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March 18, 2022

Net Zero Enablement Plan

Proposal to Achieve the Commonwealth's Climate Goals and Clean Heat Future for Customers

Boston Gas Company
d/b/a National Grid
Docket No. D.P.U. 20-80

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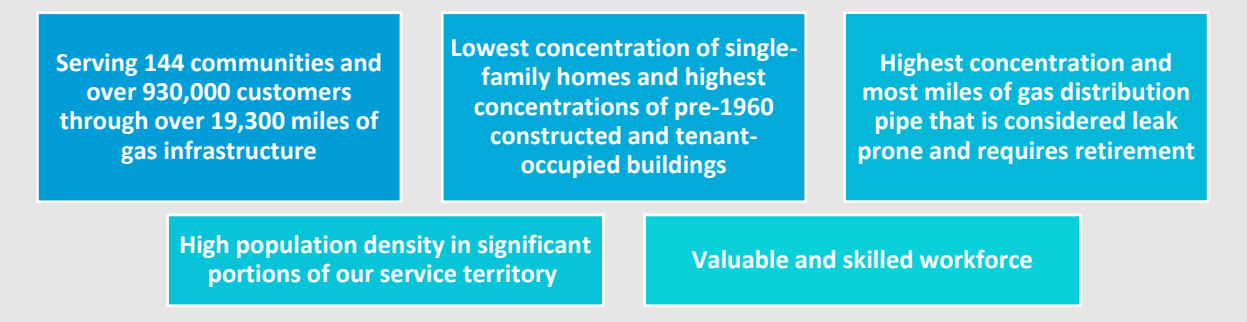
I. Executive Summary

National Grid is one of the largest investor-owned energy companies in the United States, serving more than 20 million people throughout New York, Massachusetts, and Rhode Island. National Grid believes that we are at the heart of one of the greatest challenges facing our society — mitigating climate change – through transforming our electricity and natural gas networks with smarter, cleaner, and more resilient energy solutions to meet our states' and company's goals of reducing greenhouse gas emissions. In 2020, National Grid became one of the first utilities to launch a net zero plan that targets net zero emissions **including emissions from the sale and use of electricity and gas by our customers**. To achieve this plan, we are decarbonizing our own operations, and actively exploring solutions to help our states, communities, and customers achieve a net zero energy future quickly, reliably, and affordably. National Grid is committed to taking nation-leading steps to eliminate the use of fossil fuels and provide affordable clean heating solutions to all our customers.

National Grid's Massachusetts Gas System



Key characteristics of our Massachusetts gas system are summarized below:

- Serving the heating and energy needs of 144 communities and over 930,000 customers in Massachusetts through 19,300 miles of distribution gas infrastructure.
- Lowest concentration of single-family homes and highest concentrations of pre-1960 constructed and tenant-occupied buildings, relative to other gas local distribution companies ("LDCs").
- Highest concentration and most miles of gas distribution pipe that is considered leak prone and requires replacement, relative to other LDCs.
- High population density in significant portions of our service territory.
- Valuable and skilled workforce, which provides an opportunity to use this existing talent to advance decarbonization.

National Grid's Plan for a Net Zero Gas Network in Massachusetts

National Grid is committed to achieving the Commonwealth's net zero targets. As we work to enable a net zero energy future for all our customers, we are committed to keeping affordability, equity, safety, and reliability at the forefront of everything we do. These priorities inform the pillars of the Net Zero Enablement Plan we outline below. National Grid's plan to achieve a net zero energy future for all our customers is also supported by the findings of the independent consultants'[1] report on "The Role of Gas Distribution Companies in Achieving the Commonwealth's Climate Goals" dated March 18, 2022 ("Consultant Report") submitted herewith;[2] in particular, the finding in the Decarbonization Pathways Report that a **"coordinated gas and electric decarbonization strategy, utilizing a diverse set of technologies and strategies, is likely to be better able to manage the costs and feasibility risks of decarbonization than scenarios that rely more heavily on single technologies or strategies."**[3] Consistent with this finding, National Grid's Net Zero Enablement Plan achieves the Commonwealth's 2030 and 2050 climate goals, through a decarbonized and integrated gas and electric system that:

- **Eliminates fossil fuels from our gas supply** by pursuing delivery of fossil-free gas such as renewable natural gas ("RNG") and renewable hydrogen through our network to all our customers. Over time, we will transition to 100% fossil-free gas ("renewable gas"),[4] achieving a zero-fossil gas system by 2050 at the latest.
- **Provides more resilient energy supply for Massachusetts** with continued use of the gas pipeline network, a system which would require at least a doubling of today's electric capacity to fully electrify the heating service it currently provides,[5] is underground and storm resistant, has built-in storage, and will be 100% renewable gas by 2050.

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[1] The independent consultants Energy & Environmental Economics ("E3") with ScottMadden as subcontractor (collectively "Consultants") were selected by the LDCs to review the Executive Office of Energy and Environmental Affairs' "2050 Decarbonization Roadmap" and "Interim 2030 Clean Energy and Climate Plan" to identify any pathways not examined in these roadmaps and to perform a detailed study that analyzes the feasibility of all pathways.

[2] The Consultant Report includes a "Technical Analysis of Decarbonization Pathways" report ("Decarbonization Pathways Report") and "Considerations and Alternatives for Regulatory Design to Support Transition Plans" report ("Regulatory Designs Report").

[3] Decarbonization Pathways Report at 19.

[4] Decarbonization Pathways Report at 9 defines "renewable gas" as "umbrella term referring to renewably produced alternatives to natural gas that can be blended into the distribution pipeline system. Renewable gases include biomethane produced through anaerobic digestion or gasification, renewable hydrogen and Synthetic Natural Gas (SNG) produced from renewable hydrogen and a climate-neutral source of carbon."

[5] Decarbonization Pathways Report at 59 and 60. "100% Gas Decommissioning," "2030 CECP," and "High Electrification" scenarios result in a tripling of electric capacity need compared to today. Heating load is the majority of load growth in all cases, so attributing half of electric capacity increase to heat is a conservative estimate. These high electrification scenario electric capacity estimates incorporate the impact of efficient electric heat pumps and building energy efficiency measures.

- **Enables customer use of hybrid heating systems** by supporting customer adoption of heating technologies best suited to their needs. We anticipate that by 2050, many of our customers will be best served by hybrid heating systems, where an electric heat pump covers cooling and heating during part of the year, and a gas system provides heat during the coldest months.
- **Preserves a choice of heating and cooking solutions for customers**, as they have today. Customers will always be free to choose a 100% electric solution as they can today, but can continue to enjoy the benefits of increasingly decarbonized gas heating and cooking should they wish.
- **Reduces the overall cost of achieving net zero**, by repurposing existing infrastructure to deliver renewable gases. This avoids significant electric network reinforcement, reducing the scale of the requirement for long duration electricity storage (the 'unsolved problem' of the energy transition), and the retrofitting costs for many customer homes.
- **Increases investment and adoption of energy efficiency measures**, including the prioritization of building envelope improvements, to achieve significant heating efficiency improvements across our networks. Our energy efficiency plans also include appliance efficiency measures, heat electrification, and demand response implementation.
- **Utilizes targeted electrification to provide non-pipe alternatives where safe and cost-effective.** Non-pipe alternatives include consideration of customer adoption of fully-electric heating solutions through a targeted approach to increase adoption of networked geothermal systems, ground-source heat pumps ("GSHP"), and air-source heat pumps ("ASHP").

National Grid's plan supports a variety of customer heating options while also supporting the overall affordability, equity, safety, and reliability of the energy system. While electrification will be the appropriate choice for some customers and potentially certain segments of the gas network, our existing gas infrastructure can continue to be used to meet customers' energy needs in a manner that will not only limit the overall costs of achieving net zero but, as discussed below, also increase the probability of achieving net zero targets. Our plan is aligned with the following core objectives:

- **Cost-effectiveness, affordability, and equity**: National Grid is committed to maintaining customer bill affordability and enabling an equitable net zero transition. The Decarbonization Pathways Report finds that scenarios that balance utilization of both the gas and electric systems result in outcomes that are both affordable and equitable for

customers, in contrast with all-electric scenarios, through 2050.[6] Furthermore, the Decarbonization Pathways Report states that a "hybrid strategy reduces the cumulative cost of achieving net-zero [greenhouse gases or] GHGs through 2050 by between $23-43 billion relative to scenarios that primarily rely on all-electric strategies."[7] Like the Decarbonization Pathways Report "Hybrid Electrification" pathway, shown to be least cost on an economy-wide basis, we plan to supply all our residential and commercial customers with 100% renewable gas by 2050.[8] Our Net Zero Enablement Plan builds on this hybrid strategy, and goes a step further by eliminating fossil gas for our industrial customers as well. National Grid can maintain affordability for industrial customers through technological advancements that will reduce the cost of RNG and hydrogen versus that assumed in the Decarbonization Pathways Report modeling. Our emphasis on expanding energy efficiency will further support affordability.

- **Safety, reliability, and resilience:** All gas LDC Net Zero Enablement Plans must maintain the safety and reliability of the gas networks. While a robust assessment of resilience was beyond the Consultants' scope, the Decarbonization Pathways Report acknowledges the role of the gas system in overall energy system resilience.[9] Relying on both a net zero gas system and electric network can reduce the risk of relying on a single energy system for the region's heating capacity, and the fundamental health and safety issues that result from heating service interruptions.

- **Feasibility of scaling:** Our plan limits both the need to rely on unprecedented customer electrification adoption rates as well as the level of new electric system infrastructure that must be sited, permitted, and constructed. For example, to reach 1 million electrically heated homes by 2030, as stated in the interim 2030 Clean Energy Climate Plan ("CECP"), the Decarbonization Pathways Report estimates approximately 80,000 homes would need to adopt heat pumps every year for the next eight years, roughly 20 times higher than current adoption rates.[10] With more realistic adoption rates, achieving >90% electric heat pump adoption by 2050 would require close to half of our customers to invest in new heating equipment before their current equipment reaches the end of its life. Our plan, on

[6] Decarbonization Pathways Report at 12.
[7] Decarbonization Pathways Report at 14.
[8] Decarbonization Pathways Report at 48. Figure 13 demonstrates "Hybrid Electrification" residential and commercial sectors reaching 0 MMTCO2e by 2050.
[9] Decarbonization Pathways Report at 29.
[10] Decarbonization Pathways Report at 84 and 98, footnote 84. 80,000 homes / 4,000 homes adopting ASHP in 2019 = 20 times higher than 2019.

the other hand, achieves net zero without putting this additional financial burden of purchasing new equipment on customers. Furthermore, the transition to clean electricity in combination with high levels of full electrification is expected to require both a tripling of the electric generation capacity we have today, as well as additional transmission and distribution capacity.[11] Infrastructure siting is particularly challenging in National Grid's densely populated service territory. Lastly, our plan reduces the challenges associated with the workforce transition, consistent with the Consultants' finding that "[s]cenarios with high levels of electrification imply a more challenging wor[k]force transition to train, or re-train, skilled workers."[12]

Ultimately, given the complex challenges of achieving net zero within the building sector, as well as the remaining uncertainties around technology evolution, costs, customer needs, and external economic factors, **it is critical to pursue multiple decarbonization approaches simultaneously to maximize the likelihood that net zero targets are achieved.** The Decarbonization Pathways Report recommends energy efficiency, building electrification, including strategies for all-electric new construction and hybrid electrification, use of renewable natural gas, i.e., "biomethane", as "low-regret" strategies and recommends pilots on hybrid system operation, targeted electrification, networked geothermal, and renewable hydrogen as warranting "further research and development."[13] To advance these approaches, the following regulatory and policy actions will be needed to enable adequate LDC progress toward net zero and also manage the cost to customers of the Commonwealth's energy transition:

- Enabling the procurement of renewable gas, including broadening the standards used to review LDC supply purchases to include non-fossil fuels such as RNG and hydrogen, and allowing for longer-term contracting to support project development;
- Accelerating recovery of depreciation expense to reduce the risk of long-term gas network affordability challenges;
- Increasing energy efficiency investment and prioritizing building energy envelope improvements and adoption of heat pump technologies;
- Funding research, development, and deployment activities that further gas network decarbonization;
- Establishing frameworks to incent alternatives to gas infrastructure investment where possible; and
- Supporting and formalizing the LDC role in scaling geothermal investments.

[11] Decarbonization Pathways Report at 60.
[12] Decarbonization Pathways Report at 12.
[13] Decarbonization Pathways Report at 18-19.

The LDC Common Regulatory Framework and Overview of Net Zero Enablement Plans, including a Net Zero Enablement Plan Model Tariff ("Regulatory Framework") proposed by the LDCs will allow the LDCs to progress toward decarbonization in a manner that is appropriate for their respective service territories and customer base, while providing a common approach to demonstrating progress and continuing to ensure that affordability, equity, safety, and reliability objectives are achieved.

II. National Grid Company Overview

National Grid's Massachusetts Gas System

Boston Gas Company d/b/a National Grid ("National Grid", "Company", "we" or "our") is the largest gas distribution company in Massachusetts. Further details on the characteristics of our Massachusetts gas system are provided below:

- **Serving the heating and energy needs of 144 communities and over 930,000 customers in Massachusetts through 19,300 miles of distribution gas infrastructure.** Many of these communities have significant low- and moderate- income populations, and almost all communities we serve contain at least one environmental justice ("EJ") population.

- **Lowest concentration of single-family homes and highest concentrations of pre-1960 constructed and tenant-occupied buildings**, relative to other LDCs. These characteristics make it relatively more challenging to electrify heating.[14] Additionally, many of our commercial and industrial customers have operational or facility characteristics that may not allow for full electrification – these customers represent over half of our delivered gas volume.

- **Highest concentration and most miles of gas distribution pipe that is considered leak prone and requires replacement**, relative to other LDCs, including approximately 3,000 miles of remaining cast iron, bare steel, and Aldyl-A pipe plastic pipe. The nature of our network may provide some opportunities to seek alternative approaches to replacing leak-prone pipe ("LPP"), but also challenges given the pace at which LPP must be replaced.

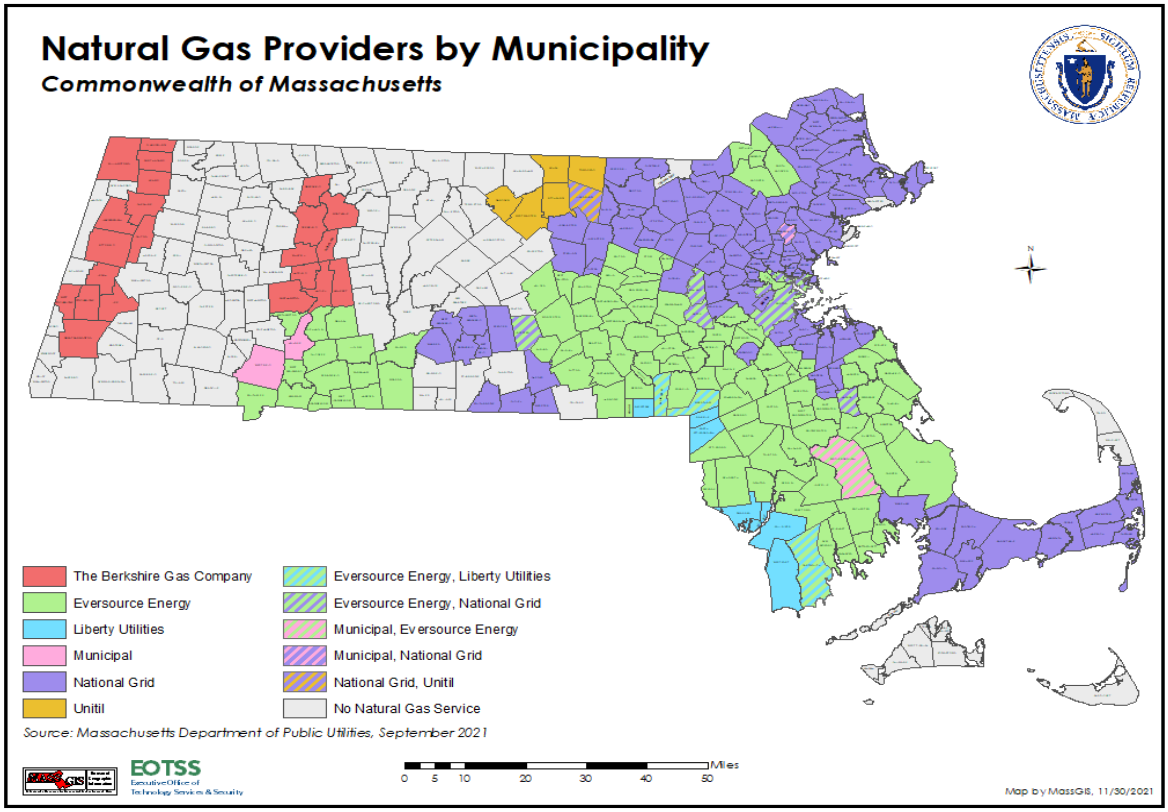
- **High population density in significant portions of our service territory.** In urban, high-density areas such as Boston, siting new electric infrastructure such as generation, substations, and transmission and distribution lines are likely to be more challenging and disruptive to the communities and environment compared to low density areas.[15] The impacts of local outages are also amplified, given the number of customers impacted.

[14] Decarbonization Pathways Report at 41.
[15] Decarbonization Pathways Report at 40.

Figure 1 below shows that National Grid operates in some of the most densely-populated areas of the Commonwealth.

- **Valuable and skilled workforce,** which provides an opportunity to use this existing talent to advance decarbonization in the Commonwealth while maintaining union and other jobs supported by our gas network.

