrid Heating Systems**: As discussed previously, National Fuel's customers frequently experience very cold days and western New York has a large population of LMI customers, so ensuring reliable, effective, and low-cost heat is especially important. Standard air-source heat pumps are typically found in warmer climates such as the southern and southwest U.S. and are not designed and built to operate effectively in colder northern U.S. climates such as National Fuel's. Therefore, they are generally not considered a viable sole heating source in the Company's service territory. Cold-climate heat pumps are typically larger and more efficient versions of a standard heat pump and are designed to operate in colder climates. However, as the temperature decreases, cold-climate heat pumps begin to see their efficiency and capacity drop and can struggle to maintain indoor air temperatures. At even colder outdoor air temperatures, the cold-climate heat pumps use built in electric resistance heating to supplement the heat pump's ability to keep a home warm. This reduced efficiency at low temperatures drastically increases the amount and cost of electricity needed to operate these systems and puts additional strain on the electric grid. Two approaches for residential heating were modeled:

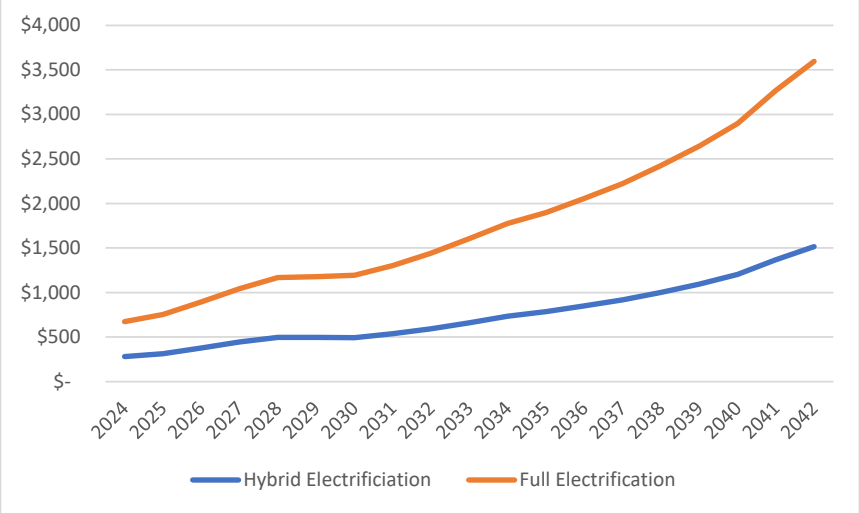
   - A hybrid gas/electric heating system option that relies on a gas furnace on colder days and a standard electric air-source heat pump on less cold days, and
   - A cold-climate electric air-source heat pump that relies on electricity for heating on all days.

   The upfront cost of a cold-climate heat pump is more than double the cost of a hybrid system ($22,200 compared to $10,100).[48] Figure V-4 illustrates that a typical residential customer heating with a gas furnace who decides to convert to a fully electric home with a cold-climate heat pump is also projected to have energy bills that are 2.4 times higher than the energy bill of a customer who converts to a hybrid heating system plus electric appliances. The projected annual energy bill Increase for a customer using a cold-climate heat pump is $3,600 in 2042 compared to approximately $1,500 if they converted to a hybrid heating system under the LTP. The difference in energy bills increases over time

[48] "Residential Home Energy Analysis," CJ Brown Energy, prepared for National Fuel Gas Distribution Corp. New York Division, August 2022 Update. Provided in Appendix G.

as significant upward pressure is expected on electric rates due to the infrastructure necessary to implement decarbonization and other grid modernization efforts.

Figure V-4
Incremental Ongoing Annual Cost of Residential Electrification
(Gas plus Electric Bills)



Full electrification using cold-climate heat pumps will also place additional strain on the electric system as more electric system build-out will be required to meet peak heating demand on cold days. According to National Grid, a hybrid heating approach will require an additional 6 GW of electric capacity in western New York by 2050 compared to current levels, but full electrification will require an additional 11 GW of electric capacity compared to current levels. In addition, it has been estimated that managing winter peaks through hybrid heating could avoid almost $75 billion of electric capital expenditures across New York through 2050.[49] Similar concerns have been noted in Quebec where the electric utility is supporting hybrid heating as a benefit to the electric system.[50]

Hybrid heating systems increase electric grid utilization during off-season periods (i.e., spring and fall when outdoor air temperatures are mild) without increasing electric loads during peak heating hours. Furthermore, facilities that are currently air-conditioned can implement hybrid heating equipment without increasing their electric service capacity or requiring neighborhood utility grids to be upgraded.

