Decarbonizing Heat in the U.S. Northeast: Workshop Insights and Key Takeaways

May 2023

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Introduction and Overview

The Energy Futures Initiative (EFI) hosted a full-day, hybrid public workshop on "Decarbonizing Heat in the U.S. Northeast" on Dec. 6, 2022. This event was held at the Massachusetts Institute of Technology's (MIT) Samberg Center in Cambridge, Massachusetts, and brought together nearly 50 regional stakeholders and thought leaders to discuss the challenges and opportunities of heating decarbonization in the U.S. Northeast, particularly for commercial and residential buildings. A primary focus of the discussion was the potential role of low-carbon fuels, such as clean hydrogen (i.e., hydrogen produced with low- or zero-carbon emissions) and renewable natural gas (RNG) (i.e., biogenic methane from organic sources and upgraded to replace fossil-based methane). The workshop considered how these low-carbon fuels could complement electrification in the region's resource mix in the context of policy drivers such as decarbonization, reliability, and cost and equity.

Ernest J. Moniz, EFI's CEO and the 13th U.S. Secretary of Energy, provided opening remarks, framing the challenges of decarbonizing the U.S. Northeast region as a call for urgency, pragmatism, and a technology-neutral focus on carbon reduction. Brian Deese, Director of the National Economic Council, gave a keynote address, covering the Biden administration's plans for a "new industrial strategy" and how these policies can shape the region's clean energy transition. Alex Kizer, EFI's Senior Vice President of Research, detailed the energy profile of the U.S. Northeast to explain how this region represents a difficult-to-decarbonize geography. Three panel discussions covered the most important next steps for regional decarbonization for industry, policymakers, and front-line communities in the U.S. Northeast (Table 1).

Table 1
Workshop Panel Topics and Participants[a]

Introduction and Opening Remarks	**Participant**
• Theme setting: decarbonization of buildings and other sectors with low-carbon fuels (e.g., clean hydrogen, RNG, clean electricity) in the Northeast. • The landscape for the region's decarbonization needs for these fuels.	• Ernest J. Moniz, *President*, *CEO* | *Energy Futures Initiative*
Keynote Address	**Participant**
• Solution space: addressing priorities for decarbonization, including the potential role/value of low-carbon fuels to overcome these challenges.	• Brian Deese, *Director* | *National Economic Council*

[a] The job titles and organizations associated with each workshop participant throughout this document were those held at the time of the event in December 2022.

Northeast's Energy Profile and Heat Decarbonization Challenges	Participant

• Data-driven discussion defining the problems with delivering clean heat in the Northeast, as well as facts that are germane to the decarbonization agenda including demography, the built environment, and environmental justice issues. Questions that guided the discussion:
  ○ How can the Northeast reach decarbonization targets reliably and cost-effectively?
  ○ What is the role of clean fuels in the region's future, considering these boundary conditions?
	• Alex Kizer, *Senior Vice President of Research and Analysis* | *Energy Futures Initiative*

Panel 1: Evaluating the role of low-carbon fuels in the region's decarbonization	**Participants**
• What are the benefits/challenges of using low-carbon fuels? • What is the timeframe to decarbonize using low-carbon fuels? • How to repurpose existing infrastructure to reduce the cost of decarbonization in the region, as well as new infrastructure needs? • How to deal with/avoid stranded assets? • Are buildings in the Northeast difficult to decarbonize? • What is the role of electrification in the decarbonization of heating and how does it compete with clean hydrogen and RNG?	Moderator: • Erin Blanton, *Managing Director, Zero Emissions Systems* | *GTI Energy* Panelists: • Tory Clark, *Senior Director* | *Energy and Environmental Economics* • Dr. Emre Gençer, *Principal Research Scientist* | *Massachusetts Institute of Technology* • Benjamin Miller, *Associate Director, Energy, Sustainability, & Infrastructure* | *Guidehouse* • Peter Narbaitz, *Director, Energy Markets & Planning* | *ICF*
Panel 2: Discussing ways to involve local communities as partners in the region's decarbonization	**Participants**
• How does the workforce want to be engaged in the transition? • How do communities want to be engaged in the transition? • What is the role of environmental justice communities in the transition? • How can the transition to low-carbon fuels improve communities? • How to bring stakeholders together in the transition to low-carbon heating. • How to address the safety of new low-carbon systems and communities.	Moderator: • Jason Beckfield, *Robert G. Stone Jr. Professor of Sociology* | *Harvard University* Panelists: • Sarah Jackson, *Climate and Energy Policy Manager, Northeast Region* | *The Nature Conservancy* • John Buonopane, *Staff Representative* | *United Steelworkers Union* • Alexandra MacLean, *President of Public Relations* | *Leonine Public Affairs* • Kerry Bowie, *Founder, President, and Executive Director* | *Browning the Green Space*
Panel 3: Reviewing policy tools that foster low-carbon fuels' supply and demand	**Participants**