Figure 1. Massachusetts Natural Gas territories and providers[16]



III. National Grid's Plan for a Net Zero Gas Network in Massachusetts

Our plan keeps the Commonwealth on track for a 50% reduction of economy-wide emissions by 2030 (relative to 1990 levels) and net zero emissions from the sale of natural gas to our customers by 2050. As we work to enable net zero, we are committed to keeping affordability, equity, safety, and reliability at the forefront of everything we do. These priorities inform the pillars of the net zero plan that we outline below. National Grid's plan to achieve a net zero energy future

[16] Commonwealth of Massachusetts, Natural Gas Providers, available at https://www.mass.gov/doc/natural-gas-providers-png/download

for all our customers is also **supported by the findings of the Decarbonization Pathways Report**, particularly the finding that a **"coordinated gas and electric decarbonization strategy, utilizing a diverse set of technologies and strategies, is likely to be better able to manage the costs and feasibility risks of decarbonization than scenarios that rely more heavily on single technologies or strategies."**[17]

Key Components of our Plan to Achieve the Commonwealth's Net Zero Targets

The key components of National Grid's Net Zero Enablement Plan are most similar to the Decarbonization Pathways Report "Hybrid Electrification." More specifically, our plan is similar to "Hybrid Electrification" in the following ways:

- **~60% gas demand reduction**. National Grid's plan anticipates overall gas demand reduction will be largely similar to the "Hybrid Electrification" scenario by 2050. Gas demand in National Grid's plan is predicted to be slightly higher than the state-wide Hybrid Electrification assumptions due to the "hard-to-electrify" characteristics of National Grid's service territory described in Section II.
- **Gas customer count similar to present day.** Though National Grid's plan shows significant gas demand reduction, gas customer count is expected to remain steady compared to today, which is consistent with the "Hybrid Electrification" scenario.
- **100% renewable gas for Residential and Commercial customers.** As seen in the "Hybrid Electrification" scenario, National Grid's plan serves residential and commercial customers with 100% renewable gas – a mix of RNG and hydrogen – by 2050.
- **Significant customer adoption of hybrid heating systems.** National Grid's plan assumes significant adoption of hybrid heating systems by 2050. Electric heat pump adoption in National Grid's plan is predicted to be lower than "Hybrid Electrification" due to the "hard-to-electrify" characteristics of National Grid's service territory described in Section II.

Although National Grid's Net Zero Enablement Plan is largely designed using the "Hybrid Electrification" scenario, the plan differs from "Hybrid Electrification" as follows:

- **Targeted electrification and networked geothermal.** Unlike "Hybrid Electrification", National Grid's plan embraces our role as a leader in evaluating opportunities for non-pipe alternatives, including consideration of targeted electrification, and networked geothermal systems. Affordability, equity, safety, and reliability will remain priorities for National Grid within these assessments.

[17] Decarbonization Pathways Report at 19.

- **100% renewable gas for Industrial customers.** Unlike "Hybrid Electrification", which leaves Industrial customers on fossil natural gas, National Grid's plan takes emissions reductions a step further by serving all customers with 100% renewable gas, including Industrial customers. Serving Industrial customers with 100% renewable gas was a feature demonstrated in the "Efficient Gas Equipment" scenario.[18]
- **Deep energy efficiency measures.** Unlike "Hybrid Electrification", which assumes the least aggressive amount of energy efficiency measures of all modeled scenarios, National Grid's plan envisions building envelope and appliance efficiency measures that would lead to higher overall energy efficiency reductions. These deep energy efficiency measures would be focused on non-hybrid heating customers where these energy efficiency measures are more cost-effective.[19]

Stakeholder Engagement in Developing National Grid's Plan

As demonstrated by our Net Zero Enablement Plan, we believe that our path to net zero must be tailored to the unique characteristics of our Massachusetts service territory and capitalize on opportunities to drive change, while also reflecting customer needs and financial realities. National Grid actively participated throughout the formal stakeholder process detailed in the ERM Report and also conducted its own outreach to its customers to allow for comment and feedback from those who had not yet been involved in the formal stakeholder process.[20] We highlight key feedback throughout this plan and the customer focus group results are included as Attachment B.

Overall, our plan cost-effectively achieves the Commonwealth's emissions targets for the building sector by using a portfolio approach that is supported by the findings in the Decarbonization Pathways Report. In the sections below, we detail the specific evidence provided by the Decarbonization Pathways Report that supports the key components of our National Grid Net Zero Enablement Plan.

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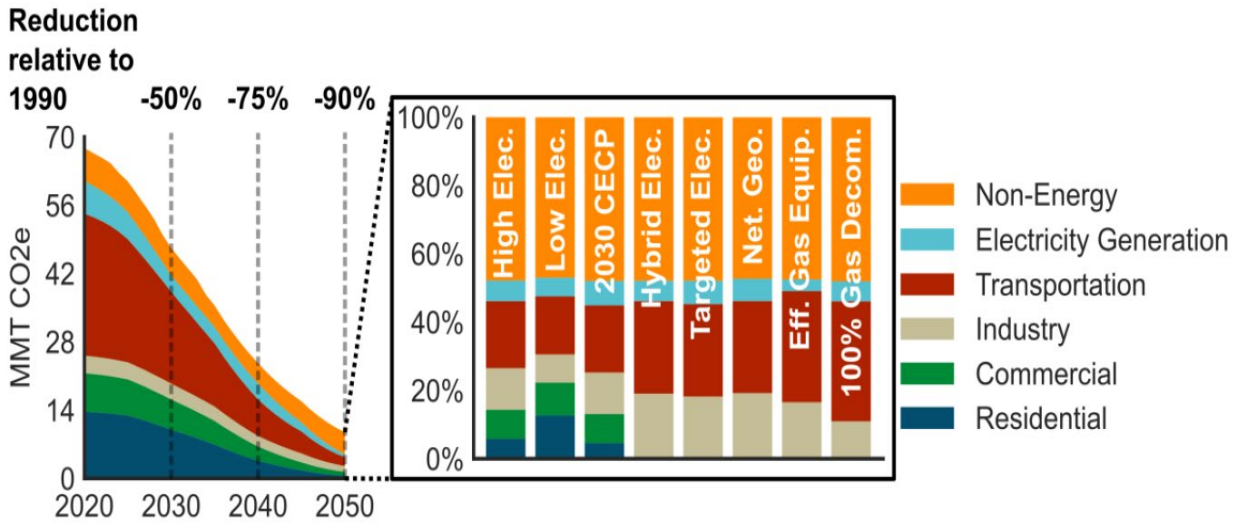
[18] Decarbonization Pathways Report at 14.
[19] Decarbonization Pathways Report at 56.
[20] National Grid attended the monthly stakeholder sessions, created customer introductory videos, co-hosted customer webinars, and responded to customer and stakeholder comments. See ERM Stakeholder Engagement Process Report ("ERM Report"). To promote customer engagement, National Grid contacted its gas customers with email addresses on file (over 350,000 residential and commercial customers) informing them of the upcoming webinars and requesting their feedback on the future of natural gas use considering the Commonwealth's net zero goal. The communication contained registration information for the webinars and links to the informational customer videos (Attachment A). National Grid also contacted chambers of commerce throughout the service territory to inform them and their members of the customer webinars, ultimately reaching approximately 6,700 organizations. Additionally, National Grid conducted an in-depth focus group of 40 residential and commercial customers to obtain further insights regarding customers' knowledge of the Commonwealth's net zero goals and their expectations for the Company's plan.

Emissions Reductions Impact of National Grid's Plan

> *"As a Massachusetts customer of National Grid, I wanted to let you know how excited I am about local, state, federal, and global efforts towards net-zero carbon emissions." – ERM Report, App. K.*

As discussed above, the key components of our plan are most similar to the Decarbonization Pathways Report "Hybrid Electrification" scenario, with some features that borrow from the "Targeted Electrification", "Networked Geothermal", and "Efficient Gas Equipment" scenarios. Figure 2 demonstrates that, although the share of emissions by sector varies by scenario (2050 sector breakout highlighted in the box to the right), all scenarios modeled in the Decarbonization Pathways Report achieve a 50% reduction in direct economy-wide emissions relative to 1990 levels by 2030, 75% by 2040, and 90% by 2050 (shown at the top of the chart). Given that the key components of our plan are consistent with the components modeled in the Decarbonization Pathways Report scenarios, we expect that our plan will achieve the emissions reductions required to meet the Commonwealth's emissions reduction targets.

Figure 2. Economy-wide GHG Emissions over time and the sectoral composition of emissions in 2050[21]



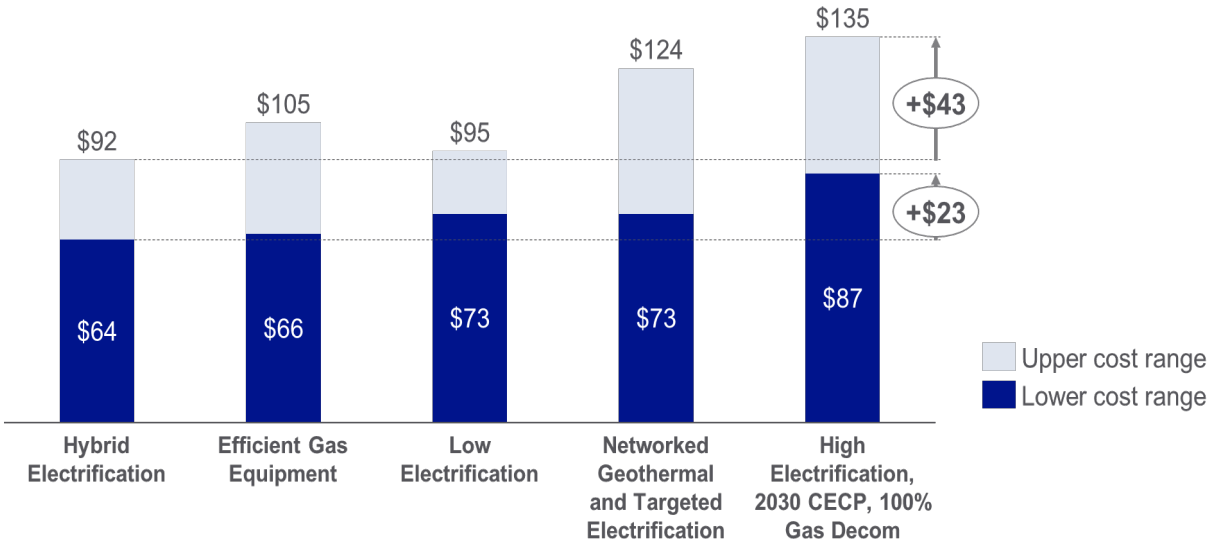
National Grid's Plan Reduces Energy System Costs to Achieve Net Zero by ~$23-43 Billion

As discussed above, National Grid's plan is most similar to the Decarbonization Pathways Report "Hybrid Electrification" scenario in aspects important to energy system costs, including similar amounts of gas demand reduction, number of customers that utilize the gas system, and usage

[21] Decarbonization Pathways Report at 48.

of 100% fossil-free gas for residential and commercial customers between now and 2050. The Decarbonization Pathways Report found that the "Hybrid Electrification" scenario "reduces the cumulative cost of achieving net-zero GHGs through 2050 by between $23-43 billion relative to scenarios that primarily rely on all-electric strategies"[22] (Figure 3). The analysis shows that plans with continued use of the gas system have lower economy-wide costs than scenarios that rely on high electrification, while still achieving the Commonwealth's climate targets. The Decarbonization Pathways Report explains that "[t]he Hybrid Electrification pathway reduces electric peak demands as space heating demands are supplied by gas during the coldest hours of the year, substantially reducing the amount of electric infrastructure required to serve peaks."[23] Hybrid Electrification also reduces cost for gas customers by "reduc[ing] the amount of renewable fuels that would need to be procured."[24]

Figure 3. Cumulative energy system costs through 2050 ($B)[25]



In addition to being lower cost, plans that utilize the gas system lower overall stranded cost risk. The Decarbonization Pathways Report states that "[s]cenarios with decreased utilization of the gas system face substantial embedded cost recovery challenges and may result in stranded

[22] Decarbonization Pathways Report at 14.
[23] Decarbonization Pathways Report at 60.
[24] Decarbonization Pathways Report at 12.
[25] National Grid figure using data from Decarbonization Pathways Report at 11.

costs."[26] Leveraging the gas system for decarbonization avoids risking ~$11 billion of stranded embedded system costs as seen in "High Electrification" and "2030 CECP."[27] These stranded costs are particularly problematic since, under current cost allocation, high electrification pathways "would result in inequitable outcomes where remaining customers would pay a disproportionate share of costs. Such an outcome is particularly concerning for lower-income customers, who are less able to reduce their exposure to gas rate increases through electrification given the upfront costs."[28]

National Grid's Plan Results in More Affordable and Equitable Outcomes for Our Residential Customers

Affordability and ensuring that no customer is left behind in the clean energy transition are key features of National Grid's proposed plan. About 30% of households within our service territory have incomes below $50,000 – buying all-electric appliances including an ASHP and implementing energy efficiency measures would represent 60-70% of their annual income at a cost of $29,000 – $36,000 (Figure 4 and 5). Though these costs could be covered by heavy subsidization, the Decarbonization Pathways Report estimates this could add additional costs ranging from $0.5-$1.8 billion per year to reach 1 million electrically heated homes by 2030. [29] Reaching 3.1 million electrically heated homes by 2050 could result in ~$5-25 billion in cumulative additional costs on top of the total economy-wide costs shown above.[30] Even with subsidies, there likely will be some customers who are not able to adopt new heating systems. Under the high electrification pathways, there is high risk that gas infrastructure costs will fall disproportionately on those that are least able to afford it.[31]

[26] Decarbonization Pathways Report at 14.
[27] Decarbonization Pathways Report at 14 and 75. "100% Gas Decommissioning" also demonstrates significant stranding risk, but mitigates some of this risk through installation of networked geothermal systems ($6.6-$10.3 billion).
[28] Decarbonization Pathways Report at 18.
[29] Decarbonization Pathways Report at 84 and 98.
[30] Decarbonization Pathways Report at 84 and 98. Cumulative cost low range assumes $6,250 incentive per customer ($0.5 B / 80,000 customers per year) and 850 K customers requiring incentives (E3's estimate of low-income households in Massachusetts, which is ~30% of total households by 2050). Cumulative cost upper range assumes $22,500 incentive per customer ($1.8 B / 80,000 customers per year) and 1.1 M customers requiring incentives ((3.1 M – 0.3 M)*40% of total households requiring incentives).
[31] Decarbonization Pathways Report at 18.

Figure 4. Overview of customer upfront costs by technology package[32]

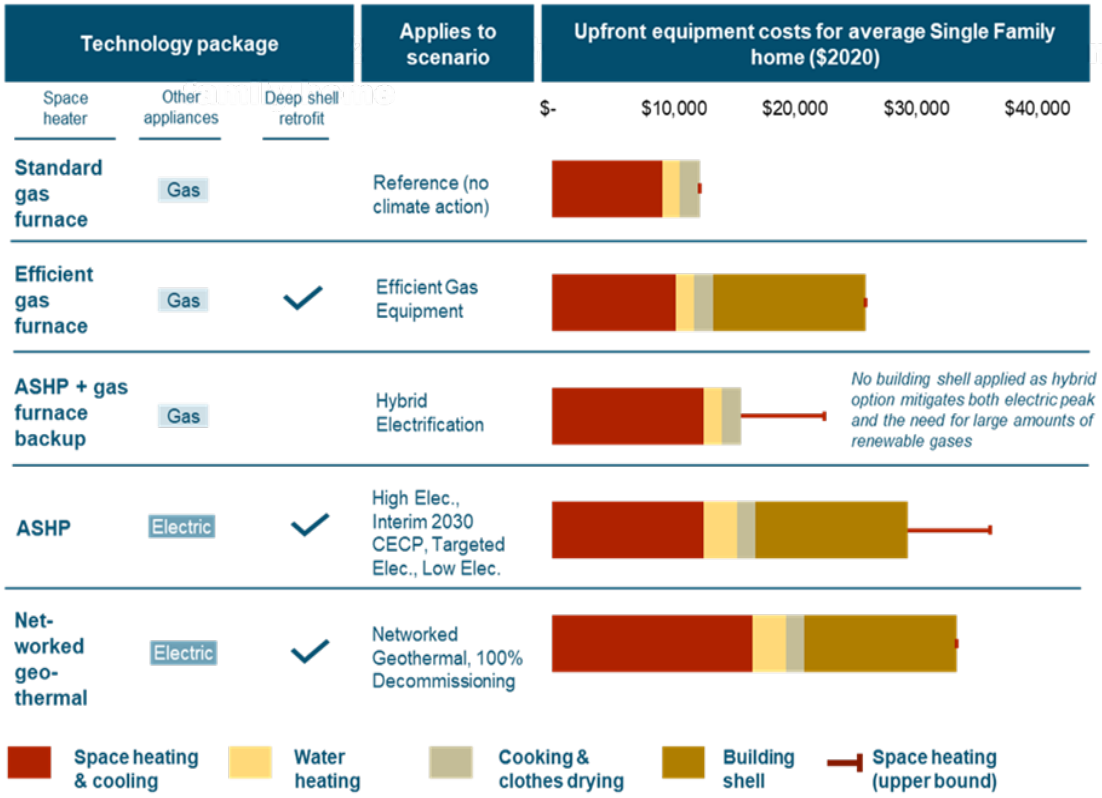
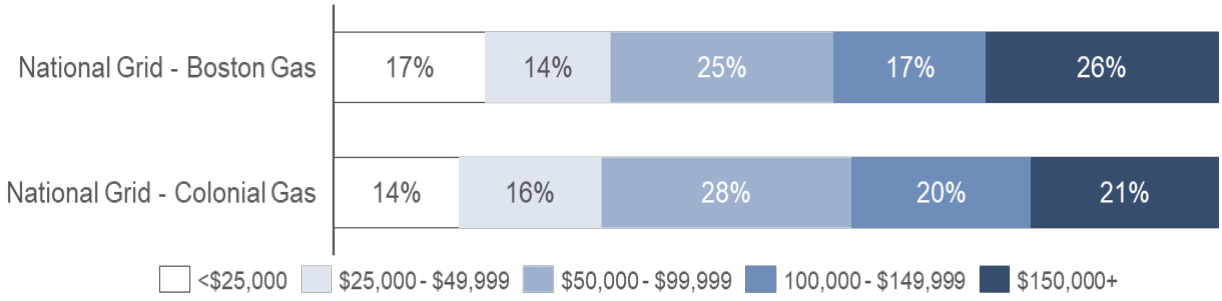


Figure 5. 2019 Household Income Distribution for National Grid's service territory[33]



[32] Decarbonization Pathways Report at 105.
[33] Decarbonization Pathways Report, Appendix 3: LDC Characteristics, at 23.