Although much has been made of the promise of cold-climate heat pumps, it is conceivable that they will never reach the efficiency and cost levels necessary to be

49 "Achieving a Low-Carbon Future in Western New York," National Fuel/National Grid, February 2022.
50 "Dual Energy for Sustainable Decarbonization", Hydro-Québec.

practical in National Fuel service territory's climate. Electrifying a gas furnace-heating home by converting to a hybrid heating system and electric appliances significantly reduces gas usage (64%) compared to taking no action, requires less upfront costs, and results in lower ongoing energy bills compared to full electrification with cold-climate heat pumps. Furthermore, shifting winter heating loads to the electric grid before it has adequate transmission and distribution capacity and before it is supplied by 100% renewable generation can have dangerous consequences on reliability and potentially increase GHG emissions as the electric energy shortfall is met with fossil fuel generation. As a result, the LTP includes developing a program for converting residential customers to hybrid heating systems and cold-climate heat pumps for residential customers are not included in the LTP at this time.

3. **Leverage Existing Infrastructure to Deliver Low Carbon Fuels:** National Fuel's existing infrastructure is necessary to transport and store RNG and hydrogen in the LTP. LTP levels of RNG are based on an optimistic growth scenario from recent RNG studies[51] related to the potential to develop anaerobic digestion projects that produce RNG from landfills, animal manure, food waste, and wastewater facilities in western New York.

   Significant research is being done to determine appropriate levels of hydrogen that can be blended into natural gas systems. In addition, the 2022 Inflation Reduction Act contains subsidies for clean hydrogen production, which should facilitate additional hydrogen development. Current technology and the current composition of the U.S. gas distribution systems suggests that approximately 5-10% hydrogen can be blended into natural gas systems. Given the possible safety concerns associated with higher concentrations of hydrogen, the LTP proceeds conservatively with a hydrogen blend starting at 0.5% in 2030 and increases over time to a target of 5% in 2039.

   It is reasonable to include significant levels of RNG in National Fuel's LTP because low- and no-carbon fuels will have a material impact on GHG emissions reductions at a relatively low cost. Some jurisdictions have recognized the potential benefits of these no- and low- carbon fuels and have created policies that encourage gas utilities to pursue their development. For example, Minnesota passed the Natural Gas Innovation Act In 2021, which allows gas utilities to pursue and recover prudently incurred costs related to innovative resources aimed at reducing GHG emissions and meeting renewable energy goals, which include biogas, RNG, and power-to-hydrogen, among others.[52] Florida also passed legislation in 2021 that provides for the cost recovery of RNG procurement by a gas utility.[53] These and other market mechanisms, like the renewable gas standards

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51 "Potential of Renewable Natural Gas in New York State", ICF April 2022. NYSERDA Report Number 21-34, p 44. National Fuel Gas Company, RNG Potential in NY & NFGDC Territory, April 2020. Provided in Appendix J.

52 H.F. No. 164 June 2021 - Natural Gas Innovation Act, Article 8 Sec.20.

53 SB 896 approved June 29, 2021. Page 4. Chapter No. 2021-178.

developed in California and Oregon and the clean heat standard recently considered in Vermont, should be considered In New York to stimulate alternative fuels development in the state.