- Which policy mechanisms can increase the affordability of clean hydrogen compared to other fuels (e.g., decrease the clean fuel premium of hydrogen, compared to natural gas)?
- How to guarantee demand for these fuels.
- Will there be enough clean hydrogen and RNG suppliers to fill the Northeast's demands?
- How to transport these fuels into the region.
- Which regulatory changes are needed to foster clean hydrogen adoption?
- How will the new IRA provisions affect policy?

Moderator:

- Madeline Schomburg, *Director of Research* | *Energy Futures Initiative*

Panelists:

- Patrick Woodcock, *Commissioner* | *Massachusetts Department of Energy Resources*
- William Akley, *President*, *Gas Business* | *Eversource Energy*
- Judith Judson, *Head of U.S. Strategy and Head of Hydrogen* | *National Grid*
- Peter McPhee, *Senior Program Director, Buildings* | *Massachusetts Clean Energy Center*

The Importance of Heating Decarbonization in the Northeast

The workshop started with remarks from Moniz, who discussed insights and strategies for the U.S. Northeast during its transition to low-carbon energy systems. Moniz also described major policy opportunities for the region to consider. Deese delivered the keynote address, focused on how a modernized industrial policy can drive new low-carbon investments in the U.S. Northeast and throughout the country.

Regional decarbonization planning should promote technology optionality and flexibility. Moniz explained that meeting the Northeast's emissions reduction goals, while managing costs and system reliability, will require pragmatism with a strong focus on, and commitment to, technology optionality and flexibility. The energy system must provide essential services (light, heat, mobility, electricity, etc.) reliably at all times. Energy delivery infrastructure must be available, reliable, and secure as the system transforms to low carbon. And success will require aligning the interests and commitment of a range of important stakeholders. For example, in 2020, EFI developed the report *Net-Zero New England: Ensuring Electric Reliability in a Low-Carbon Future* in collaboration with Energy and Environmental Economics (E3), focusing on power sector decarbonization. This report showed that grid optionality and flexibility in terms of the scale and type of available resources lead to cost-effective, reliable, and clean systems. Moniz also discussed this pragmatism in the context of COP27, quoting Lord John Browne, the Chairman of EFI's Advisory Board, that "pragmatism executed at speed is better than perfection delivered too late."[b]