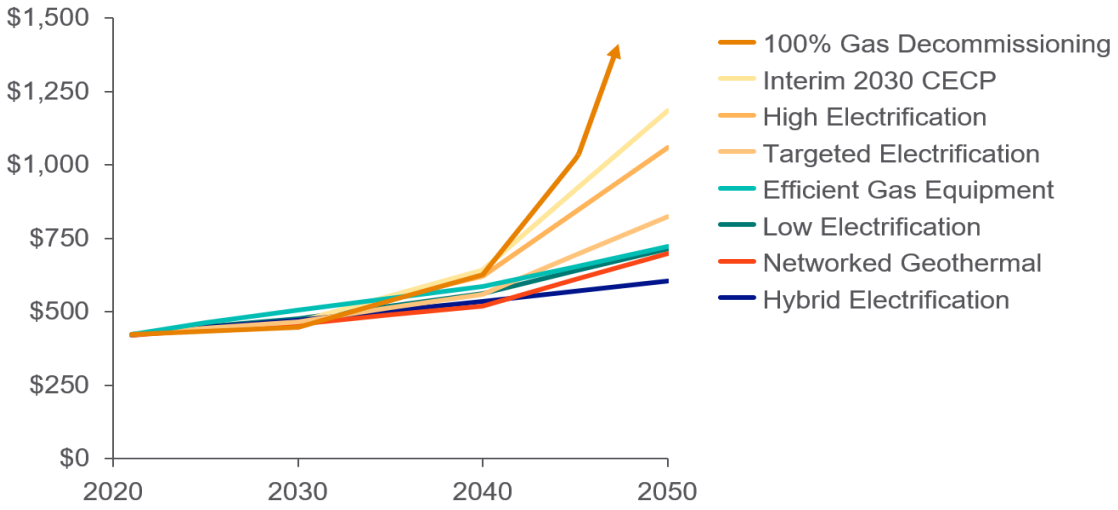
National Grid's plan takes a balanced approach that ensures all customers have affordable clean heating solutions by leveraging the use of electric heating technologies while maintaining a role for a renewable gas network as needed to manage costs and reliability. Figure 4 shows that hybrid heating system configurations make the upfront cost of installing heat pumps much more affordable for residential customers by keeping their gas equipment for use on the coldest days.[34] In addition, total energy costs for customers who install hybrid heating is lower than customers that go all-electric over the next decade or more.[35] In fact, over 80% of residential customers that adopt ASHPs through the MassSave program today are likely installing them as hybrid heating systems.[36] The affordability benefits of significant system-wide adoption of hybrid heating systems actually extend beyond the customers that physically install hybrid heating systems onsite – as seen in Figure 6, scenarios that continue to utilize the gas network keep energy costs affordable for all residential customers that continue utilizing renewable gas heat, whether through an efficient gas heater, a hybrid heating system, or in a future where LDCs also deliver heat through targeted all-electric solutions such as networked geothermal.

[34] Hybrid heating systems mitigate both electric peak and the need for large amounts of renewable gas. The reduction in electric system capacity needs and lower consumption of renewable gas lower ongoing monthly energy bills for customers. Hybrid heating systems also minimize upfront costs by reducing the need for costly building shell retrofits (i.e., building insulation and other measures that improve building energy efficiency) and by enabling installation of smaller heat pumps.

[35] E3 Customer Affordability Model, as described in Decarbonization Pathways Report, Appendix 3: Modeling Frameworks and Assumptions at 53.

[36] Massachusetts Energy Efficiency Program Administrators Quarterly Report, Fourth Quarter, 2021, section titled Bi-Annual Data, at 3 of 75. https://ma-eeac.org/wp-content/uploads/Quarterly-Report-of-the-PAs-2021-Q4-Final.pdf. (16,235 total ASHP - 2,933 total full ASHP replacements) / 16,235 total ASHP customers = 82% partial ASHP installations.

Figure 6. Estimated Average Total Monthly Energy Costs for Residential Customers that Utilize the Gas System ($/month).[37]



In further recognition of the unique needs across our service territory, National Grid acknowledges that there may be location and project-specific opportunities for non-pipe alternatives such as networked geothermal or targeted electrification. The Decarbonization Pathways Report identifies these non-pipe alternatives as "worth further research and development."[38] Therefore, National Grid's plan includes consideration of non-pipe alternatives – targeted electrification and networked geothermal – where feasible to consider, so that future gas system investments are made as cost-effectively as possible and stranded cost risks are minimized to the greatest extent possible. However, this will need to be done in a way that continues to prioritize public safety and reliability of our gas system as well as customer choice.

[37] National Grid figure using data from E3 Customer Affordability Model shown at 10-year increments, except for "100% Gas Decommissioning" which ends in 2045. "100% Gas Decommissioning" shows an upward arrow beyond 2045 since costs are expected to increase significantly as customer count approaches 0, while $6.6-$10.3 billion of embedded system costs remain. Figure 6 shows National Grid – Boston total cost of ownership for a Residential Pre-1940 Single Family home, which is the most common residential home typology in our service territory. Cost estimates show "Non-migrating" total cost of ownership (lower bound) for "100% Gas Decommissioning," "Interim 2030 CECP," "High Electrification," "Targeted Electrification," Low Electrification," and "Networked Geothermal" scenarios. Cost estimates also show a weighted average of "Migrating" and "Non-migrating" total cost of ownership (lower bound) for "Efficient Gas Equipment" and "Hybrid Electrification" scenarios weighted by the proportion of customers adopting the "Migrating" technology and those that do not. A weighted average is used in these scenarios because customers with both the "Migrating" and "Non-migrating" technology, namely efficient gas heating equipment, hybrid heating systems, and standard gas heating equipment, all use gas for heat.

[38] Decarbonization Pathways Report at 18.

National Grid's Plan Results in More Affordable Outcomes for Our Commercial and Industrial Customers, which creates economic development benefits for the Commonwealth

> *"We rely on natural gas for our entire business and tenants' heating system. We switched away from oil specifically to be more efficient. Removing access to natural gas would be detrimental to our business and the cost of changing our system again would put us under." – ERM Report, App. K.*

Analysis from the Decarbonization Pathways Report also shows that Commercial energy costs are expected to be lower for customers that utilize gas than customers that fully electrify through the mid-2040s.[39] This is driven by both lower gas equipment costs and a significant cost difference between gas and electricity rates on a per-energy-unit basis.[40] As a result, we anticipate lower hybrid or full electrification adoption within our Commercial customer base over the next few decades, even as larger amounts of renewable gas are incorporated. Industrial energy costs were not evaluated in detail by the Consultants, but given the relatively small number of Industrial customers and large diversity of energy profiles within this group, we expect net zero solutions for this group to be highly tailored to their specific needs. Maintaining a significant number of total customers on the gas network, whether through an efficient gas heater, a hybrid heating system, or a targeted all-electric solution such as networked geothermal – even if overall demand for gas reduces significantly – lowers the costs significantly for Commercial and Industrial customers to affordably achieve net zero.

National Grid's Plan Preserves Customer Choice for Heating and Cooking

> *"I believe no one should be forced to change their method of heating, cooking and water heating their home from their existing method to meet future government mandates. Any new technologies that develop to decrease greenhouse gases should be incorporated only into new installations with comparable savings." – ERM Report, App. K.*

National Grid's plan achieves the Commonwealth's net zero targets without strict requirements for customers to choose specific heating or cooking technologies. To achieve the Commonwealth's 2050 net zero targets in electrification-focused scenarios, the Decarbonization Pathways Report indicates that annual installations would have to be approximately 20 times higher than historical adoption rates by the end of this year and sustain these same high rates through 2030.[41] If this rapid increase is not achieved in time, reaching over 90% adoption of electric heat pumps by 2050 would require significant levels of early

[39] Decarbonization Pathways Report at 106 and E3 Customer Affordability Model.
[40] Decarbonization Pathways Report at 106 and based on data from the E3 Customer Affordability Model for National Grid - Boston. 2030 High Electrification Commercial electric rate is $5.77 / therm ($0.197 / kWh * 29.3001 kWh / therm), whereas 2030 Efficient Gas Equipment Commercial gas rate is $1.66 / therm.
[41] Decarbonization Pathways Report at 84 and 98, footnote 84. 80,000 homes / 4,000 homes adopting ASHP in 2019 = 20 times higher than 2019.

retirement of heating equipment, which National Grid estimates could be close to 50% of gas heaters. National Grid's plan allows for continued optionality for customers and achieves net zero targets without requiring rapid increases in electrification rates.

National Grid's Plan Reduces Emissions without Relying on Significant Changes to Customer Heating Equipment or Energy Infrastructure by Integrating Renewable Gas

National Grid's plan blends increasing amounts of renewable gas into the distribution pipeline, enabling emissions reductions without significant changes to existing infrastructure or customer behavior. Regardless of net zero pathway, all scenarios modeled in the Decarbonization Pathways Report rely on renewable gas by 2050, with the Efficient Gas Equipment scenario requiring roughly three times more renewable gas than the Hybrid Electrification scenario.[42] The Decarbonization Pathways Report also identifies biomethane as a "low-regret decarbonization technology" and renewable hydrogen as a decarbonization technology "worth further research and development."[43] Integration of renewable gas into the distribution pipeline can spur the development of this key decarbonization lever, regardless of pathway, and can deliver emissions reductions without significant infrastructure investment or customer disruption.

As mentioned above, National Grid's plan relies on a total volume of renewable gas that is similar to the "Hybrid Electrification" scenario. Combining the minimal infrastructure changes and conservative reliance on renewable gas, National Grid's plan is more likely to result in higher cumulative emissions reductions than electrification pathways that require significant infrastructure investment and changes in customer behavior.

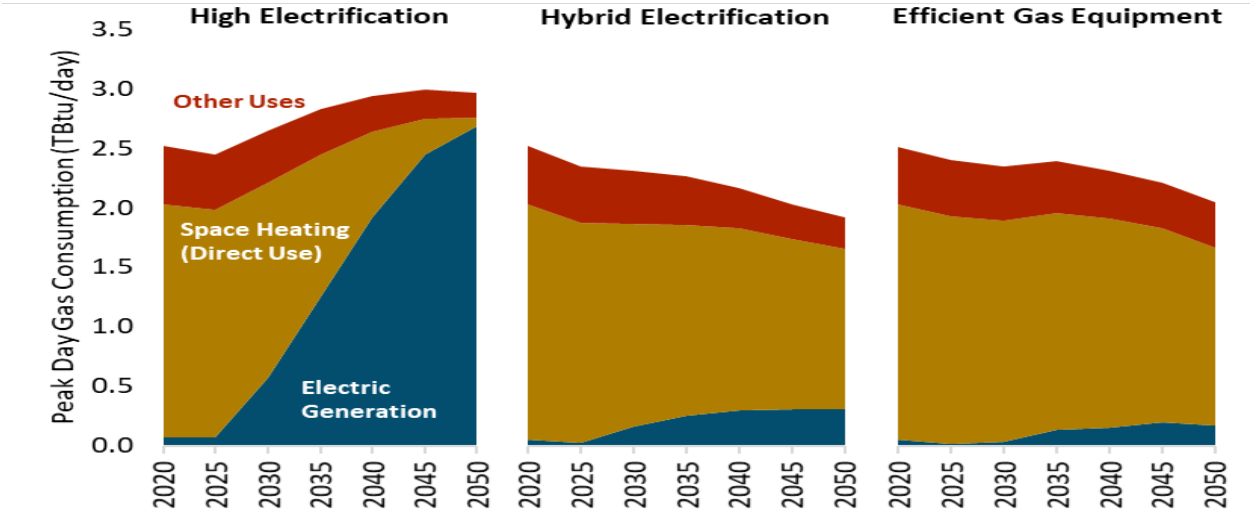
National Grid's Plan is More Likely to Provide Higher Energy System Reliability and Resilience by Utilizing Both the Gas and Electricity Systems

By relying on both the gas and electric system for heat decarbonization, National Grid's plan is more likely to maintain today's level of energy system reliability and provide more resilient energy delivery through 2050 and beyond. National Grid's plan supports reliability by reducing dependence on high gas volumes during peak times. The Decarbonization Pathways Report showed that by 2050, scenarios with high electrification may require approximately 50% more total gas volume on a peak day compared to scenarios that utilize the gas network for heat (Figure 8).[44] High electrification scenarios also require about 15% more gas volume than peak day gas consumption today. This increase in dependence on gas is due to the increase in electric system

[42] Decarbonization Pathways Report at 47 and 50.
[43] Decarbonization Pathways Report at 18-19.
[44] Decarbonization Pathways Report at 65.

dependence on renewable gas for firm capacity during these peak winter days, which could result in more renewable gas supplies being needed for the "High Electrification" scenario than for the "Hybrid Electrification" scenario during peak winter days.

Figure 7. Illustration of changes in peak winter day gas volumes for three decarbonization pathways. Total gas volumes include zero-carbon pipeline gas, including hydrogen. [45]



Additionally, National Grid's plan reduces overall electric capacity needs. LDCs currently serve around three times the peak demand of the electric network in Massachusetts[46] – an all-electric approach would require a **tripling** of ISO New England ("ISO NE") electric generation and significant build out of electric transmission and distribution.[47] If combustion-related resources were eliminated completely from the electric system for firm capacity requirements, E3's prior work found that ISO NE "would require 51 GW more renewables and 126 GW (710 GWh) more energy storage compared to an electric system using combustion as firm capacity."[48] This would be equivalent to a roughly seven-fold increase in electric system capacity compared to today.

Though the siting of this level of generation and transmission equipment will be challenging, there are even greater concerns for the feasibility of siting distribution equipment within our densely populated service territory. As the Decarbonization Pathways Report outlines, "LDC

[45] Decarbonization Pathways Report at 65.
[46] Assumes 2.5 Tbtu all gas LDC peak day gas volume (Decarbonization Pathways Report at 38), 22 GW ISO NE peak demand (Decarbonization Pathways Report at 54), and 46% MA average load share of ISO NE from 2016-2020, (ISO New England Annual Generation and Load Data for ISO NE and the Six New England States, September 28, 2021).
[47] Decarbonization Pathways Report at 60.
[48] Decarbonization Pathways Report at 61.

service areas with higher population density may be harder to cost effectively electrify, given the challenges associated with neighborhood-scale/group adoption dynamics and siting electric network infrastructure."[49] Given that our service territory shows significant distribution level capacity constraints today, we anticipate that these challenges would appear in the near-term with significant levels of electrification.

In addition to siting considerations, National Grid's plan alleviates time pressure to rapidly adapt electric reliability standards as electric loads change. The Decarbonization Pathways Report states that electric reliability "current standards have not been designed or rigorously evaluated in the context of an electric grid that serves the majority of transportation and space heating needs, in addition to other electric loads."[50] Balancing energy needs between both the electric and gas systems as demonstrated in National Grid's plan would decrease the rate of change and allow for more time to amend reliability standards as electric loads change.

Finally, National Grid's plan supports overall energy system resilience both by virtue of maintaining two energy systems and through the underground and seasonal storage capabilities of the gas network. The Decarbonization Pathways Report states that "studies have found that the gas network can support resilience in the energy system by offering features such as seasonal energy storage, underground infrastructure, and linepack."[51] Given the health and safety implications of maintaining heat service in our service territory, National Grid's plan utilizes the gas network to decarbonize heat in a way that results in overall higher reliability and resilience.

"A few weeks ago we experienced a severe Northeaster storm which resulted in no electric power for thousands of Massachusetts residents living on Cape Cod. For the better part of four days, we were unable to cook, unable to watch TV, no wi-fi, etc. The one positive note was our natural gas fireplace insert allowed us to stay warm when we needed the warmth. A few neighbors had almost full electric service since they could rely on a natural gas powered generator. Now just imagine if electricity was the only source of energy. It would have been a real disaster. This just underscores the need to have an alternative source of energy." – ERM Report, App. K.

[49] Decarbonization Pathways Report at 40.
[50] Decarbonization Pathways Report at 90.
[51] Decarbonization Pathways Report at 29.