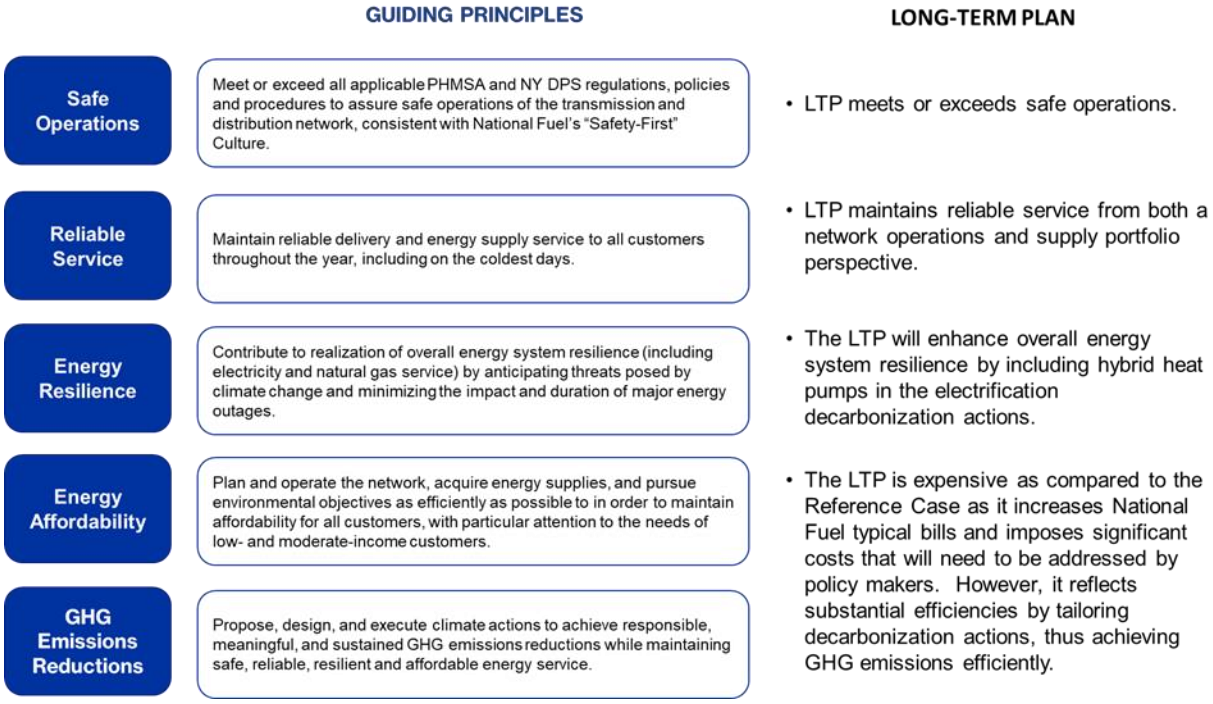
NATIONAL FUEL'S LTP DELIVERS ESSENTIAL FEATURES AND BENEFITS TO ITS CUSTOMERS AND COMMUNITIES:

1) The LTP prioritizes safety and reliability by diversifying energy sources and continuing the Company's LPP replacement program;
2) The LTP preserves customer choice and provides a more affordable option while relying on the gas system to ensure effective heating during the coldest days and nights of the year;
3) The LTP addresses affordability and reduces energy cost burdens for LMI and other customers;
4) The LTP achieves meaningful reductions in GHG emissions by 2042, prioritizing emissions reductions for LMI customers;
5) The LTP is not merely aspirational; it is technically feasible and contemplates technology advances during the 20-year period;
6) The LTP is also feasible from an infrastructure standpoint. It reflects resource and timing constraints related to the conversion of heating and cooling to electricity and the buildout of electric infrastructure to reliably serve incremental demand;
7) The LTP contributes to a resilient energy system that involves coordination between the natural gas and electricity industries; and
8) The LTP is flexible and can adapt as energy technology and policy evolve in the future.

Consistency with the Guiding Principles

The final step in the development of National Fuel's Long-Term Plan is to validate its compliance with the overall set of Guiding Principles and with each principle. This assessment is presented in Figure V-5.

Figure V-5
Compliance with Guiding Principles



Benefit-Cost Analysis

The Gas Planning Order requires gas utilities to include a BCA in its long-term plan filing. The Commission's BCA Framework Order[54] designated the SCT as the primary BCA method. The SCT was performed for the LTP by comparing the NPV of the LTP's incremental benefits and costs relative to the Reference Case over the 20-year planning horizon. The Benefit Cost Ratio ("BCR") must exceed a 1.0 to "pass". The LTP did not pass the SCT test with a BCR of 0.57. Assumptions used in the BCA are described in Appendix C. BCA results for the LTP are shown in Table V-5, below.

[54] Case 14-M-0101, Reforming the Energy Vision, Order Establishing the Benefit Cost Analysis Framework, issued January 21, 2016.