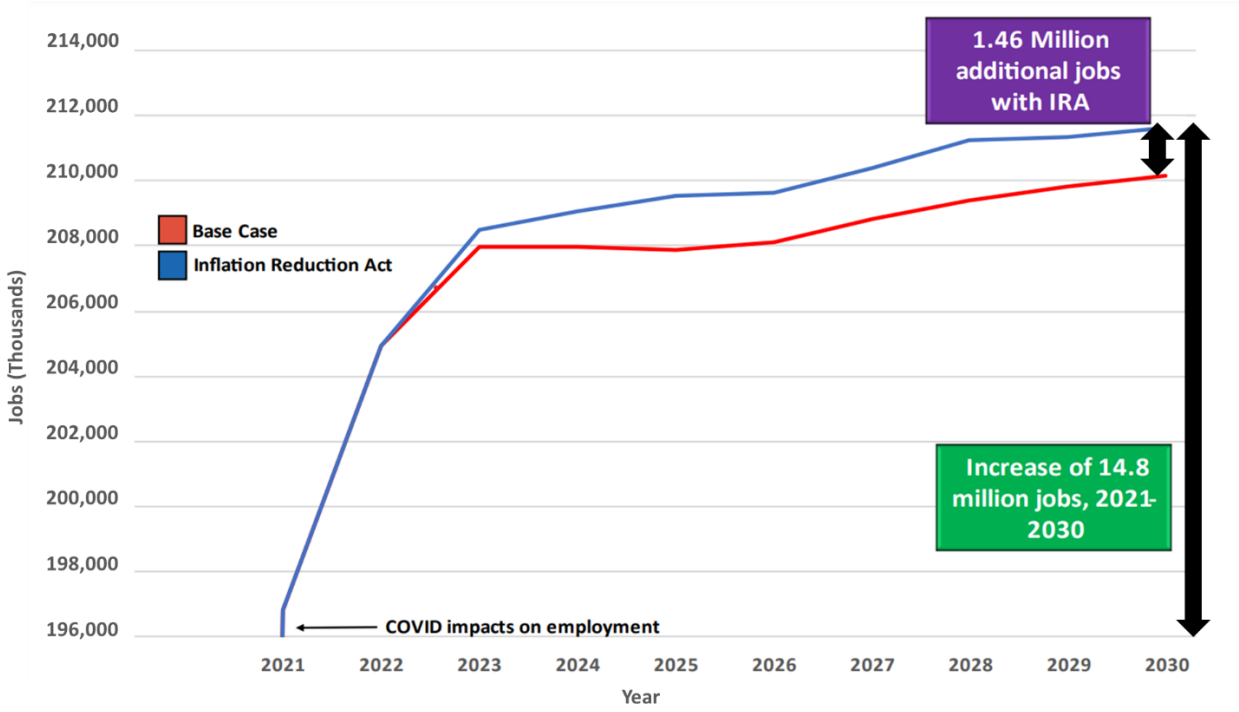
[b] The 2022 United Nations Climate Change Conference or Conference of the Parties of the UNFCCC, or COP27, took place in Egypt in November 2022.

There are "boundary conditions" that make the Northeast region a difficult-to-decarbonize geography. Moniz explained that there are fundamental aspects of the energy sector (i.e., boundary conditions) that must be successfully navigated when planning for decarbonization. In the Northeast, many of these boundary conditions will influence the suite of low-carbon options. For example, the Northeast is land-constrained and densely populated with relatively limited natural energy resources, aging infrastructure, and winter weather conditions that can stress buildings and energy supplies. These regional characteristics make residential and commercial building decarbonization—often viewed as a sector that is relatively easier to electrify—particularly challenging. The region should emphasize solutions that limit new infrastructure builds and support energy resilience. Technologies such as offshore wind power, imported hydropower, nuclear power, clean hydrogen, and low-carbon fuels can offer substantial upside if siting and permitting challenges are met. Failure to consider and accommodate the region's energy system boundary conditions and the region's distinctive economy, geography, and built environment could create costly and inefficient outcomes as the region moves to net-zero emissions over the coming decades.

The Bipartisan Infrastructure Law (BIL), Inflation Reduction Act (IRA), and the CHIPS and Science Act provide a crucial foundation for regions and sectors to immediately invest in new low-carbon solutions. Moniz described how the 2030s and 2040s will be crucial decades for reaching net-zero economywide emissions by midcentury and that near-term policy options must be leveraged effectively. Modeling done by the Labor Energy Partnership (LEP), a collaboration between EFI and the AFL-CIO, showed that the IRA will provide important benefits to job growth, the overall economy, and greenhouse gas (GHG) emissions reductions.[1] The modeling showed that the spending associated with the IRA would create nearly an additional 1.5 million jobs by 2030 compared with a business-as-usual (BAU) scenario, while also reducing GHG emissions by 37% relative to a 2005 baseline (Figure 1). For the Northeast, it is essential to determine how to employ the resources of this recent legislation and overcome the regional challenges of rapid decarbonization, particularly in heating applications that provide crucial services to homes, hospitals, and commercial and industrial facilities.