National Grid's Plan Utilizes the Skill Set of our Existing Workforce to Decarbonize the Energy System

Finally, National Grid's plan leverages the skill set of our existing gas workforce, including a significant number of union workers, to achieve the Commonwealth's net zero goals. While quantification of workforce impact was out of scope for the Decarbonization Pathways Report, it noted the challenge of retaining knowledge and experience within the LDC workforce for scenarios with rapid electrification.[52] This experience is critical for ensuring the safe and reliable operation of the gas network throughout the energy transition. The Decarbonization Pathways Report also acknowledged the challenge of implementing workforce transition plans with rapid electrification of LDC customers.[53] Limited or moderate electrification supports both LDC operation and the ability to develop satisfactory training opportunities for individuals interested in transitioning to roles within the electric industry or alternative energy technology fields. National Grid's plan allows for more gradual electrification and continued high utilization of a decarbonized gas network that would allow the gas workforce to use their existing skill set to support the net zero transition.

IV. Building a Low-Carbon LDC Future: Regulatory and Policy Frameworks

The transformation of the energy system necessary to achieve net zero requires LDCs to evolve not only their fuels but their ways of working with customers and communities, recovering costs, and planning for a holistic, fossil-free energy future. Changes in customer heating technologies, when and how customers utilize the gas network, and the need to manage and fairly allocate costs associated with the transition in ways that ensure customer affordability will require our regulatory and policy frameworks to evolve as well.

The current regulatory framework under which gas LDCs operate developed from a historical premise of continued demand growth and infrastructure investment to serve that growth. The core regulatory objective is the provision of safe and reliable gas delivery service at just and reasonable rates. From a regulatory perspective, there is currently minimal, if any, interaction between gas and electric network planning, demand forecasting, and regulatory reviews.

To facilitate the transition to net zero, multiple reforms will be necessary. Regulatory frameworks will need to support utility cost recovery in a future characterized by declining demand, and enable planning based on consideration of both electric and gas system needs. LDCs will need regulatory clarity on cost recovery for new technologies, alternatives to traditional investments, and actions that can minimize the risk to customers who remain on the gas network.

[52] Decarbonization Pathways Report at 96-97.
[53] Decarbonization Pathways Report at 97.

The Company has identified a menu of regulatory and policy reforms as important next steps. While not all these reforms fit within the current scope of the Department of Public Utilities' ("Department's") authority, they are included to provide as complete a view as possible of how the LDCs can evolve their businesses to meet the Commonwealth's climate goals without compromising system safety, reliability or the reasonableness of customer rates.

Among this menu, there are two key steps the Department can and should take now which will result in meaningful GHG reductions in the near term on the existing gas network and make significant progress in reducing stranded cost risk:

- Enabling the procurement of renewable gas, including broadening the standards used to review LDC supply purchases to include non-fossil fuels such as RNG and hydrogen, and allowing for longer-term contracting to support project development; and
- Accelerating the recovery of depreciation expense to reduce the risk of long-term gas network affordability challenges.

In addition, the following regulatory and policy actions are critical to enabling LDC progress toward net zero and managing the cost of the Commonwealth's energy transition:

- Increasing energy efficiency investment and prioritizing building energy envelope improvements and adoption of heat pump technologies;
- Funding research, development and deployment activities that further gas network decarbonization;
- Developing regulatory frameworks to incent alternatives to traditional gas network investment; and
- Supporting and formalizing the LDC role in scaling geothermal investments.

We discuss these actions in more detail below, as well as in the Regulatory Framework

Finally, we address additional regulatory items raised in the Regulatory Designs Report that in the Company's view are best advanced in future proceedings and policy discussions. These include rate design, decoupling, and the potential broader socialization of net zero transition costs.

Enabling the Procurement of Renewable Gas Supply Alternatives

The Decarbonization Pathways Report found that LDC utilization of low-carbon or zero-carbon fuels such as RNG and hydrogen will facilitate meeting the Commonwealth's climate goals.

How use of 100% Renewable Gas will assist in achieving Net Zero

National Grid's plan for 100% renewable gas will rely on using a mix of RNG and hydrogen. RNG is pipeline-quality biomethane produced from biomass or biogas. Biogas is a renewable energy; it is created as a direct result of transforming organic waste using anaerobic digestion. RNG is carbon neutral because it is captured methane from animal or food waste or other biomass sources that otherwise would have entered directly into the atmosphere, but instead is combusted. Combustion of RNG from organic sources results in the release of greenhouse gases that have *at least 20 times less global warming potential* than if the methane from those organic sources had been released directly into the atmosphere.[54] In simple terms, the use of RNG represents the recycling of carbon that is already circulating in the environment, in contrast to the combustion of fossil fuel that releases new carbon emissions that were previously sequestered in the earth. For this reason, RNG is considered to have net-zero emissions.

Therefore, RNG provides two distinct GHG emissions benefits: 1) the benefit associated with the destruction of upstream methane already in the environment that when combusted is less potent; and 2) the benefit associated with displacing fossil natural gas with a biogenic carbon source that is already part of the natural carbon cycle: the carbon emissions that result with RNG use is carbon that already is in or would be released into the atmosphere. Additionally, RNG is interchangeable with natural gas in existing gas pipelines and is fully compatible with existing infrastructure.

Much of the RNG that enters the gas system comes from dairy farming, wastewater treatment plants, food waste, landfills, and other sources that produce methane naturally as part of their operations. Methane is a potent greenhouse gas, about 28 times more powerful than carbon dioxide over 100 years and 86 times more powerful over a 20-year timeframe. By finding an alternate use for this methane, it provides local farming communities, municipalities, and other public entities an economically viable way to reduce their greenhouse gas emissions while displacing fossil fuels, and helping the state meet its climate goals. Analysis supports the value of RNG in reducing building sector emissions. For example, MJ Bradley and Associates found that RNG used to heat a home and fuel residential appliance will provide GHG benefits compared to using electricity today and far into the future, even when the grid becomes 75% zero-emitting.[55]

The Company appreciates the interest of stakeholders, regulators, and policymakers in ensuring that any frameworks to support RNG procurement provide clarity on accounting for and

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[54] "Basic Information About Landfill Gas" United States Environmental Protection Agency, https://www.epa.gov/lmop/basic-information-about-landfill-gas

[55] MJ Bradley & Associates. Renewable Natural Gas: Potential Supply and Benefits. Renewable Natural Gas Issue Brief Part III of IV. July 2019. https://www.mjbradley.com/sites/default/files/RNGSupplyandBenefits07152019.pdf.

attributing emissions reductions. To that end, the Company is committed to collaboration with the Massachusetts Department of Environmental Protection and other interested stakeholders to develop frameworks that support such accounting.

Enabling renewable gas supply and procurement

The Regulatory Designs Report notes that LDC's abilities to use these renewable fuels is limited by both the size of supply and the current structure of Department planning and procurement models.[56] To address these issues, the Regulatory Designs Report suggests that:

- A requirement be set for use of minimum levels of fossil alternatives; and
- LDCs develop customer supply service offerings which use fossil alternatives.

Low-carbon and zero-carbon fuels – alternatives to the traditional, fossil gas used today – provide an opportunity to make immediate progress toward advancing the Commonwealth's climate goals utilizing existing network infrastructure and without changes to customer-end use appliances. Incorporating even modest proportions of fuels such as RNG and hydrogen can lead to significant emission reductions across our gas networks. In Massachusetts, if sellers of natural gas were to replace just 5% of existing natural gas sales with RNG by 2030, this would result in a 5% reduction in annual GHG emissions, equaling more than 1.1 million metric tons of CO2-equivalent reductions per year, roughly the same as the annual emissions of 240,000 light-duty vehicles.[57]

Moreover, supplies of RNG and hydrogen can scale to cost-effectively help decarbonize heating alongside electrification policies. RNG supply in the US is growing, and volumes necessary for the Northeast could be achieved through RNG procurement from supply resources across the Eastern US at pro-rata levels equivalent to our region's share of the eastern US supply of geologic gas. As described later in this section, multiple utilities are offering their customers the option to purchase fossil alternative such as RNG.

In a similar way, the production of renewable hydrogen can scale to supply a large proportion of the region's heating need, reaching at least a 20% blend of today's gas volumes.[58] In-region production of renewable hydrogen can complement the planned build-out of offshore wind in the Northeast. With its announced Hydrogen Energy Earthshot, the US Department of Energy has set a goal of getting the costs of hydrogen to $1 per $1 kg within one decade.[59] Along with the

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[56] Regulatory Designs Report at 14.
[57] Emission reduction estimate assumes RNG is considered GHG-neutral, consistent with the Consultant Report, Appendix 1 at 27-28. Actual emissions reduction value could depend on mix of RNG feedstocks.
[58] Decarbonization Pathways Report at 50. 7% hydrogen by energy = 20% hydrogen by volume
[59] https://www.energy.gov/eere/fuelcells/hydrogen-shot

federal investments in hydrogen as part of the recent Infrastructure Investment and Jobs Act, it is clear hydrogen is expected to play a major part of a net-zero energy economy.

The Columbia Center on Global Energy Policy ("CGEP") recently analyzed pathways to decarbonizing the natural gas pipelines, and found that in the scenarios presented in the Princeton Net-Zero America study, hydrogen systems begin expanding substantially starting in the mid-2030s, reaching total hydrogen volumes in 2050 of 60 million tons or six times hydrogen production in the US today.[60] As CGEP noted, this is below what the US would need for a fully hydrogen-based economy but still enough to serve 14 percent of the total US energy demand. Moreover, the extent to which the US can ramp up hydrogen production through 2040 will depend on whether policies are in place to support it.

To fully achieve the benefits of decarbonized fuels in advancing the Commonwealth's climate goals, both regulatory mechanisms and market-based policy solutions requiring legislation will be needed.

First and foremost, National Grid and the LDCs need authorization to develop an RNG procurement program and engage in competitive solicitation processes for RNG. As described in the Regulatory Framework, we along with the LDCs, **propose that the Department expand its current least-cost procurement standards to allow consideration of the societal benefits of offering decarbonized fuels to customers.** Each LDC would still need to obtain approval of any RNG contract, including the evaluation of the environmental benefits provided by RNG.

LDCs also need to provide options for customers to purchase decarbonized fuels from gas suppliers which could **enable customers to elect a higher proportion of clean heating fuel based on their own climate goals or obligations** under state policy through voluntary green gas tariffs. This program would allow customers purchase RNG to meet all or a portion of their energy needs, providing further customer choice tailored to the customer's individual needs, goals, and means. Doing so will allow LDCs to reduce the emissions of the energy delivered by its networks and reduce customers' carbon footprint of their thermal energy use while they use their existing gas equipment.

However, one of the biggest challenges for the development of fossil gas alternatives mirrors one of the biggest challenges we faced in decarbonizing the electric system: project developers' inability to form long-term offtake agreements for projects that have useful lives of 20 years or

[60] CGEP Investing in Natural Gas Pipelines report, April 2021 at 36. Columbia | SIPA Center on Global Energy Policy | Investing in the US Natural Gas Pipeline System to Support Net-Zero Targets.

more. This creates an unstable, high value but short-term market for RNG developers. To create a stable market, reduce developer risk, and lower prices, National Grid recommends the Commonwealth put in place a renewable heating fuel standard ("RHFS") that requires sellers of natural gas to procure a growing proportion of their supply from qualifying fuels such as RNG or low-carbon hydrogen. Similar to the renewable portfolio standards ("RPS") used by Massachusetts and other states[61] to scale investment in wind and solar energy resources, this policy would increase production of RNG and hydrogen. By establishing demand requirements for electricity produced from renewable sources, RPS policies have resulted in increased production of wind and solar energy across the country – for example. Lawrence Berkeley National Labs found that roughly half of all growth in U.S. renewable electricity ("RE") generation and capacity since 2000 is associated with state RPS requirements and that for particular regions, including the Northeast, RPS policies have remained a dominant driver for RE growth.[62] An RHFS will create similar results for low-carbon and zero-carbon fuels.

Recognizing the important role RNG and other renewable fuels can play in lowering greenhouse gas emissions from customers' natural gas usage, a number of states have advanced regulatory and policy mechanisms intended to support the role of decarbonized heating fuels in advancing emissions targets. Selected state efforts are summarized below in Table 1.

Table 1. Summary of state efforts to advance RNG and other renewable fuels

State	Description
California	CA Public Utilities Commission required to establish biomethane procurement targets.[63] Proposed Decision issued by California Public Utility Commission on February 18, 2022 would require California gas utilities to procure, by 2030, 12 percent of 2020 core customer natural gas demand, creating a total 2030 annual market for RNG of approximately 72.8 BCF of gas statewide.[64]
Colorado	In June 2021, enacted into law Senate Bill 21-264 to advance Colorado's goal to reduce GHG emissions from gas distribution utilities by requiring gas distribution utilities ("GDUs") to implement clean heat plans which demonstrate the GDU's strategy to meet specified clean heat targets. The law defines a clean heat resource

[61] Thirty states and the District of Columbia currently have renewable portfolio standards in place.
[62] U.S. Renewables Portfolio Standards, 2021 Status Update: Early Release, by Galen Barbose (Feb. 2021) on behalf of Lawrence Berkeley National Laboratory; the report and supporting materials can be found at rps.lbl.gov
[63] CA Pub Util Code § 650 & 651 (2020).
[64] California Public Utilities Commission, updated Proposed Decision of Commissioner Rechtschaffen on "Decision Implementing Senate Bill 1440 Biomethane Procurement Program" Rulemaking 13-02-008 (February 18, 2022).

	as including gas demand side management programs, recovered methane, green hydrogen, and beneficial electrification.[65]
Illinois	Illinois Commerce Commission approved proposal of Nicor Gas Company to offer a program called "TotalGreen" to provide Nicor Gas customers with a way to offset the environmental effects of their natural gas use through the acquisition of environmental commodities, including RNG environmental attributes. The TotalGreen program will offer two primary blended options to customers: a product that includes a higher proportion of RNG credits (between 5% and 20%, with the remaining balance from carbon offsets). Participating customers will pay higher price for environmental commodity acquisition with no impacts to non-participating ratepayers.[66]
Maine	Maine Public Utility Commission approved the voluntary RNG attribute program of Summit Natural Gas of Maine, Inc. that provides the option to residential and small-commercial customers of purchasing enough RNG attributes to offset 10%, 25%, 50%, or 100% of their average monthly natural-gas usage. The monthly cost would equal Summit's costs to acquire the attributes.[67]
Michigan	Michigan PSC approved a voluntary emission offset program (VEOP) that modified the DTE Gas Company BioGreenGas program approved in 2015 that had allowed DTE to charge an additional $2.50 monthly fee to offset premium price of RNG: The new approved VEOP pilot program enables residential customers to offset all or a portion of their natural gas usage by purchasing blocks and paying a commensurate monthly fee - 95% of emission reductions would be from carbon offsets and 5% of emission reductions will be from RNG.[68]
Minnesota	Passed Natural Gas Innovation Act in June 2021 that allows a natural gas utility to submit an "innovation plan" for approval by the Minnesota Public Utilities Commission. An innovation plan could propose the use of renewable energy resources and innovative technologies such as: (1) renewable natural gas (2) renewable hydrogen gas (3) energy efficiency measures and (4) innovative technologies that reduce or avoid greenhouse gas emissions[69]

[65] http://leg.colorado.gov/sites/default/files/2021a_264_signed.pdf

[66] Illinois Commerce Commission Order in "Northern Illinois Gas Company d/b/a Nicor Gas Company Proposed general increase in rates and revisions to other terms and conditions (tariffs filed January 14, 2021" docket 21-0098 at 126 (November 18, 2021).

[67] State of Main Public Utility Commission Docket No. 2019-00116, "Order Approving Stipulation, Summit Natural Gas of Maine, Inc. Requests for Approval of New Tariff Sheets for Voluntary Renewable Natural Gas Attribute Program" (October 28, 2019).

[68] Michigan Public Service Commission Order I "In the matter of the request of DTE Gas Company seeking authority to amend its voluntary BioGreenGas program and implement a new voluntary renewable gas program pilot" Case No. U-20839 (October 29, 2020).

[69] SF 421 "A bill for an act relating to energy; establishing the Natural Gas Innovation Act; encouraging natural gas utilities to develop innovative resources; proposing coding for new law in Minnesota Statutes, chapter 216B.

Missouri	Enacted law effective as of August 28, 2021 requiring the Public Service Commission to adopt rules for gas corporations to offer a voluntary RNG program with prudent, just, and reasonable costs to be recovered by an automatic adjustment clause.[70]
Nevada	Requires the Commission to adopt regulations authorizing utilities that purchase natural gas for resale to engage in RNG activities and directed these natural gas utilities to incorporate 1% of RNG into their supply by 2025; 2% by 2030; and 3% by 2035.[71]
Oregon	Oregon Public Utility Commission required to adopt by rule a RNG program for large and small natural gas utilities.[72] In 2020, the Oregon Public Utilities adopted regulations establishing a RNG procurement process and standards, targets, and limits for large and small natural gas utilities in procuring RNG. [73]
Utah	Public Service Commission approved Dominion's GreenTherm program, a voluntary program that provides Dominion Energy Utah natural gas customers an opportunity to support clean RNG. Customers can elect to have a number of units, known as "blocks," or five therms, of RNG added as a surcharge to their monthly gas bill, and Dominion Energy then purchases "green attributes" (credits associated with the production of RNG) on the customers' behalf. The voluntary monthly surcharge for one block was set at $5 and would be the minimum monthly surcharge.[74]
Vermont	Vermont Public Utility Commission approved RNG program for Vermont Gas Systems produced from agricultural waste, manure, municipal waste, plant material and compost, that will allow retail customers to choose to buy RNG in amounts equal to 10%, 25%, 50%, or 100% of their total monthly requirements.[75]
Washington	Requires gas companies to offer by tariff a voluntary RNG service to all customers to replace any portion of the natural gas provided by the gas company.[76]

https://www.revisor.mn.gov/bills/text.php?number=SF421&version=latest&session=ls92&session_year=2021&session_number=0

[70] HB734, Renewable Natural Gas (Section 386.895) signed on July 6, 2021, https://www.senate.mo.gov/21info/bts_web/bill.aspx?SessionType=R&BillID=64882351.