Table V-5
BCA Results

Long-Term Plan Benefit Cost Analysis	Discount Rate 6.92%
Societal Cost Test	**NPV**
Benefit: Avoided Electrical Costs ($)	$ (42,883,556)
Benefit: Avoided Gas Costs ($)	$ (1,447,160,027)
Benefit: Avoided Gas Main, Service & Appliances ($)	$ (6,876,489)
Benefit: Avoided Emissions, Societal Cost ($)	$ (1,057,268,688)
Benefit: Avoided ICAP for Peak kW, Summer ($)	$ (10,668,854)
Total Benefit ($)	$ (2,564,857,614)
Cost: Incremental Electricity Cost ($)	$ 1,185,417,738
Cost: Implementation Costs ($)	$ 3,276,127,574
Cost: Increased Emissions, Societal Cost ($)	$ 29,407,762
Cost: Incremental ICAP($)	$ 27,398,541
Total Cost($)	$ 4,518,351,615

Benefit/Cost Ratio	0.57

The majority of the benefits accrue from avoided gas costs as well as avoided emissions, while the majority of the costs accrue from incremental electric costs and implementation costs.

There are several items in the SCT that were not included as they are difficult to quantify, including reliability/resiliency improvements, non-energy benefits, and non-energy costs. In addition, the increased electric costs included in the SCT were limited to those directly related to converting gas equipment to electric. Increases in electric costs due to electric rates increasing for all customers for all electric use (e.g., to run existing electric equipment such as refrigerators) were not quantified or included in the SCT.

BCA ratio is 0.57 despite the effort to achieve GHG emissions reductions at a low cost. Given the high costs associated with most of the decarbonization actions, it is unlikely that most decarbonization actions would pass a SCT. National Fuel believes that the combination of decarbonization actions included in its LTP represents a responsible plan to reduce GHG emissions, enhance the resilience of the energy supply system, and deliver safe, reliable and affordable energy service. National Fuel notes that other NY LDC's have received Commission approval to proceed with certain non-pipe alternative projects with similar BCA ratios.[55]

[55] NYS PSC Case 17-G-0432: Order Approving Petition for Non-Pipe Alternative Projects, with Modifications.

Key Uncertainties and Considerations

The LTP represents a 20-year perspective, a challenging future that will be characterized by continued evolution of policies, economic and environmental trends, and technological innovation. As such, each of its key drivers is subject to some level of uncertainty, including:

- Customer perspective and acceptance with respect to building heating and cooling system modernization as they apply to fuel sources, equipment technologies, and conservation;
- Regulatory actions related to the CLCPA legislation and emission reduction targets that may be imposed on the gas distribution system over the next 20 years;
- Continued evolution of New York energy policy and Commission regulatory requirements (e.g., allowing the cost of RNG and hydrogen to be recovered by utilities, policies to mitigate up-front cost barriers associated with installing equipment at customer premises to enable decarbonization);
- Technology advancement including the viability and scalability of several different technologies related to: (1) heat pumps; (2) RNG; (3) hydrogen; (4) TENS (including district geothermal); and (5) carbon capture and storage; and
- Market conditions including workforce training and availability, supply-chain issues, inflationary pressures, investor initiatives, and global energy instability.

Important considerations in developing the LTP include: (a) whether certain emerging technologies can be quickly implemented to contribute to meaningful GHG emissions reductions within the first three years (i.e., by 2025), and (b) whether pilot programs are needed to test technologies' and/or new business models' viability and scalability to meet customer demands or contribute to the supply portfolio. The Company will carefully evaluate these considerations as it pursues the decarbonization initiatives in its Long-Term Plan, all while continuing to ensure that it provides safe, reliable, resilient and affordable energy for its customers.

Other Considerations

Potential Retirement of Segments of Leak-Prone Pipe and NPAs

The Gas Planning Order requires that LDCs, "identify, in the annual reports required by this Order, the locations of specific segments of leak-prone pipe that could be abandoned in favor of NPAs and where infrastructure projects may be needed in the near future to maintain reliability." The Commission states further that consideration of weatherization, demand response, and electrification programs targeted to a neighborhood may enable LDCs to abandon segments of

leak-prone pipe. The overall goal is to avoid investments to replace pipe where it is feasible to do so, but particularly in disadvantaged communities.[56]

Although National Fuel is proposing a "no-infrastructure" LTP, it will consider NPAs as an alternative to replacement of leak-prone pipe if circumstances indicate that it may be possible to abandon segments that would otherwise need to be replaced. Any such segments will be identified in National Fuel's annual reports.