Figure 1

Job creation from the Inflation Reduction Act, 2021 to 2030[2]



This figure shows modeling results on how the Inflation Reduction Act (IRA) could contribute to job creation over the coming decade compared with a BAU scenario. The BAU scenario assumptions are largely derived from the U.S. Energy Information Administration's Annual Energy Outlook Reference Case and include benefits from the 2021 Bipartisan Infrastructure Law. The IRA case scenario assumes the IRA would help the United States reach its nationally determined contribution commitments, finding the most efficient way to achieve emissions reductions across the economy. Source: Labor Energy Partnership, 2023.

Building on recent legislation with long-term investments of public capital, a "modern American industrial strategy" can unlock meaningful decarbonization potential. In his keynote address at the workshop, Deese underscored the fact that current policy momentum can support low-carbon fuels. Deese described how aggregated public and private investment from the administration's strategy would total nearly $3.5 trillion over the coming decade. Adding new public investment in areas where private investment alone cannot meet the country's economic and national security interests is crucial to strengthening "our national bottom line," Deese said. The federal government has not instituted an effort of this scale for nearly half a century, during which much of the country, including the Northeast, experienced a period of industrial decline. This industrial revitalization will rely on long-term public funding to "crowd in private investment" that reaches the people, workers, communities, and companies that "will actually generate all of

this productivity and innovation," Deese said. The next steps will focus on strong policy implementation and identifying ways to boost public-private partnerships.

With these industrial policies established, their implementation and execution will be the most crucial and challenging to achieve economywide decarbonization. Deese outlined the Biden administration's vision for a successful industrial policy today that will require a three-pronged approach focused on infrastructure, innovation, and clean energy. This approach will need to overcome a variety of global economic factors (e.g., pandemic supply chain disruptions, the Russian war in Ukraine, inflation, globalization reassessments) in addition to regional boundary conditions. Deese proposed a reorientation of the federal government around "novel partnerships" to demonstrate the industrial policy "opportunity at scale," using the U.S. Department of Energy (DOE) Hydrogen Hubs (H2Hubs) program as an example that would help to accelerate the innovation pathway from research and development (R&D) to commercialization. While the IRA provides a long-term tax credit for companies to invest in clean hydrogen production, the BIL's H2Hubs program brings together the full hydrogen value chain in regional networks of producers, distributors, and end users to create demonstration projects "at scale and speed." With successful implementation of these policies, clean hydrogen could supply 14% of total energy demand by 2050 (Brian Deese, National Economic Council). Focusing on the U.S. Northeast, Deese suggested that these policies and strategies could bolster demand for other clean fuels as well, whether using RNG in existing infrastructure to reduce emissions, developing geothermal district heating systems (i.e., a community level system for distributing heat generated in a centralized location), or using IRA funding for heat pumps and grid modernization to transition Northeast communities away from fuel oil and save households up to 50% in heating and cooling costs.

Scoping and implementing projects at scale and speed will necessitate "reforming how we build in America." Deese highlighted the Biden administration's plans to dedicate additional resources to the agencies tasked with streamlining permitting processes and to overhaul the systems that track and manage project development. These changes would depend on federal permitting reform to increase the speed of project permitting and siting.[c] Implementing these large industrial strategies quickly also will require bringing front-line and marginalized communities into these projects. Community-oriented policies—such as tax benefits for companies that build projects in traditional energy communities or a $27 million "green bank" to foster the low-carbon transition in disadvantaged communities—are the types of "innovative industrial programs … essential to meeting our climate and economic goals," Deese said. Beyond the federal government, these reforms will require national mobilization across nongovernmental organizations, private businesses, and local and state governments. Deese concluded his remarks with a call to action focused on "rebuilding and reindustrializing our country, building at scale and speed, with climate and community at the center."

[c] As of April 2023, both houses and parties of the 118th Congress have proposed bills on federal permitting reform for energy projects that are currently under review and debate.