[71] NV SB 154 enacted June 2019.

[72] 2019 Senate Bill 98, ORS 757.390 to 757.398.

[73] Oregon Public Utility Commission Order, "In the Matter of Rulemaking Regarding the 2019 Senate Bill 98 Renewable Natural Gas Program" (July 16, 2020).

[74] Utah Public Service Commission, Docket No. 19-057-T04, "Order Approving Settlement Stipulation" on Application of Dominion Energy Utah for the Creation of a Voluntary Renewable Natural Gas Program (July 30, 2019).

[75] Vermont Public Service Commission Order on "Petition of Vermont Gas Systems, Inc. for a renewable Natural Gas Program and Optional Tariff" (September 6, 2017).

[76] RCW 80.28.390.

Accelerating Recovery of Depreciation Expense

Managing and fairly allocating gas network costs – particularly between present and future gas customers, a principle known as intergenerational equity – will be a critical part of ensuring an affordable transition that minimizes the risk of stranded gas network assets. Any pathway to a net-zero heating sector that involves reductions in annual gas demand will create challenges for LDC cost recovery across time and intergenerational equity, though the magnitude of these challenges vary across scenarios. The Regulatory Designs Report notes that, as customers depart the gas system, they will avoid paying their share of the costs of system investments that were made to serve them, creating challenges to affordability for customers remaining on the gas network, as well as a mismatch between utilization of the system and the current approach of recovering embedded network costs based on the useful lives of network assets.[77]

As with the electric network, investments in gas pipelines are made to serve a peak demand. The costs of these investments are recovered incrementally over the life of the asset through depreciation expense that is included in the LDC's revenue requirement, which is then recovered from customers through a combination of fixed and volumetric charges. As the number of customers and the nature of their gas demand changes, those customers who continue to rely primarily on natural gas for heating use may over time become responsible for maintaining a system intended to serve a greater number of customers with higher overall demand. This risk also exists in any scenario where annual gas throughput declines. For example, customers that install heat pumps and use the gas furnaces only for back-up heat will contribute less to the recovery of depreciation expenses over time; customers who cannot, or choose not to, install dual-fuel heating systems will end up bearing a disproportionate share of these depreciation expenses.

In response, the Regulatory Designs Report suggests creating new depreciation schedules for gas assets that better align the collection of depreciation expense with the level of customer gas use – for example, an option that ties depreciation schedules to the utilization rates of gas assets. The Regulatory Design Report notes that this approach helps address concerns related to unrecovered rate base as customers leave the system and, in doing so, helps to mitigate affordability and equity concerns. [78]

National Grid agrees with this recommendation. Under any decarbonization pathway, new depreciation expense recovery schedules should be explored to ensure that a smaller number of customers are not bearing a disproportionate share of overall depreciation expense in the future.

[77] Regulatory Designs Report at 31.
[78] Regulatory Designs Report at 39.

Further, there is value in beginning to accelerate recovery of depreciation expense now to most effectively balance the traditional principles of intergenerational equity, cost causation, and avoidance of rate shock, while maintaining near-term affordability. If the collection of depreciation expenses is accelerated early and sustained over time, then even relatively modest increases in depreciation expenses recovered would allow for significant reductions in future bill impacts and in undepreciated rate base by 2050.

Similar analysis by various non-profits including the Environmental Defense Fund ("EDF"), Gridworks, and the Regulatory Assistance Project ("RAP") has arrived at similar conclusions. EDF found that accelerated depreciation is among the preferred cost recovery tool because it brings forward recovery when appropriate and connects it to the demand of the gas system as the gas system was sized to due to certain demand.[79] If gas supply or customer count is lower in the future, then depreciation expense should be lower in the future. Moreover, EDF's study found that accelerated depreciation can minimize ratepayer and investor risk while avoiding large rate shocks.[80] Likewise, Gridworks recommends the acceleration of depreciation schedules because, while customer rates would rise in the short-term, this approach would save customers money in the long term. Finally, RAP concluded that utilizing accelerated depreciation will be an effective way to lower an LDC's rate base. As others did, RAP deduced that while this approach will cause modest rate increases in the short-term, it will result in lower rates in the future. All three conclude that one of the major benefits of accelerating recovery of depreciation expense is the reduction in rate increase risk to remaining gas customers in the future.[81]

National Grid understands that accelerating the recovery of LDC depreciation expenses will lead to short-term increases in customer bills. In our view, this is even more reason to act quickly. Those short-term bill impacts will be reduced if additional funds to pay depreciation expense can begin sooner rather than later. Any resulting bill increases will then be spread over a larger number of years and customers, lowering the average customer bill impact. For example, beginning to accelerate depreciation in 2025 versus 2030 would provide an additional five years over which to spread the short-term bill increases from accelerated depreciation, which will help keep these short-term increases more affordable to customers.

In National Grid's most recent gas rate case (D.P.U. 20-120), National Grid evaluated shortened depreciation timelines to recognize the impacts of decarbonization through shorter service lives

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[79] *Managing the Transition, Proactive Solutions for Stranded Gas Asset Risk in California*, by Environmental Defense Fund (2019) https://drive.google.com/file/d/1V4GZAe0hN8r9Eua4VESWlKpA4sQ699hL/view.

[80] Managing the Transition at 29-30.

[81] Anderson, M., LeBel, M., & Dupuy, M. (2021, May). *Under pressure: Gas utility regulation for a time of transition*. Regulatory Assistance Project.

for certain accounts, namely Account 367.00 (Mains), Account 369.00 (Measuring and Regulating Station Equipment), and Account 380.00 (Services), and proposed depreciating over shorter service lives for these accounts. The Company's depreciation expert witness also modeled several different gas consumption scenarios including accelerated depreciation using the "sum of the years digits" methodology.[82] The Department did not approve the Company's shorter service lives proposal, noting it was premature in light of the ongoing D.P.U. 20-80 proceeding and that the Department "anticipates that future capital spending and related depreciation issues will be discussed in that [D.P.U. 20-80] proceeding as part of broader policy decisions affecting LDCs."[83]

Given the Department's order and the findings in the Regulatory Designs Report that supports the affordability benefits of acting quickly and gradually to accelerate recovery of depreciation expense,[84] the Company is proposing the collection of a **Depreciation Advance Contribution** as part of the Net Zero Enablement Plan Model Tariff to begin collection from current gas customers of funds that can be applied to offset future depreciation expenses.[85] The Company proposes that this contribution would be calculated as 5% of the Company's annual depreciation expense for Account 367.00 (Mains), Account 369.00 (Measuring and Regulating Station Equipment), and Account 380.00 (Services). As the Company noted in D.P.U. 20-120, these accounts have relatively long lives that are most likely to be affected by decarbonization and reductions to gas demand.[86] The funds collected through this contribution would be used to offset increases in base rates in the Company's next rate case, in which the Company will propose depreciation schedules reflective of the impact of decarbonization initiatives. Since the Company's next rate case is in four years (i.e., for rates effective October 1, 2026), a modest increase in customer bills commencing upon the effective date of the Company's Net Zero Enablement Plan tariff will

[82] See D.P.U 20-120, Exhibit NG-NWA-1 (Ned Allis Direct Testimony), at 29-30.
[83] National Grid, D.P.U. 20-120, at 244, note 119 (2021).
[84] The Regulatory Designs Report at 40 states "[i]n the near term, the UOP depreciation method raises rates, which improves the economics for customers considering electrification. The increased electrification may create additional burdens for those customers who remain on the gas system. One option to address the rate impact concerns is to phase-in over time the higher depreciation rates." The Company is proposing the Depreciation Advance Contribution to limit the potential bill impacts over time of accelerating recovery of depreciation expense.
[85] The Company is proposing the Depreciation Advance Contribution in accordance with Section 2.6 of the Model Net Zero Enablement Tariff that provides: "Depreciation expense associated with gas infrastructure at the end of the test year in the Company's last base distribution rate case, as adjusted by the provision of its Performance-Based Ratemaking Plan, as applicable, is recovered through the base distribution rates and may be appropriate for acceleration to mitigate future impacts on customers arising from the implementation of NZEP initiatives. Accelerated depreciation expense, or contributions thereto, may be recoverable where first presented to the Department for specific review and approval by the Department."
[86] See D.P.U 20-120, Exhibit NG-NWA-1 (Ned Allis Direct Testimony), at 31.

support a path toward long-term gas network affordability, particularly for low-income customers.[87]

Coordinating Gas and Electric System Planning

The Regulatory Designs Report identifies improved coordination of gas and electric system planning as a potential approach to help mitigate the risk of stranded assets, and to support system reliability and resilience. The need for coordinated electric and gas planning is also referenced by key advocates in their recent analyses of potential updates to gas utility regulatory frameworks to support climate goals.[88] EDF, for example, notes that coordinating planning across the energy networks is necessary to look at the impact changes in demand will have on electric generation dispatching and resources, how electrification will impact gas networks investment and demand, and how best to find "the right low-cost, low-carbon" solutions for customers.[89]

A number of planning considerations must be addressed as part of the transition as the Department balances its mandate to consider the greenhouse gas emissions impacts of activities it approves in light of the Commonwealth's net zero targets with its responsibility to ensuring safe, reliable, and affordable energy service.

First, the Department should work with the LDCs and stakeholders to evolve its current long range planning process, intended to ensure that customer requirements can be served reliability over five-year planning horizons using approved forecasts, to reflect consideration of decarbonization goals and the expectation that long-term gas demand will be reduced under all pathways. The rate at which customers adopt potential heating technologies complicates forecasts of future demand, and specifically, the timing of an inflection point in gas demand. The Department and LDCs will need to evaluate how to most effectively integrate forecast uncertainty introduced by potential decarbonization policy outcomes into supply planning processes and how forecasting methodologies can be efficiently updated over time to ensure that they keep pace with the transition. The evolution of the long-range planning process should also consider the impact of climate change on annual and peak gas demand, the level of geographic granularity and conservatism used in forecasting and planning, and the planning horizon. As an early step to evolving the current long-range planning process, we recommend that the Department convene a technical session with the LDCs to explore forecasting amidst demand uncertainties related to the net zero transition.

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[87] Low-income customers unable to participate in decarbonization programs are likely to spend an increasing higher share of their income on energy. Decarbonization Pathways Report at 103.

[88] EDF, reports; "Gas Regulation for a Decarbonized New York," Synapse Energy Economics Inc, prepared for the Natural Resources Defense Council (June 2020) at 10.

[89] "Aligning Gas Regulation and Climate Goals: A Road Map for State Regulators," EDF (Jan. 2021) at 23.

National Grid's Downstate New York (DNY) Distributed Infrastructure Solution: In DNY, in response to a gas capacity constraint emerging in the near-term and growing thereafter, National Grid's 'Distributed Infrastructure Solution' is a portfolio of demand-side programs and targeted infrastructure enhancements to meet our customer's energy needs. After extensive internal analysis and evaluation of available supply, infrastructure, and demand-side options, National Grid determined a portfolio of incremental energy efficiency and demand response programs, along with enhancement projects that expand the capacity of existing gas infrastructure, best balanced cost, reliability, and feasibility to address the projected gap between customer gas demand and available supply. We tested this solution against a net zero demand projection that assumes aggressive new policies are adopted under New York's Climate Leadership and Policy Act that slow, stop, and reverse the projected growth of gas demand. We believe that this Solution is consistent with New York's and National Grid's net zero goals, meets our near-term customer gas demand growth, and offers the flexibility to right size National Grid's gas capacity portfolio over time.

Second, the LDCs and the Department should collaborate on the best ways to support LDC alternatives to traditional infrastructure to meet short-term demands for increasing supply without jeopardizing the long-term need to reduce demand. This should include broadening the suite of solutions available for LDCs to solve supply-demand imbalances by enabling LDCs to consider distributed infrastructure solutions, geographically targeted, non-programmatic demand-side management solutions, and limitations on customer connections in addition to traditional supply options. Any solutions put forward by LDCs should be tested against the Commonwealth's net zero targets and an LDC's responsibility to ensuring safe, reliable, and affordable energy service. National Grid's Distributed Infrastructure Solution in New York, discussed in the accompanying text box, provides a valuable example of a process that has enabled balancing our obligation to provide safe, reliable, and affordable energy service to our customers with state and corporate net zero goals. Similar holistic approaches for meeting customer energy needs that leverage supply, infrastructure, and demand-side options should be considered critical tools for the Commonwealth while uncertainties remain around when gas demand will begin to decline on the path to net zero. Such solutions will be crucial to ensuring an affordable, no-regrets transition to a net zero energy system.

Third, coordinated system planning across gas and electric utilities will be needed to promote the most efficient gas and electric system investments, assess potential areas for targeted electrification, and ensure that customer heating needs can be served reliably throughout the transition. Such coordinated planning can help to enable cost minimization and efficient deployment of solutions by supporting an understanding of the relative costs of serving segments

of customers through electric and gas. [90] As the Department has recognized, it is essential that utilities continue to take a long-term view to ensure long-term reliability for customers given the complexities in siting and constructing prudent energy system investments, as well as the potential implications of climate change.[91] The Department, especially, is tasked with ensuring long-term energy system security, including assessing long-term gas and electric system demands, capacity, and facility investments.[92] As an early step to enable coordinated planning across the Commonwealth, LDCs should pilot coordinated planning on one or more sections of their gas networks. Evaluation of potential locations should consider opportunities to prioritize delivery of efficiency and clean heat solutions to low-income or environmental justice communities among the criteria used for selection.

We recognize that such coordination will be most straightforward when a single utility provides both gas and electric service in a given location. We know too that individual LDC vary in the level of analytical resources available to advance such planning. These considerations will impact the timeframe for advancing coordinated planning. For these reasons, rather than propose a specific approach to coordinated gas and electric planning, or specific pilot requirements for coordinated planning, we propose that LDCs be expected to demonstrate progress in advancing coordinated gas and electric planning as part of their Net Zero Enablement Plans, including discussion of how non-pipe alternatives such as targeted electrification have been evaluated as part of this effort.

Increasing Energy Efficiency Investments

Energy efficiency will continue to play a key role in decarbonizing Massachusetts and is a core component of National Grid's proposed plan and our overall vision for a net zero future.

National Grid, and all the LDCs, have a proven record of delivering energy efficiency programs to Massachusetts' gas and electric customers. Massachusetts utilities have successfully run energy efficiency programs since the 1980s and the State has been ranked as one of the most efficient states by American Council for an Energy-Efficient Economy ("ACEEE") for the last 10 consecutive years. By adding electrification incentives to these energy efficiency models in starting 2019, utilities have decarbonized buildings more holistically and economically. National Grid is committed to working with stakeholders, the other Program Administrators ("PAs"), and our regulatory partners to undertake the energy efficiency expansion needed to make progress toward net zero. As discussed below, such collaboration will be needed to ensure that sources of outside funding are increased and program targets set to ensure that customer bill impacts

[90] Under Pressure: Gas Utility Regulation for a Time of Transition (raponline.org); As RAP notes, such coordination can help to identify potential gas network savings or areas where electrification may be challenging (see footnote 39).
[91] D.P.U. 20-75 at 29 (FN3).
[92] M.G.L. c. 164, § 69I.

remain manageable. In addition, expanded focus on providing access to low-income and environmental justice populations will be essential.

By 2050, we expect building heating energy efficiency improvements of at least 30% on average across our gas network by 2050 through a combination of efficient heating equipment, thermal retrofits and new construction. In addition, the adoption of heat pump technologies for heating and cooling purposes will have to increase dramatically in the next 10 years.

The Decarbonization Pathways Report states that incentives like those that energy efficiency PAs currently manage help facilitate customer migration to more efficient and decarbonized buildings. This is especially the case during the earlier ramp up periods of scenarios where customer migration is not as significant. However, the Decarbonization Pathways Report notes that current incentives are likely insufficient to facilitate migrations on the scale and pace of the most aggressive customer migration scenarios. In addition, the Regulatory Designs Report found that there may be adverse impacts if electrification adoption is funded solely from utility rates. This adverse impact also has the potential to disproportionately impact EJ communities.

Specifically, the Decarbonization Pathways Report finds that 5 of the 8 pathways analyzed reach 1 million electrically heated homes by 2030, through a combination of electric resistance heating, ASHPs, GSHP and Hybrid Heat Pumps, a level that implies an annual average conversion of 80,000 homes per year.[93] Converting 80,000 homes per year to heat pumps would equate to incentive costs of $320 million per year of support at current incentive levels of $4,000 per home. Achieving the level of growth and market penetration required to get to 80,000 homes per year would require currently unknown increases in incentives. Additionally, higher incentives would be required for income eligible, and, potentially, moderate income customer segments to make these conversions economically feasible.

To meet any aggressive building decarbonization and electrification targets needed for Massachusetts to achieve its climate goals, the funding mechanisms for energy efficiency will need to be expanded. The current model of energy efficiency programs puts the cost burden on the electric and gas customers. While this model worked well in the past, as building upgrade and conversion strategies become more aggressive, additional outside funding will be needed to continue the proven success of Massachusetts' building efficiency and decarbonization programs. In the near term, National Grid is exploring multiple pathways to access additional funding streams in support of delivering benefits to customers at the lowest possible bill impact. At the federal level, this includes coordinated efforts with stakeholders to explore potential direction of funds under the American Rescue Plan Act of 2021 toward support of energy efficiency efforts. In addition, the National Grid is currently evaluating federal funding

[93] Decarbonization Pathways Report at 84 and 98.

possibilities through the Infrastructure Investment and Jobs Act ("IIJA") and will pursue funding opportunities that align with the efficiency programs where practicable. National Grid is also considering how to leverage federal funding for affordable housing and projects in Gateway Cities to support energy efficiency, as well as how to work with schools or others within the education sector who may receive federal funding directly yet may need support to identify and implement projects.