Pursuant to the Gas Planning Order, National Fuel submitted proposed suitability criteria on August 10, 2022. Also on this date, the Joint LDCs filed an NPA Shareholder Incentive Mechanism SIM and cost recovery procedures. The Commission has yet to issue an order that addresses these three NPA issues. This will not have any impact on the Long-Term Plan. Rather, National Fuel will apply the suitability criteria and other aspects as directed by the Commission in its final order(s).

LMI Customers and Disadvantaged Communities

The Gas Planning Order requires that the LDCs, "identify the disadvantaged communities in their service territories, explain the impacts to disadvantaged communities of any proposed projects, and explain how the LDC will ensure that an appropriate portion of the benefits of any proposed NPAs such as energy efficiency, demand response, and electrification accrue to disadvantaged communities."[57] National Fuel does not have any proposed projects that will disproportionately impact its disadvantaged communities. It does, however, have pipeline replacement projects that will occur within disadvantaged communities, with the exception of any NPAs that avoid the project and enable the abandonment of pipe segments. In addition, National Fuel proposes to have a specific program to target weatherization projects to LMI customers. National Fuel will consider taking a similar approach to electrification in its next plan, with the benefit of a more detailed implementation plan.

[56] Gas Planning Order, p. 39.
[57] Gas Planning Order, p. 40.

VI. Conclusions

VI. Conclusions

National Fuel's LTP maintains the safety and reliability of distribution and supply service, while enhancing overall system resilience. It strikes an appropriate balance between GHG emissions reductions and costs, as measured by the impact on gas customer bills and the Decarbonization Policy Costs. National Fuel's LTP achieves this balance by prioritizing efficient and effective individual decarbonization actions and derating less effective and more expensive actions. The LTP also considers the implementation and technological feasibility constraints related to each decarbonization action. This LTP is the first of several plans that will be updated every three years to reflect the evolution of technology, implementation constraints, and policy.

Evolution of Regulatory Policy

National Fuel anticipates that regulatory policies will continue to evolve as New York's natural gas and electric utilities design plans to help achieve the state's GHG reduction goals. Regulatory policy is established in generic proceedings as well as utility-specific proceedings. National Fuel is an active participant in all generic proceedings that have potential implications for the natural gas business and for its customers. Over the past few years, National Fuel has been collaborating with other New York LDCs to submit comments in many of these proceedings. National Fuel will continue to promote GHG emission reduction policies and regulations that support safe, reliable and affordable energy choices for its customers throughout western New York.

Next Steps

National Fuel will pursue several priorities that are aligned with the three key strategies of the LTP and will contribute to meaningful reductions in GHG emissions in furtherance of the State's overall goals. They include:

- **Energy Efficiency:** Design, implement, and make significant investments in energy efficiency programs in all sectors to achieve decarbonization goals. These include residential weatherization and building shell retrofits that reduce energy loss through enhancements to the building envelopes, primarily by increasing insulation, sealing air leaks, and upgrading windows. Weatherization programs include programs that are tailored to meet the needs of LMI customers. In addition, National Fuel will implement a behavioral energy efficiency program.
- **Hybrid Heating Systems:** Develop a large-scale project to expediently begin converting a diverse group of residential customers to hybrid heating systems and test the ability to provide a reliable, effective, and affordable source of heating even on cold days. These hybrid pilots will explore the use of controls and switch points to achieve efficiencies and

provide reliable comfort on the coldest days of the year. In addition, electrify the heating systems of many non-residential customers (small commercial, universities, large multi-family buildings).

- **Existing Infrastructure:** National Fuel will facilitate development of the RNG market in western New York by sourcing and integrating RNG supplies from anaerobic digestion-based feed stocks (i.e., animal manure and food waste). National Fuel will also develop a pilot program to test the limits of integrating and blending hydrogen into its system.

In addition, National Fuel will continue its efforts to develop existing network geothermal pilots and begin to explore geothermal projects for new housing developments in the service areas. Where necessary, the Company will seek appropriate regulatory approval(s) for the implementation of these initiatives.

National Fuel looks forward to implementing the decarbonization actions articulated in this Long-Term Plan, and is hopeful that the state will view the plan as a model that can be utilized in other regions of the state with similar economic, geographic and other characteristics to the Company's western New York service territory. The priorities that have guided the development of this LTP - ensuring safe, reliable, resilient and affordable energy for consumers - should be reflected in the state's overall decarbonization efforts as well.