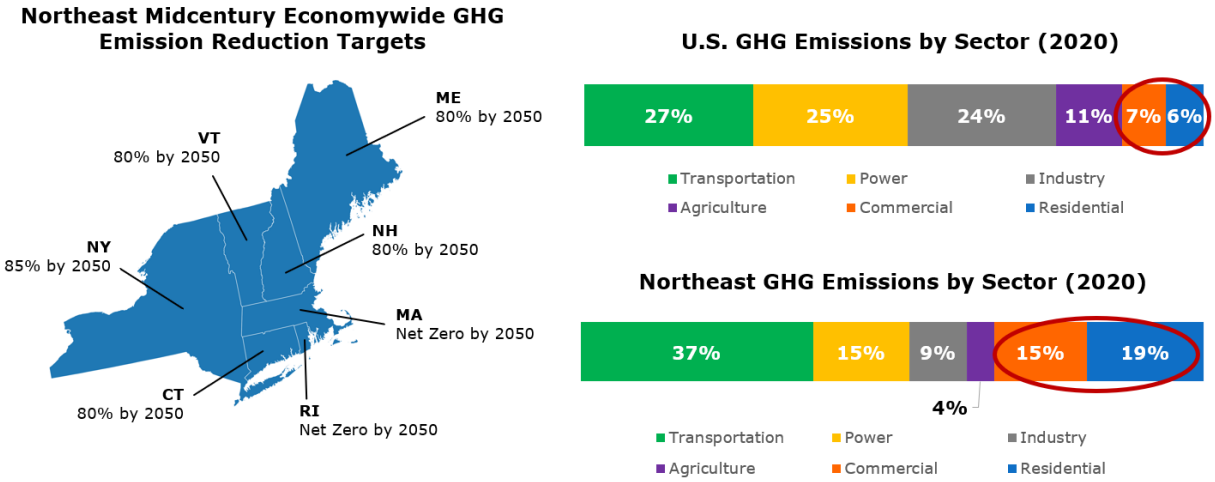
The Energy Profile of the U.S. Northeast

To help participants better understand how the U.S. Northeast represents a difficult-to-decarbonize geography, Alex Kizer, EFI's Senior Vice President of Research, detailed the main characteristics of this challenge and set the scene for the workshop. These regional boundary conditions illustrate the sequencing needed to address intrinsic interrelationships between the energy infrastructure, social structures, natural environment, and political activities of this region.

The Northeast region is committed to substantial reductions in economywide emissions. New York and the six New England states have adopted economywide GHG emissions reduction targets of at least 80% by midcentury, with Massachusetts and Rhode Island recently adopting a net-zero commitment (Figure 2). The sectoral breakdown of the region's emissions shows the importance of reducing both the residential and commercial sectors' emissions, which mostly come from natural gas and petroleum used for heating. As a result, the share of total emissions from the Northeast's commercial (15%) and residential (19%) sectors are roughly two to three times higher than the national average (7% and 6%, respectively). At the same time, the emissions from the power sector are much lower in the Northeast (15%) than the U.S. average (25%). Industrial emissions in the United States (24%) as a whole are considerably higher than in the Northeast (9%) in contrast to transportation emissions (27% and 37%, respectively), reflecting the lower participation of industrial activity in the region's economy when compared with the rest of the country.[3]

Figure 2

The Northeast's low-carbon targets and emissions by sector[4,5,6,7,8,9,10,11]



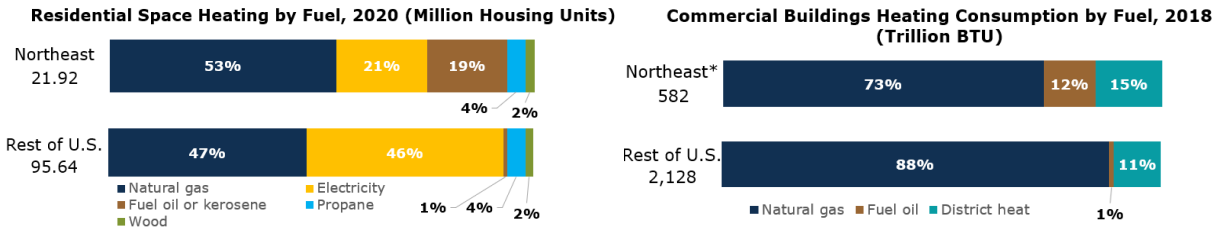
The seven Northeast states of the United States all have GHG emissions reduction targets of at least 80% by midcentury (left). Given that buildings (i.e., the residential and commercial sectors) make up more than one-third of the regional

emissions profile, the Northeast faces a distinctive challenge to rapidly decarbonizing its economy compared with the rest of the country (right). Source: U.S. Environmental Protection Agency, 2022.