In addition to expanding funding sources, program design and implementation must ensure that customer bill impacts of efficiency programs remain reasonable. This will require setting program targets in a way that balances the level of ambition necessary to make rapid progress toward decarbonization with allowing for the market developments (i.e., customer education, installation contractor training and workforce development investments, distribution network development) necessary to support sustained market transformation. Further, to ensure stable bill impacts, energy efficiency plans must find innovative ways to reduce customer acquisition and program delivery costs to make room for incentivizing more expensive technologies and increasing incentives for moderate income customers.

Finally, ongoing close attention will need to be focused on low-income and EJ communities. National Grid is steadfast in its commitment to ensuring equitable access to our energy efficiency programs for all customers and specifically, increasing the participation of hard-to-serve residential, commercial, and industrial customer segments. Program designs will need to continue to consider and evaluate equity goals and consider the systemic and institutional structures that may make it easier for some customers to access energy efficiency products and programs but more challenging for others to do so. We will continue to work on advancing access to vulnerable customers and work proactively to think about how energy efficiency solutions can help these customers limit their energy costs as we advance the transition to net zero.

Funding Net Zero Technologies Research, Development and Deployment Activities

The Consultants found that demonstration of new technologies, operating practices, services and/or business models is a necessary part of advancing any of the decarbonization pathway scenarios described in the Decarbonization Pathways Report. The Decarbonization Pathways Report identified a number of specific technologies, including: hydrogen blending; power-to-gas; networked geothermal; biomass gasification; carbon capture and hybrid electrification

systems.[94] However, the Consultants noted that both pilots and initial procurements are needed to better understand and advance scalability of these technologies in Massachusetts.[95]

Moreover, achieving high levels of electrification is going to require large-scale transformation of customer end-use and community or neighborhood scale coordination of decarbonization decisions and investments. The extent to which transformations can occur at that scale is uncertain.[96] In addition to exploring the technical feasibility aspects, as discussed in the next section, National Grid and the LDCs will need to investigate practical, logistical implementation guidelines, customer service solutions, and participation terms for projects that entail multiple customer coordination.[97]

The Regulatory Designs Report identifies the need for new regulatory guidance for review for pilot approval as well as cost recovery mechanisms that support deployment of innovative electrification and decarbonized technologies. [98] National Grid agrees that exploring and testing new, low-carbon technologies in the early stages of evaluation, development, and adoption (including networked geothermal) will facilitate meeting the Commonwealth's climate goals. If demonstration projects are insufficiently funded, regulators and stakeholders could lack visibility into key projects directed at decarbonization and evolution of gas networks, limiting a shared view of where innovation is occurring, what is being learned, and where the greatest opportunities exist to accelerate progress. Necessary innovation could proceed too slowly to meet climate targets and customer and stakeholder expectations.

As a result, National Grid recommends the Department require the LDCs to establish demonstration project programs which support achievement of the LDC's net zero pathway while safely and reliably meeting customers' energy needs. These demonstrations can inform the LDCs and the Department and other policymakers with respect to reducing customer demand for gas, decarbonizing delivered gas via RNG and hydrogen, reducing greenhouse gas emissions, and optimizing the use of existing gas infrastructure. As CGEP notes, policies can be put in place now that facilitate compatibility of LDC systems with low- and zero-carbon fuels. In particular, CGEP calls for regulators and LDCs to take a step-by-step approach by identifying parts of their networks and end-use customers that can be modified to enable things like hydrogen blending and other zero-carbon fuels in sections.[99]

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[94] Decarbonization Pathways Report at 109-110.
[95] Decarbonization Pathways Report at 99, 112, 114 and 116.
[96] Decarbonization Pathways Report at 116.
[97] Additional customers service and procedures for decarbonization initiatives considerations are described in the Regulatory Designs Report at 25-27.
[98] Regulatory Designs Report at 29.
[99] "Investing in the US Natural Gas Pipeline System to Support Net Zero Targets, CGEP (April 2021) at 49.

The intent of demonstration programs will be to advance the development of new technologies, operating practices, services and/or business models consistent with policy direction. National Grid plans to explore demonstration programs that contribute to the following categories of benefits and learnings (although not limited to these categories or items as technologies evolve):

- **Optimizing the use of existing gas infrastructure by:**
    - Exploring and quantifying the system benefits and best means of optimizing the use of dual-fuel heating systems for customer and environmental value;
    - Coordinated gas and electric planning on network segments for long-range optimization of both types of infrastructure;
    - Conducting gas network hydraulic analysis to identify potential for segment decommissioning and understand pressure and flow impacts of and remediations for segment decommissioning, ensuring safe and reliable service for remaining gas customers; and
    - Using advanced leak repair techniques as an alternative to replacement.
- **Decarbonizing delivered gas via RNG and Hydrogen by:**
    - Blending renewable natural gas and hydrogen into existing networks;
    - Advancing the interconnection of RNG and H2 projects including research to support gas quality, conditioning, and safety standards;
    - Examining options for the delivery and utilization of 100% hydrogen gas within an area of an LDC network;
    - Advancing “power-to-gas” production methods, including methanated hydrogen; and
    - Testing biomass gasification using sustainable feedstocks.
- **Reducing GHG emissions and other emissions associated with delivery and use of natural gas by:**
    - Using advanced leak detection technologies;
    - Adopting lifecycle emissions analysis and means of prioritizing system investments, including repairs, based on environmental considerations as well as safety and reliability; and
    - Addressing any issues of indoor air quality
    - Leveraging carbon capture technologies

- **Reducing gas network demand with:**
    - Real-time gas demand monitoring and analysis;
    - Expanded gas demand response programs;
    - Adoption of gas heat pumps;
    - Use of networked geothermal systems;
    - Demonstrations for electrification and energy efficiency to avoid infrastructure investment (LPP and/or capacity investment);
    - Transition strategies for existing gas customers;
    - Behind the meter biogas production; and
    - Industrial decarbonization.

The demonstration programs will be designed to enable faster and more predictable deployment of new technologies, operating practices, services, and business models to support the Commonwealth's climate goals. We propose the Department approve these categories of projects as part of their review of Net Zero Enablement Plans if they conclude the demonstration projects reflect incremental activities that advance the Commonwealth's policy goals.

Related funding programs in other jurisdictions can serve as examples, and show the value of investing in these kinds of program, including:

- **New York's Millennium Gas R&D Funding**[100] In 2000, New York's Public Service Commission allowed LDCs to establish new tariffs to collect funding for medium to long-term gas research and development in areas such as pipe installation and repair and maintenance. Funds are collected through a surcharge on customer usage and can be used for R&D projects that will last two years or longer. LDCs must spend 80% of their annual Millennium funding on co-funded R&D projects. The customer usage surcharge is reset every year.

- **New York's REV Demonstration Program:**[101] In 2015, New York's Public Service Commission directed the six electric distribution companies ("EDCs") large electric IOUs to develop and file demonstration projects to advance the goals of the "Reforming the Energy Vision" ("REV") regulatory initiative. Funded by up to 0.5 percent of each utilities'

[100] New York Public Service Commission Case No. 99-G-1369 - Petition of New York Gas Group for Permission to Establish a Voluntary State Funding Mechanism to Support Medium and Long Term Gas Research and Development (R&D) Programs. Order issued February 14, 2000.
[101] New York Public Service Commission Case 14-M-0101. Order Adopting Regulatory Policy Framework and Implementation. Order issued February 26, 2015.

distribution revenue, the funded projects advanced network, distributed generation, advanced metering, electric transportation, storage, and distributed energy resource ("DER") integration technologies.

- **Vermont's "Innovative Service" Pilot Mechanism**[102]**:** Part of Green Mountain Power's ("GMP") multi-year regulation plan, this mechanism offers expedited approval time on pilots related to products and services that advance clean energy and decarbonization. This mechanism was utilized for the development of GMP's battery partnership with Tesla.[103]

- **UK's Office of Gas and Electricity Markets ("OfGem") Network Innovation Allowance:** The UK's utility regulator, OfGem, oversees the Network Innovation Allowance ("NIA") mechanism which provides dedicated funding for gas and electric utility innovation programs with regular reporting of results. Funding must "focus on the energy system transition and/or addressing consumer vulnerability, and which companies would not otherwise take forward as part of business-as-usual activities for each network licensee." Network licensees, analogous to the Commonwealth's LDCs and EDCs, make the decisions as to which innovation projects they take forward with their NIA. NIA projects have included feasibility studies for 100% hydrogen distribution networks, field trials for hydrogen-blended gas detection equipment, biomethane potential analysis, and a study of electric network peak impacts from electric heat pumps.

To make sure that customer funds are being used as efficiently as possible, National Grid suggests that the Department limit LDC recovery in this area to an annual amount equal to 0.75% of an LDC's revenue requirement, using the same methodology as is used to calculate LDC revenue requirements for GSEP. Cost Recovery would be through the Net Zero Enablement Plan Model Tariff proposed in the LDCs' Regulatory Framework. In addition, LDCs should be encouraged to collaborate and share learnings and project data on their respective demonstration programs with each other and stakeholders.

Developing Alternatives to Capital Investments

The Regulatory Designs Report identifies embedded gas network costs as a major risk to customers, and many stakeholders have identified the need to change utility incentives and cost

[102] Vermont Public Utility Commission Case No. 18-1633-PET, Petition of Green Mountain Power Corporation for approval of a multi-year regulation plan pursuant to 30 V.S.A. § 209, 218, and 218d, Order, 30, 201 (April 2019).
[103] Vermont Public Utility Commission, Notice of GMP Innovative Pilot: Energy Bundle, Case No. 19A-3193, August 5, 2019.

recovery practices to address "disincentives" for alternative investments. For example, EDF notes that non-pipeline alternatives can be a "critical way" to control costs of the energy transition and manage any contractions of natural gas demand or system size.[104]

National Grid's plan anticipates that a share of our customers will be served by non-pipeline alternatives ("NPAs") – such as targeted electrification and networked geothermal service – by 2050. To that end, regulatory support for alternatives to capital investments will be necessary. Such support should be grounded in cost-effectiveness and ensure that any alternative solution can be implemented consistent with reliability and safety requirements. Moreover, any capital alternative framework should be inclusive of but not limited to demand side solutions, targeted electrification, and utility geothermal, and enable opportunities such as "repair versus replace" to limit incremental capital investments where it is a feasible solution. As discussed later in this section, the Company is proposing that NPAs be included within the LDC Net Zero Enablement Plans.

Finally, where solutions involve targeted electrification, it will be critical to address the processes, standards, and policies relevant to their implementation. Practically, solutions that require coordination among groups of customers raise implementation challenges that must be addressed. For example, switching a neighborhood currently served with gas service to networked geothermal service will require participation of most, if not all, the customers in the immediate area; if one customer does not wish to participate, the viability of the project may be threatened. Key considerations for process, standards, and policies include, but are not limited to, the requirements and timeline around customer notification, customer response timelines and options, and financial and logistical support for participating customers.

Supporting LDC Investment in Geothermal Technologies

The Decarbonization Pathways Report contemplates a broad range of scenarios for the evolution of the LDCs and their networks. Many of those approaches could be facilitated by the evolution of the regulated LDC business model to one based not on delivering a commodity but providing a service such as heating through district thermal networks, from offering "heating as a service" or "energy efficiency as a service", to financing and deploying air source heat pumps. The Consultants found potential advantages to this approach, including higher efficiency due to sharing of heating and cooling loads across buildings and reductions to the impact of electrification on the electric system. [105]

[104] "Aligning Gas Regulation and Climate Goals: A Roadmap for State Regulators" at 27; EDF (Jan. 2021).
[105] *The Role of Gas Distribution Companies in Achieving the Commonwealth's Climate Goals,* Independent Consultant Report, Appendix 2: Literature Review, March 18, 2022 at 9.

In Massachusetts, there is a growing recognition amongst stakeholders and policymakers of the potential for renewable district thermal for decarbonizing the heating (and cooling) of buildings. District thermal networks can utilize a range of sources for heating and cooling, such as geothermal wells, nearby water sources, and waste heat from nearby buildings or infrastructure (such as sewage systems or subway tunnels). These networks leverage existing heat sources to maximize energy efficiency and exchange thermal energy at large economies of scale, expanding options for customers with limited onsite energy potential.

For example, in recent Department proceedings, HEET has advanced the idea of "GeoMicroDistricts" where LDCs harness their experience, legal status, and existing customer base to provide utility-scale renewable thermal energy.[106] Doing so, HEET says, will provide increased safety, reliability, and access to renewable heating sources while supporting the Commonwealth's emissions reduction policies and accelerate the electrification of the state.[107]

Both National Grid and Eversource have initiated networked geothermal demonstration projects. National Grid's project, approved in December 2021,[108] will demonstrate networked geothermal systems in up to four sites, to assess the efficiency potential of shared loops, and investigate how they may be deployed optimally to create value for existing gas customers and new customers, including as an alternative to leak-prone pipe replacement. Eversource's project, approved in in October 2020,[109] will demonstrate the potential for networked geothermal in a mixed-used urban neighborhood, using public ways to serve customers with diverse heating and cooling profiles (residential and commercial/industrial customers).

The Department and the Consultants both view geothermal networks as having the potential to significantly reduce GHG emissions, and see value in projects that test the effectiveness and scalability of utility-owned geothermal networks with the potential to reduce current barriers to widespread adoption in furtherance of the Commonwealth's climate policies.[110]

The LDCs are well-positioned to deliver a new low-carbon heating policy strategy at scale, in coordination with planning and operation of the gas and electric networks, and in collaboration with municipalities and regional planning agencies. Massachusetts is in a leading position to advance district heating through their regulated gas distribution utilities, in partnership with the competitive market for geothermal heating and cooling technologies and services. A 2021

[106] NSTAR Gas Company d/b/a Eversource Energy, D.P.U. 19-120, at 134 (2020).
[107] D.P.U. 19-120 at 134.
[108] Boston Gas Company d/b/a National Grid, D.P.U. 21-24, at 32 (2021).
[109] D.P.U. 19-120 at 155-156.
[110] D.P.U. 19-120 at 139; Decarbonization Pathways Report at 116.

NYSERDA report found that: "Municipal franchise agreements could provide utilities with unique advantages in building out district geothermal services within existing easements and public rights of way that would help facilitate scaling geothermal. These rights would be particularly advantageous to overcoming legal and cost barriers to district geothermal in medium- and high-density urban areas."[111]

We understand that as a creation of statute, the Department has only the authority that it receives from the legislature. To advance the potential for a networked geothermal utility business, National Grid recommends that policy makers modify the statutory purpose of the Commonwealth's gas utilities and update the definition and responsibilities of natural gas utilities to include the provision of thermal energy via investment in renewable thermal infrastructure.

Regulatory Framework: Net Zero Enablement Plans

Process and Components

To facilitate the Department's review of LDC progress in their support of the Commonwealth's climate goals, we, along with the other LDCs, recommend the Department create a new "Net Zero Enablement" process, described in the LDC Regulatory Framework.

Under this Regulatory Framework, National Grid and each LDC is submitting its initial Net Zero Enablement Plan (i.e., this plan document) for review and approval by the Department, designed to both continue efforts underway in their respective three-year energy efficiency plans to significantly advance decarbonization in the Commonwealth and advance the Consultants' recommended regulatory designs in the short term.

In addition, the LDCs seek Department approval of a framework for future iterations of LDC-specific Net Zero Enablement Plans. The LDCs jointly propose the following framework for future plans, which will be designed to continue the advancement of decarbonization initiatives identified by the Consultants, and additional decarbonization initiatives that may materialize during the 2023-2050 time period:

1. LDCs will propose to file Net Zero Enablement Plans on a 3-year cycle, to align with 3-year energy efficiency cycle, using a 5 and 10-year planning horizon to allow for review, evaluation of progress, plan updates and proposed modifications to the LDC Net Zero Enablement Plan, as warranted or appropriate.

[111] https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Clean-Power-Innovation/21-22-Overcoming-legal-and-Regulatory-Barriers-to-District-Geothermal-in-NY.pdf

2. LDCs will demonstrate evaluation of non-pipeline alternatives to mitigate the need for incremental investments in gas infrastructure, as applicable.

3. LDCs will provide data to inform decision making during the transition.

4. LDCs will provide periodic updates regarding progress towards addressing transition issues, including EJ issues.

5. Other enabling proposals under consideration by LDCs.

In addition, we recommend that the Department direct LDCs to include in their plans activities and investments necessary to advance their individual net zero vision including, but not limited to:

- **Costs associated with low-carbon or zero carbon fuel utilization**, including implementation of standardized interconnection practices, billing practices, or other emerging utility costs associated with utilization of decarbonized fuels. Regardless of any particular LDC purchases of these fuels, the LDCs must work with state and federal regulators to address standardized gas quality, interconnection and billing practices as more decarbonized fuels come online. Incremental costs associated with this could be reviewed and recovered in this process rather than separately reviewed in rate cases to ensure that work can begin promptly once an LDC's plan is approved.

- **The Depreciation Advance Contribution**, as applicable, calculated as 5% of the Company's annual depreciation expense for Account 367.00 (Mains), Account 369.00 (Measuring and Regulating Station Equipment), and Account 380.00 (Services).

- **Funding for demonstrations of emerging or innovative technologies, operating practices, services, and business models**, including but not limited to activities pertaining to optimizing the use of gas infrastructure, decarbonizing delivered gas, reducing emissions from delivery and use of natural gas, and reducing gas network demand. As noted above, we recommend the Department set a cap on the amount of funding for these activities based on a percentage of annual LDC revenue requirements. To receive approval for these types of activities, the Department must find that the proposed activities (1) are consistent with applicable laws, policies and precedents; (2) have reasonable in size/scope/scale in relation to the benefits anticipated; (3) have adequate evaluation; and (4) have reasonable bill impacts to customers.[112]

[112] D.P.U. 21-24 at 15.

- **Non-pipe alternative investments**, including but not limited to avoidance of future infrastructure investments needed to serve existing gas customers, avoidance of future infrastructure investments which would be needed to serve those customers currently served by delivered fuels who seek natural gas service, and:
    - Changes to gas service extension cost-recovery policy;
    - Geothermal investments; and
    - Incremental energy efficiency and demand response programs.
- **Gas and Electric Coordination.** Within the Net Zero Enablement Plan, the LDCs should demonstrate how coordination with relevant EDCs has informed assessment of potential non-pipe alternatives.

To evaluate the LDC's Net Zero Enablement Plans, we recommend that the Department use a standard of review that:

> The LDC's transition portfolio is reasonably designed to contribute to the reduction of GHG emissions to meet net zero emissions by 2050, without compromising the safety, reliability and affordability of service offered to current customers.

Data Reporting

Finally, it will be critical that the Department and all stakeholders have transparent data about how the LDCs activities and strategic vision align with the Commonwealth's climate goals. To that end, National Grid recommends the Department direct the LDCs to present the following data with each plan filing:

- Customer data: number of customers currently receiving, requesting, being denied, or departing gas service; this includes an estimation of customers who have installed electric heating systems but not requested termination of gas service.
- Customers opting for decarbonized fuel supply offering, volume and costs of decarbonized fuels purchased for customers.
- A tabulation of current emissions, including emissions associated with all grades of leaks and a tabulation of leak-prone pipe infrastructure by material.
- A tabulation of infrastructure that can accommodate decarbonized fuels.

- Current and projected customer delivery rates, delivery bills, and total bills for the next three years; such information will identify incremental impacts from planned activities.

- Impacts of our activities on environmental justice communities as defined in Massachusetts law. A neighborhood is defined as an Environmental Justice population if one or more of the following four criteria are met:
    - the annual median household income is not more than 65 per cent of the statewide annual median household income;
    - minorities comprise 40 per cent or more of the population;
    - 25 per cent or more of households lack English language proficiency; or
    - minorities comprise 25 per cent or more of the population and the annual median household income of the municipality in which the neighborhood is located does not exceed 150 per cent of the statewide annual median household income.

Additional Regulatory and Policy Considerations for Future Proceedings

Changes to Rate Design and Cost Allocation

The Regulatory Designs Report discusses modifications to both electric and gas customer rates that would help to support more widespread customer adoption of decarbonized heating technologies. With respect to electric rates, the Regulatory Designs Report suggests that a shift to winter peak demand would provide an opportunity to use time variant rates and critical peak pricing structures to encourage efficient utilization of the electric system.[113] Such a rate design would reduce the amount of electric infrastructure needed to serve peak demands by providing customers with an economic incentive to use gas heat for backup during winter peak days, thus lowering their electricity demand during winter peak times.

With respect to gas rates, the Regulatory Designs Report notes that customers' dual-fuel heating systems will have substantially different usage profiles than traditional gas heating customers. Current cost-allocations and rate structures will under-recover network costs from hybrid customers.[114] The Regulatory Designs Report suggests possibly establishing a separate rate class for hybrid customers, and the potential to move toward higher fixed charges or demand charges.[115]

[113] Regulatory Designs Report at 22.
[114] Regulatory Designs Report at 21-22.
[115] Regulatory Designs Report at 23.

The Company agrees that modifications will be necessary to ensure that rates are sufficiently cost-reflective, stable, and equitable as the transition to net zero evolves. However, given that each LDC will have unique considerations when looking at new rate designs, we believe that these issues are best addressed in each LDC's rate case where the Department and stakeholders can evaluate proposals based on the needs of each LDC's customers, system cost drivers, and net zero pathway.

Changes to Revenue Decoupling

The Regulatory Designs Report also notes that the current "per customer" revenue decoupling approach, which enables the LDCs to retain incremental revenues from new customers until rates are reset, is unlikely to be sustainable as decarbonization progresses and the number of gas customers declines over time.[116] The Regulatory Designs Report suggests that a decoupling approach reconciled to total revenues, similar to the current model for EDCs, may be a preferable approach.[117]

The Company agrees that the current approach to revenue decoupling is unlikely to be sustainable as the transition to net zero moves forward. We believe that additional analysis and investigation is needed to determine appropriate reforms to revenue decoupling, and recommend that this be considered in a future investigation.

Broader Socialization of Gas Network Costs through Cross Utility Payments

The Regulatory Designs Report identified that, in the latter phases of a transition to decarbonized heat, it may be necessary to more broadly socialize the costs of the gas distribution system.[118] The Consultants noted that customers with the means to electrify leave behind an unrecovered portion of the gas network investments needed to serve them. Continuing to recover these costs solely from gas customers would concentrate those costs on a shrinking gas customer base, which would increase costs for those customers that are not able to leave the gas system. The need for such an approach is likely to less pronounced, and perhaps non-existent, in pathways that retain higher levels of gas network utilization.

Allocating some of these costs to electric customers ensures that they continue to be spread over the same number of customers as was originally intended. The Regulatory Designs Report explored a handful of approaches to allocating these costs, all of which can broadly be considered some form of a "cross-utility payment."[119] Creating regulatory and policy mechanisms that allow

[116] Regulatory Designs Report at 22-23.
[117] Regulatory Designs Report at 23.
[118] Regulatory Designs Report at 40-45.
[119] Regulatory Designs Report at 42-44.

for payments across utilities (primarily electric to gas utilities) may be important in the future to ensure a fair allocation of costs.

While National Grid expects that pathways that emphasize a holistic, hybrid energy vision that utilizes the existing gas network are less likely to result in cross-utility payments than pathways centered on electrification, we recognize that there is value in exploring and developing approaches that might be needed to more equitably allocate transition costs and effectively compensate gas utilities for the services they provide in a net zero future where heat is provided by both electric and gas systems.

In *Under Pressure: Gas Utility Regulation for a Time of Transition*, RAP concludes that one way to ameliorate the rate impacts of the clean energy transition on gas customers is for regulators to allocate an increased share of general expenses to electric customers. Regulators could also impose "exit" fees on customers that disconnect from the gas system, using these funds to assist remaining gas customers with increased costs.[120] Similarly, EDF has explored the concept of exit fees, concluding that when a gas utility makes a fixed cost investment on a customer's behalf and then the customer disconnects from the gas system, it may be equitable for that customer to pay a cross-utility payment or exit fee which represents the customers' share of the investment made on their behalf. As a direct exit fee may be seen as a disincentive to electrify, EDF agrees that it may make sense to more broadly socialize such costs.[121]

V. Conclusion

National Grid is committed to achieving the Commonwealth's net zero targets. As we work to enable net zero, we are committed to keeping affordability, equity, safety, and reliability at the forefront of everything we do. These priorities inform the pillars of our plan and we appreciate the opportunity to present our vision to achieve a net zero energy future for all our customers.

[120] Anderson, M., LeBel, M., & Dupuy, M. (2021, May). Under pressure: Gas utility regulation for a time of transition. Regulatory Assistance Project (RAP) at 16.
[121] Environmental Defense Fund (EDF) "Aligning Gas Regulation and Climate Goals: A Road Map for State Regulators," (Jan. 2021) at 30.

Attachment A

nationalgrid

The Future of Natural Gas in Massachusetts

Massachusetts is exploring the future of natural gas used in homes and businesses and by large commercial and industrial customers. We'd like your thoughts.

Whether you live in Massachusetts or run a business here, the future of natural gas impacts us all. That's why we would like your input on a plan to ensure a safe, reliable, and equitable transition to the future of energy in our state.

The Massachusetts Department of Public Utilities (DPU) directed the Massachusetts gas companies to explore pathways for a clean energy future – for you and our future generations. This includes the critical goal to reduce greenhouse gas emissions to net zero by 2050. Our part in achieving "net zero" includes removing the same amount of greenhouse gases we produce or avoiding them altogether through new technologies, to reduce emissions that contribute to climate change. These new technologies could impact home appliances like heating systems, boilers, gas stoves, and water heaters and a variety of commercial and industrial equipment that use natural gas. That's a big job, and one that needs the public's support and input to succeed.

Here's how to share ideas and get involved:

Attend a live webinar to learn more and provide your feedback. Please register below for one of the sessions to reserve your spot, attendance is limited.

December 15, 6:30 pm-7:30 pm

December 16, 12 pm-1 pm

Send us an email at
futureofgas@erm.com

Email Us

Check out these videos for more information.

View Videos

Call our hotline to provide your feedback.

1-833-285-7160

Want to learn more before you get in touch? Click on the link below.

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National Grid

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Avis important. Veuillez traduire immediatement.
Questa è un'informazione importante,
si prega di tradurla.
Это очень важное сообщение.
Пожалуйста, попросите чтобы
вам его перевели.
Đây là một thông báo quan trọng.
Xin vui lòng dịch thông báo này.

Attachment B

The Future of Natural Gas In-Depth Customer Research

Results Report

December 2021

nationalgrid

Objectives & Approach

Residential

Commercial

National Grid is involved in a regulatory process regarding Massachusetts' net zero greenhouse gas emissions by 2050 and has developed three informational videos to explain the process and technologies being considered. This research will provide insight into customers' overarching feelings regarding the transition from traditional natural gas to alternative energy sources and determine informational needs moving forward.

nationalgrid|customercouncil

Survey Approach

One-on-one blog-style online interviews facilitated by a moderator:

- 60-90 minutes online per participant
- Moderator probes asynchronously throughout study

Qualitative approach leveraging our online panel of Residential and Commercial customers to understand:

- Customers' ideal vision for natural gas usage in Massachusetts
- Familiarity with and interest in alternative energy sources
- Information desired about natural gas and alternative energy sources
- Concerns and considerations regarding the energy transition for natural gas
- Familiarity with Massachusetts net zero emissions goals
- Questions and concerns about future lack of availability of natural gas
- Any additional feedback regarding National Grid's energy transition

Participation

34 MA Residential Gas/Dual Fuel Customers

Segments

- Young Green Movers: n=9
- Affluent Conservers: n=11
- Seeking Guidance: n=2
- Effortless Independents: n=1
- Mature Basics: n=3
- Educated Eco Friends: n=7
- No segment assigned: n=1

LMI Status

- LMI: n=4
- Non-LMI: n=30

6 MA Commercial Gas/Dual Fuel Customers

- Small & Seamless: n=2
- Lean & Green: n=2
- Seeking Solutions: n=1
- Effortless Independents: n=1
- Big Business: n=1

National Grid Observable differences between Residential and Commercial results highlighted where applicable.

Field Dates: 11/16/21 – 11/24/21

Executive Summary: The Future of Natural Gas

nationalgrid

Key Takeaways: 5 Things You Need to Know

1	2	3	4	5
Customers have limited knowledge of the MA net zero emissions goal	**There is support of the MA net zero goal to combat climate change once customers become aware**	**Solid interest is seen in alternatives to natural gas, but barriers to adoption that must be addressed**	**Customers seek additional information on alternative fuel sources and updates along the path to achieving the goal**	**The role National Grid plays in the transition puts the energy company in a positive light for most**
Most have no existing knowledge of the net zero goals but generally approve of them. Some mention they are aware of other large-scale efforts to curtail carbon emissions, including by other companies, and understand their purpose.	Customers understand that non-renewable fuels such as natural gas usage should be reduced and feel the transition will have a positive effect. Some express concerns that these efforts may not be prioritized due to the enormity of the task. 2050 sounds far off to some and want to see progress ahead of then.	Most recognize the transition to alternative energy is advantageous and are willing to adopt it, if feasible. Residential customers most interested in renewable natural gas, but geothermal and solar most appealing to commercial customers. Primary concerns for adoption are cost, environmental impact, long-term sustainability, and impact to their lifestyle.	Additional information on actual costs of conversion and usage, as well as the pros and cons of each energy source will be helpful. Customers want continued updates on the progress being made towards the goal.	Customers generally approve of National Grid's role in the transition to alternative energy. Most feel optimistic knowing their energy provider is a partner in these efforts and they will positively impact future generations.

Recommendations

Looking Ahead

Continue to provide information about MA net zero goals, the energy transition and how it will affect their household and community available, so customers can feel better prepared.

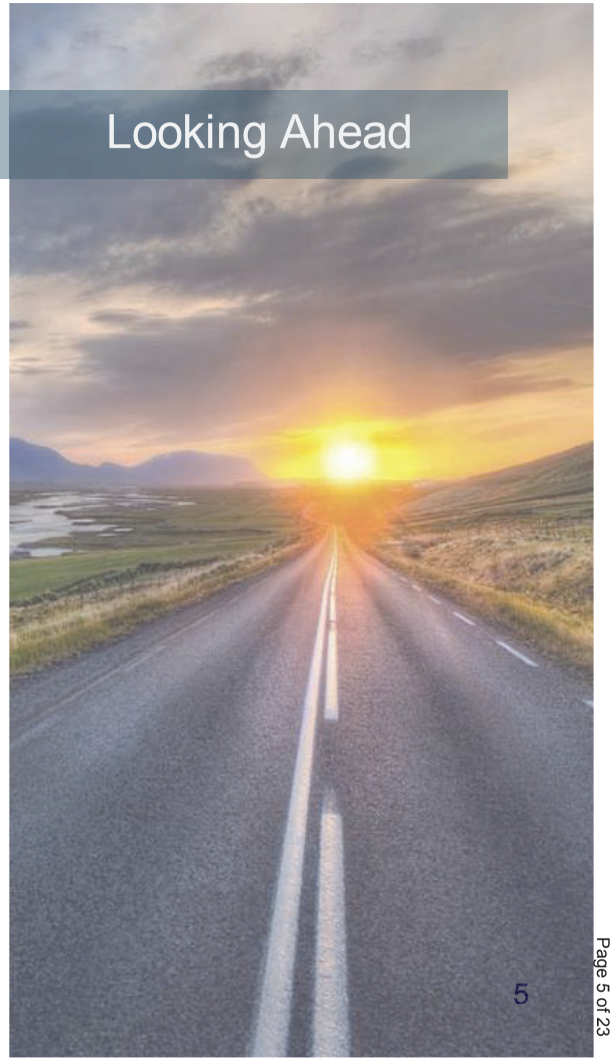
Specifically, provide information on:

- Clear benefits and drawbacks to each energy source
- Cost expectations (installation, maintenance, regular usage, etc.)
- Long term energy savings/expenditures
- Available incentives and assistance from National Grid
- Expected impact to their lifestyle
- Environmental/ecological ramifications (pollution, sustainability, climate change, etc.)
- Issues with implementation or integration
- What are some milestones sooner than 2050 and timing of future rollouts
- Action items to ensure preparedness and to assist in transition

Explore ways to make customers feel like they are "part of the ride" on the journey.

National Grid can share milestones with customers for the completion of projects or infrastructure, along with any steps that they should take to ease the transition.

Leverage the current momentum and global engagement around combatting climate change to show National Grid's role in the transition.



Detailed Findings: Customer Knowledge of & Feelings About Net Zero Emissions Goals

nationalgrid

Most lack initial awareness of the MA emissions goal and National Grid's involvement but are positive about it.

Residential

Commercial

Most feel National Grid's exploration of alternative energy sources is a responsible, future-looking measure to ensure that its customers have continued access to energy sources.

- Some mention a need for National Grid to ensure that an energy transition is made responsibly and not solely at the cost to consumers.
- A few feel these goals are a high priority and should be met sooner than 2050.
- Others remain skeptical of the eco-friendly approach to these efforts or feel these goals may be overly optimistic or unrealistic.

Some express fervent support of efforts to move towards a cleaner energy future and feel a net zero emissions goal is necessary to help combat climate change.

"National Grid should be looking at alternative energy sources, They need to stay current and offer its customers, relevant options should better alternative become available."
*– **Commercial, MA, Small & Seamless***

"I have great respect for National Grid for its ambitious programs, due mainly to my good experience with National Grid, and its reputation. The service and response times for issues, are always at a high level so I think that its goals would be attained in a manner to face the many challenges that the world has now in helping climate control."
*– **Residential, MA, Educated Eco Friends***

Some recognize the goals as an initiative being adopted by many companies across different industries and are aware of similar efforts.

"I was not aware of this effort, but I am so glad that national grid is working to meet a net zero carbon emission… I'm happy that national grid is taking steps towards addressing climate change. Global warming is a real issue, and national gas/oil are finite resources we need to start taking steps to converting to renewable energy sources and reducing carbon emissions."
*– **Residential, MA, Young Green Movers***

"I know of incentives to switch to alternate solutions like wind power or to have an electric charger but didn't know the goal of company itself."
*– **Residential, MA, Affluent Conservers***

"I haven't heard anything about the National Grid plan to meet net zero carbon emissions target but am curious to learn more."
*– **Residential, MA, Young Green Movers***

"I think they are trying to find other sources of energy that will not deplete the ozone or hurt the world for future generations."
*– **Residential, MA, Effortless Independents***

Detailed Findings: Familiarity, Drivers & Barriers to Alternative Energy Sources

nationalgrid

Customers are most familiar with Heat Pumps and Hydrogen energy sources, but Renewable Natural Gas is most appealing.