Residential and commercial heating represent difficult-to-decarbonize sectors in the U.S. Northeast region. Homes and businesses in the Northeast depend on natural gas and petroleum for most of their heating needs; other heating sources include electricity and biomass. Natural gas provides roughly three-quarters of the region's heat, and fuel oil accounts for nearly 20% and 10% of residential and commercial heating, respectively—an order of magnitude higher than that of the rest of the United States (Figure 3).[12,13]

Figure 3

Northeast residential and commercial heating profile by fuel type[14,15]



This figure shows the residential space heating fuel data for individual households in the Northeast compared with the rest of the United States (left). The figure also contains heating fuel consumption data for the commercial sector comparing the Northeast with the rest of the country (right). The Northeast Census Region includes New Jersey and Pennsylvania for commercial building data. Data from: U.S. Energy Information Administration Residential Energy Consumption Survey, 2022, and Commercial Buildings Energy Consumption Survey, 2018.

While there are multiple alternatives, there may not be one single option for reliably and cost-effectively meeting the heating needs of the region's commercial and residential sectors.

There are a handful of technologies that could play a role in decarbonizing the Northeast's heating needs in commercial and residential buildings:

- Air source heat pumps (ASHP), for example, are an important option for meeting heating needs. "Cold climate" ASHPs can work when temperatures fall below five degrees Fahrenheit, and some communities—such as Framingham, Massachusetts—are experimenting with geothermal heat pumps through district heating networks that also operate well in extreme temperatures.[16] While the technology continues to improve, the maximum capacity of an air-source heat pump still declines as outdoor temperatures fall and many ASHPs require supplemental heat in extremely cold conditions.[17] Moreover, widespread heat pump adoption will impact overall system load and must be managed accordingly.[18] In cold winter climates such as the Northeast, ASHPs could employ hybrid systems with a fuel-fired furnace to increase efficiency at low temperatures and reduce electricity use. Also,

most modern ASHPs have integrated electric resistance heating for backup in low temperatures.[19]

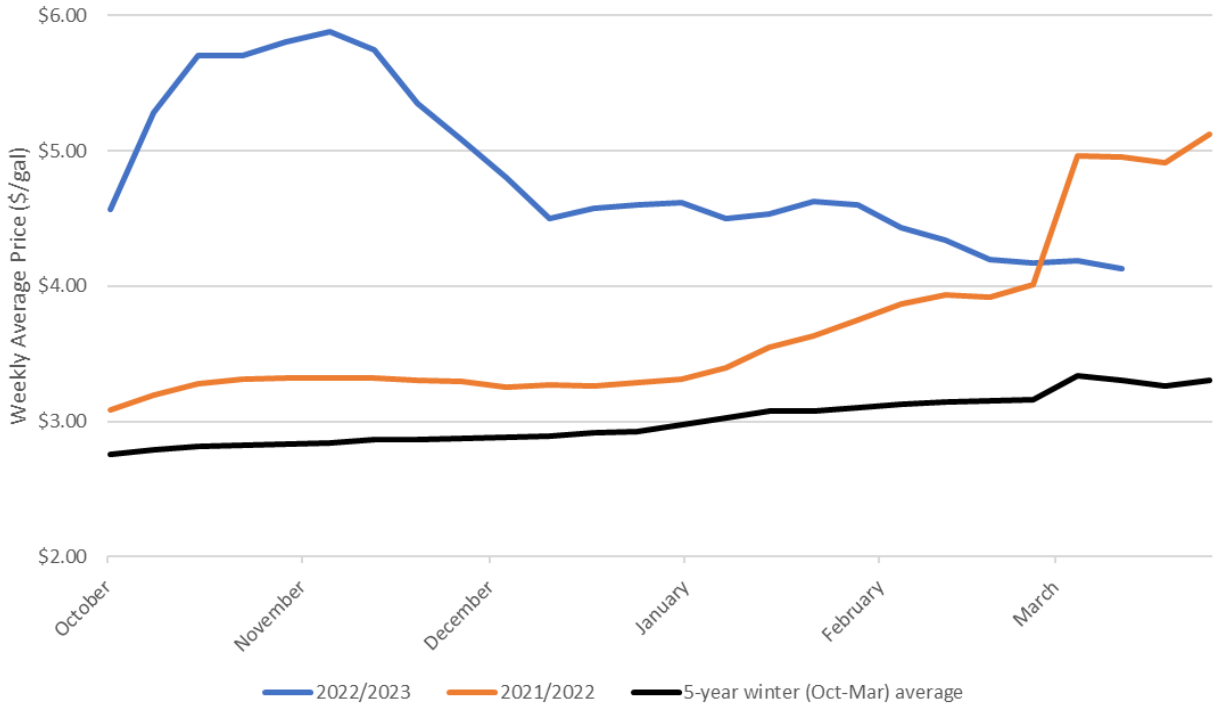
- Standalone electric resistance heating also could provide a viable heating option for use in commercial and residential buildings given its low capital costs.[20] Resistance heating use, however, remains constrained by the electricity grid in the case of power outages or high electricity costs during extreme weather events.
- Renewable natural gas (RNG) can serve as a drop-in clean replacement for natural gas, though supply is limited (both nationally and regionally) because of high production costs compared with fossil natural gas, costs of transport with new pipeline interconnections, and high technical requirements to upgrade biogas to meet gas quality specifications for existing pipeline systems.[21]
- Blending clean hydrogen into the region's natural gas system also provides a drop-in option (up to certain blend limits today) to reduce emissions from sectors that feed off the gas grid, such as heating. Using clean hydrogen for heating presents challenges regarding cost, roundtrip efficiency, and safety, but it also could create ready-made off-takers for hydrogen and provide an opportunity for expanding clean hydrogen demand—a critical element needed for market development.[d]

Switching from fuel oil is important for emissions reduction, though it will be crucial to replace its role as a backup fuel, especially during tough winter months. "Reliable and cost-effective heating for water and space is a critical infrastructure," which quickly becomes both a security and equity issue for "homes, hospitals, and factories that must provide heat during long periods of harsh winter conditions," Kizer said. However, fuel oil dependence creates a major challenge for regional decarbonization because of petroleum's carbon intensity and price volatility, which remained relatively high through 2022. The weekly average price of residential heating oil in New England for Nov. 7 nearly doubled from $3.32/gal in 2021 to $5.88/gal in 2022 (Figure 4).[22] Continued global supply chain disruptions also have exacerbated the Northeast's petroleum supply constraints, which largely come from port shipments (alongside the regional heating reserve, which contains around 1 million barrels of petroleum for use during supply shortages).[23] Box 1 explores regional energy challenges from extreme weather events in late December 2022 and the potential impact of clean fuels to support a threatened electricity grid.

[d] EFI's report *The Future of Clean Hydrogen in the United States: Views from Industry, Market Innovators, and Investors* released in September 2021 details some of the primary safety concerns of investors related to clean hydrogen development, including its high flammability and explosivity.

Figure 4

Weekly average price of residential heating oil in New England, October 2022 to March 2023[24]



From October 2022 to March 2023, the average price of residential heating oil was volatile, changing by nearly $2/gal and peaking at $5.88/gal on Nov. 7, 2022, prior to the winter season (blue line). These values were higher than at the same time the year prior, although prices spiked in late February/early March 2022 (orange line). Across both years, prices have remained higher than the average over the past five years (gray line). Data from: U.S. Energy Information Administration, 2023.