Residential

Commercial

Renewable natural gas is of higher interest for residential use due to its compatibility with existing infrastructure and appliances.

- Some mention solar, wind, and nuclear energy as alternatives they would consider, which is driven by a perception of long-term sustainability.
- Cost, feasibility, and environmental impact are consistently mentioned as obstacles for adoption.

Commercial customers are more likely to mention an interest in solar and geothermal heat pumps due to familiarity and the practicality of installation alongside existing infrastructure.

- They also consistently express concerns about how an alternative energy might impact business costs, as well as the environmental impact of alternative sources.

Alternative Energy Sources of Interest

- Renewable natural gas
- Air source heat pumps
- Geothermal heat pumps
- Solar (Commercial)

Information Needed

- Applicability for residential use
- Implications for climate change and pollution
- Overall feasibility of integration

"I know that "air source" heat pumps are the most common kind, that resemble typical residential air conditioners. These are what people get installed when they get a "mini-split" system. I think it is rather uncommon to hear them referred to as air source. Geothermal is more costly to install."
– Residential, MA, Affluent Conservers

"Based upon the name, I am assuming that the natural gas that I am now using could be "recycled" in some way to make it cleaner, and used over again… I thought that it would be able to use some of the current natural gas resources, thus making it more cost-effective."
– Residential, MA, Mature Basics

"Geothermal seems like it would be a no-brainer for new construction now. Heat pumps, I understand, are much more efficient now and costs are on-par with NG but either requires a forced air system or wall units. Would be great if there was a technology that was more compatible with baseboard/radiator heating as a retrofit."
– Commercial, MA, Small & Seamless

"We have a large property and wonder if solar panels would provide enough power to reduce our dependency on Natural Gas. Our facility is very large, so if solar isn't able to do power the entire campus -- maybe it could provide enough energy to heat and operate equipment needed for both of our pools (we have 2 Olympic size swimming pools,1 indoor pool, and 1 outdoor pool)."
– Commercial, MA, Big Business

Conversion or replacement of current energy sources is a major consideration for customers.

Residential

Commercial

If natural gas was no longer an option, participants mention solar, renewable natural gas, heat pumps, nuclear, and wind as alternatives.

- Ultimately, if they're going to have to replace their energy source, they want to ensure that it's safe, practical, economical, and available.
- Energy efficiency and cost effectiveness are primary drivers for energy sources.

"I like the idea. My concerns are, however, getting stuck with a large modification bill to install or not benefiting as expected. I want to make a difference, but expense is a big concern to me."
*– **Residential, MA, Educated Eco Friends***

"Solar is more prevalent and has an eco-system including reasonable costs. Geothermal since for heating in winters this is an option that will work regardless of the weather conditions."
*– **Commercial, MA, Lean & Green***

Many express concerns about the continued, widespread use of fossil fuels and interest in alternative energy sources.

- They also mention concerns about the economic implications of a transition to other sources of energy, both personally and on a larger scale.

"In both instances, there needs to be a cost benefit or little to no cost increase. The technology also needs to be proven and reliable for the long term. I'm not interested in investing in unproven or cutting-edge technology that may not pay off in a reasonable time frame."
*– **Residential, MA, Educated Eco Friends***

"Geothermal or air-source heat pumps for home heating/cooling; efficient, safe, clean, electrical stoves in the kitchen are also a strong interest. To me, these technologies represent among the highest energy efficiency we can work to achieve with current technology, providing high levels of comfort at reasonable cost."
*– **Residential, MA, Young Green Movers***

Customer concerns include cost, the feasibility and reliability of new technologies, and their impact on the environment.

Residential

Commercial

Residential Concerns

Commercial Concerns

Detailed Findings: Information Needs About the Transition

nationalgrid

After viewing the videos, customers want additional information about a transition to alternative energy to understand its impact on them personally.

Residential

Commercial

Most would like to hear more about the positive and negative aspects of using different alternative energy sources.

- Specifically, details regarding the costs associated with upgrading, maintaining, longevity, and efficiency are compelling.

Providing a depth of readable material will help customers understand the transition, its impact on their household, and increase their interest and acceptance of it.

- Customers expect to be contacted directly about the availability of this information and any relevant updates pertaining to the energy transition.

Customers want information on…

- Pros/cons of each type of energy source
- Customer availability of energy sources
- Cost information short/long term
- Environmental/ecological ramifications
- Practical application/installation and impact on lifestyle
- Timing of rollouts
- Required changes to infrastructure/lifestyle per energy source
- National Grid transition assistance (incentives/installation)
- What customers can be doing to help

"I need to see the graphic representations explained further. It's great to see that there are options that will be available but how will we get them to where we are? Meaning: what is the distribution structure and will I be able to benefit from it. And what does the install/modification look like to the average existing homeowner? I want to see where these energy source come from… not just workers and then a graphic of the end result."
– Residential, MA, Educated Eco Friends

"I would like to understand initial investment costs, installation costs, maintenance, durability and energy efficiency vs current gas heating. Also, in case of solar, if there is surplus energy if such could be stored or distributed. I think there is a barrier to change and upgrade from the current heating system, as long as such is working. In the case that I would need a new heating system, I am more motivated to look at alternatives. As long as all is working, I am less motivated."
– Residential, MA, Seeking Guidance

"I would like to know what the associated estimated costs for each alternative energy source would be compared to current options. A monthly cost as well as an upfront installation cost/ any rebates incentives for switching… I think the best way to share this content would be to send an email with a direct link to the information on their website."
– Residential, MA, Young Green Movers

"I don't think much is missing, other than a clearer call to action -- a "here's what you can do to help us achieve net zero" message. That may not be the intent of this series though… I would think the most effective way to communicate this would be to include a brief narrated list of the quick top 3 steps households can take immediately to help support the transition to a greener energy future. Keeping these as "quick things you can do today" can help make it clear that this transition is not strictly about spending significant amounts of money to replace/upgrade key infrastructure, but is the sum of a number of small steps which are supplemented by technology upgrades"
– Residential, MA, Young Green Movers

Customers' primary concern is the lack of detailed information about the benefits and drawbacks of energy sources from National Grid.

Residential

Commercial

Customers want timely, detailed updates as National Grid proceeds with changes throughout the energy transition.

- Most expect regular updates about the transition and its implementation, as well as any issues encountered.

Customers recognize that the energy transition will require the replacement or retrofitting of existing appliances and equipment.

- This associated cost is a hurdle but tolerable if it's lessened by long term energy savings and incentives from National Grid.

Commercial customers are concerned about the costs transitioning and the financial impact on their business.

- Customers expect to have to make accommodations to their budgets to incorporate any new energy technology.
- They hope to be able to take advantage of incentives to ease the financial burden.

"People tend to be resistant to change and lazy. So are companies. Human beings in general tend to resist change and cling to the status quo, even when the writing is on the wall. Especially so if it there is any personal effort or cost involved."
– Residential, MA, Young Green Movers

"The challenges will be higher costs, potentially, as well as any conversion costs, etc."
– Commercial, MA, Small & Seamless

"Retrofitting older buildings. Especially homes and businesses that use radiators/baseboard heating."
– Commercial, MA, Small & Seamless

"Government interference, people stuck in their ways and those who don't think there is a concern or problem. These newer technologies will cost money and corporations and people will refuse to pay."
– Commercial, MA, Lean & Green

Challenges

- Potential drawbacks of alternative sources
- Disruptions to way of life
- Prohibitive costs
- Issues with implementation (lack of compatibility in some areas)
- Resistance to change (slow adoption/political motivations)
- Lack of/building of infrastructure (slow adoption/additional costs)

"By communicating what is happening with the rollout. The information provided should include: is the plan on target, is it on budget for both National Grid and the consumer, issues that have arisen, and comments from customers who have switched."
– Residential, MA, Mature Basics

Customers find the information in the videos appealing, interesting, and easy to understand.

Residential

Commercial

The information in the videos is presented clearly and is easy to understand due to the effective use of imagery.

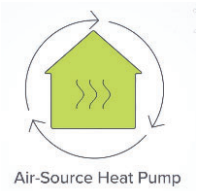
- Customers feel the videos provide enough detail to help them understand the most critical aspects of these efforts.
- Breaking up the information across three videos, while challenging with short attention spans, ensures that the information is easy to absorb.
- After viewing the videos, participants generally feel more informed about alternative energy sources and what National Grid will be doing to help MA customers transition away from natural gas.

They appreciate that the videos provide information about alternative sources of energy and details to help them understand why they are viable options.

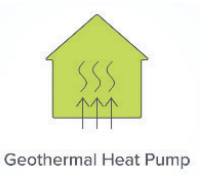
- Customers feel increasing awareness of these efforts and presenting the rationale for the energy transition is valuable.

Most interesting Aspects

- How alternative energy sources work
- Availability of alternative energy sources
- Diagrams and illustrations
- Explanation of the net zero goal



Air-Source Heat Pump



Geothermal Heat Pump

"These videos are EXACTLY what I need to see. I want to understand what is happening, available and what will make a difference."
– ***Residential, MA, Educated Eco Friends***

"The most interesting aspect has to be the actual descriptions of the renewable energy resources being considered, as I had only the most dim memories about what each of them were. I'd very much like to know more, in depth, and especially about what each of the produce as a consequence of use (like with the H2O being produced by hydrogen use)."
– ***Residential, MA, Young Green Movers***

"Definitions of the various terms of energy, and the regulatory requirements. All very clear to the participants. I like the manner of the presentation, all positive messaging, no meaningless propaganda!"
– ***Residential, Educated Eco Friends***

"The videos are clean, sharp, and to the point. They educate and highlight the coming alternatives…I find the mandate of 0-net by 2050 most educational because I had never known that prior to the video."
– ***Commercial, MA, Seeking Solutions***

The videos meet customer expectations for the future of natural gas and help them understand the impact of this transition.

Residential

Commercial

Most recognize that natural gas, as a fossil fuel, will need to be phased out eventually.

- Some are unsure about the viability of the transition and did not have any previous expectations about natural gas in the future.
- Others have questions and concerns about the rationale behind the established net zero timeline.

Though most have a general understanding that the transition will affect their household, some feel the effect on their household and community is not clearly explained.

- To better understand the impact of the transition, some would like further detail on specific costs and potential lifestyle changes that will occur.

"Its not clear at all. It seems like the changes suggested (again, there's no plan) would require massive infrastructure changes which would require years of planning, building of power stations and major upgrades to the power grid. None of these were mentioned in the videos."
– Residential, MA, Affluent Conservers

"It makes me highly aware that Natural Gas will no longer be available as it is now in the next 20 years and less after that. It's important to become educated with the options and make plans to modify/update your home/business to comply with the next step of using an alternative energy source."
– Residential, MA, Educated Eco Friends

Commercial customers similarly recognize that there will be costs associated with a transition to an alternative energy source.

- Reactions are a mixed:
  - Some have an understanding of the net benefits of using alternative energy sources.
  - Others simply recognize that the adoption of new energy technology will be a reality for their businesses.

"It's clear that these new technologies spread across the local area will have a positive effect… Since National Grid serves a wide swath of customers across Massachusetts, the video made it clear that all Massachusetts areas can help in achieving the Net 0 by 2050 goal."
– Commercial, MA, Seeking Solutions

"I am clear that we will have to change how we consume energy as we transition to new modes of energy… I expect there will be capital costs and an incremental operating costs that the business has to either absorb or increase some prices for the customers."
– Commercial, MA, Lean & Green

Detailed Findings: Perception of National Grid's Role in Transition

nationalgrid

Overall, customers feel hopeful and optimistic about the transition to zero net emissions and are excited that it will lead to a cleaner planet.

Residential

Commercial

Optimism about the transition is motivated by customers' understanding of the environmental impact of fossil fuel usage and the benefits of using sustainable energy.

- Some express cautious optimism because of the unknown economic and environmental ramifications of this transition.
- Others express concerns around the political expedience of this transition and are uncertain of the commitment that National Grid has towards this collective effort.

Most are very interested in transitioning to the energy sources in the videos, if they are safe, feasible, and not prohibitively expensive to implement.

- Some remain hesitant without additional information about household/business costs resulting from an energy transition.

Residential: Words to Describe Feelings about the Transition

Commercial: Words to Describe Feelings about the Transition

"I would definitely use the energy sources featured if they were available and viable for my home. I am a bit concerned that it could entail buying new appliances, but clearly consumers also have a role to play in making this work."
– Residential, MA, Young Green Movers

"Clean energy is the key to saving our planet and the future generations to come. It's vital and all should be concerned to do their part to improve."
– Commercial, MA, Lean & Green

"I'm always interested in hearing about new tech, but asking if I'd use it is not something that's easy to answer without knowing things like cost, safety, reliability, etc. Basically, this stuff is to knew. I'm not going to gamble on unproven tech."
– Residential, MA, Educated Eco Friends

Customers feel these clean energy efforts are valuable and give them a positive impression of National Grid the net zero emissions goal.

Residential

Commercial

Customers see the videos as a valuable effort to educate them about energy sources.

- Some worry about the feasibility of the goals in that timeframe without significant investment and change.
- Many are looking for additional information about the process by which these goals will be met.

"A responsible ecofriendly company willing to make changes to meet energy demands of the future."
– Residential, MA, Help Wanted

"Obviously very valuable because this is the way the political winds are blowing, so we can either work to make this happen or waste time and money on conflict,"
– Residential, MA, Mature Basics

"Shows NG is progressive thinker on new technologies to address climate change and values the input and participation of their customers, noting issues of concern in a major transition!"
– Residential, MA, Affluent Conservers

National Grid's involvement in these efforts is considered positive, with many recognizing the need for their involvement in the transition.

- However, a few are wary of whether National Grid will be fully committed to these efforts and if they are more concerned with the optics rather than with the actual energy transition.

Most are aware of the long-term environmental impact of continued natural gas usage and expect National Grid to act responsibly with the best interest of their customers regarding the future of energy availability.

- A few have less interested net zero goal and are more concerned about their overall energy costs.

"The impression is that National Grid is poised for the future and will be a leader in the years to come... 2050 is a long way off and yet National Grid is already preparing for the upcoming changes by educating its consumer base."
– Commercial, MA, Seeking Solutions

"There are always the legal, logistical and financial issues, and while those are usually resolvable this could be another instance of the "haves" vs. "have nots".- which status can change over the course of time. I see the biggest challenge and barriers is getting people to "buy in" - e.g., comprehend the end of the day benefits - and embrace the changes and consequences without having it feel as forced upon them or that a group is making a financial windfall from the changes."
– Residential, MA, Mature Basics

Appendix

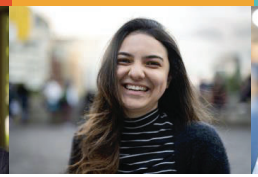
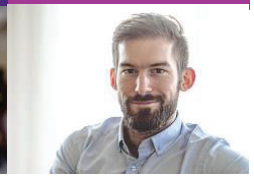
nationalgrid

Stimuli– Video Evaluation Link

https://thefutureofgas.com/overview

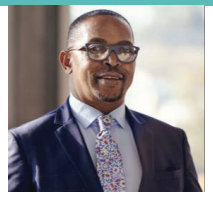
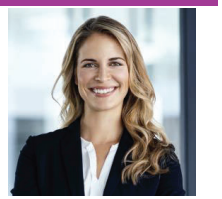
Residential Needs-Based Segments

Segments influence strategic and tactical efforts, including strategy, marketing, branding, and product/service offerings

	EDUCATED ECO-FRIEND	AFFLUENT CONSERVER	SEEKING GUIDANCE	YOUNG GREEN MOVER	MATURE BASIC	EFFORTLESS INDEPENDENT
						
	"Prove to me you care about the environment"	*"Help me save with informed energy decisions"*	*"Provide me personalized ways to lower my bill"*	*"Show me you care about our communities"*	*"Make it easy to reach you and provide simple communications"*	*"Be transparent and provide a seamless way to interact with you"*
Demo-graphics	• Highly educated • Mostly homeowners	• Large homes and energy bills • Mostly suburban families	• High bill as portion of income • Mix renters/owners • Mostly female	• Urban • Renter	• Empty nester • Longest customers	• Mix of renters, families, homeowners
Needs	• Renewables • Solutions to reduce energy use • Provider gives back to the community	• Solutions that increase comfort • Info on EE products/rebates • Mobile app	• Affordable solutions • Advice on how to save • Easy website, predictable billing	• Socially conscious, community focus • Green options • Help to minimize expenses	• Being able to reach a person • Simplicity • Less interested in energy solutions	• Personal comfort over conservation • Ease of business • Web, mobile options

Commercial Needs-Based Segments

Commercial segments can be combined with vertical industry to provide a sharper focus on best ways to satisfy customers

	LEAN & GREEN	SMALL & SEAMLESS	SEEKING SOLUTIONS	NO FRILLS	BIG BUSINESS
					
	"Show you care about the environment with more action, less words"	*"I don't need much, just an easy way to get in touch with you"*	*"Be more proactive instead of reactive when communicating with me"*	*"Make it straight forward to reach someone"*	*"Make it easier to manage multiple accounts and locations"*
Size based on energy use	• Smallest companies	• Small companies	• Medium companies	• Medium companies	• Largest companies
Needs	• Socially conscious • Renewables • Energy advice, recommendations	• Ease of business • Online & mobile tools • Renewables lower priority	• Energy management solutions • Predictable bills • Advice and info to track usage, savings	• Effective customer service • On time service • Prepared & responsive in emergencies	• Commercial solutions • Help to manage multiple accounts • Advice on products, services, providers