Box 1

Energy Security Case Study: Winter Storm Elliott in New England 2022

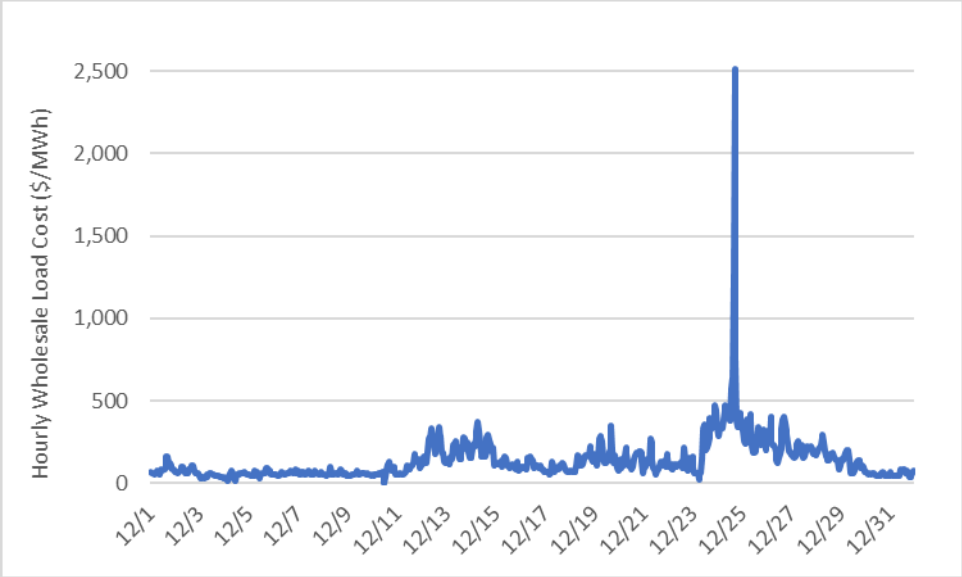
The bomb cyclone that crossed much of the United States during late December 2022, known as Winter Storm Elliott, was a stark reminder that the energy sector is an essential national infrastructure facing growing challenges as extreme weather events become more frequent and severe. Across the country, from Dec. 23 to 26, the storm contributed to more than 10,000 delayed flights, approximately $5.4 billion in damages to private and public property, and more than 60 fatalities.[25] On Dec. 24, more than 1.6 million electricity customers were without power nationwide—largely due to load shedding activities—because the extremely low temperatures froze natural gas infrastructure, rendering parts inaccessible.[26,27,28]

While the U.S. Northeast did not experience the country's worst energy reliability outcomes during this weather event, both the electric and gas grids responded to surges in demand, resulting in supply shortages. During the event, ISO New England (ISO-NE), the independent grid operator for the six-state region, released alerts about possible power reserve shortfalls and made attempts to purchase

emergency supplies from neighboring Regional Transmission Organizations (RTOs). This situation caused electricity prices to jump over the $2,000 per megawatt-hour (MWh) price cap on Dec. 24 compared to just $30/MWh the previous week (Figure 5).[29] Natural gas-fired power plant output declined during this period largely because the already limited pipeline capacity was increasingly diverted to supply residential and commercial heating customers.

Figure 5

ISO-NE hourly wholesale electricity cost for December 2022[30]



This graph shows the hourly wholesale price of electricity for ISO-New England (ISO-NE) for December 2022. It is important to note the extreme price anomaly that occurred between Dec. 24 and 25 because of supply shortages. Data from: ISO-New England, 2023.

A combination of factors resulted in a relatively tight natural gas market. First, the supply shocks due to Russia's invasion of Ukraine have impacted the entire natural gas market, as some former importers of Russian gas, especially in Europe, sought new sources of supply via liquified natural gas (LNG). Second, the LNG market still runs on long-term contracts and a highly variable spot market (that can still require multiyear contracts), which limits the ability to access new LNG cargoes on-demand. Finally, the Northeast is limited in its ability to purchase U.S. shipped LNG because of the Jones Act, which requires any domestic shipments between ports to take place on U.S.-flagged ships and crews. As a result, the U.S. fleet has no LNG tanker eligible for the Jones Act, and these restrictions prevent shipments between producers in the Gulf Coast and consumers in the Northeast, forcing these states to rely on foreign LNG.[e,31,32,33,34,35]

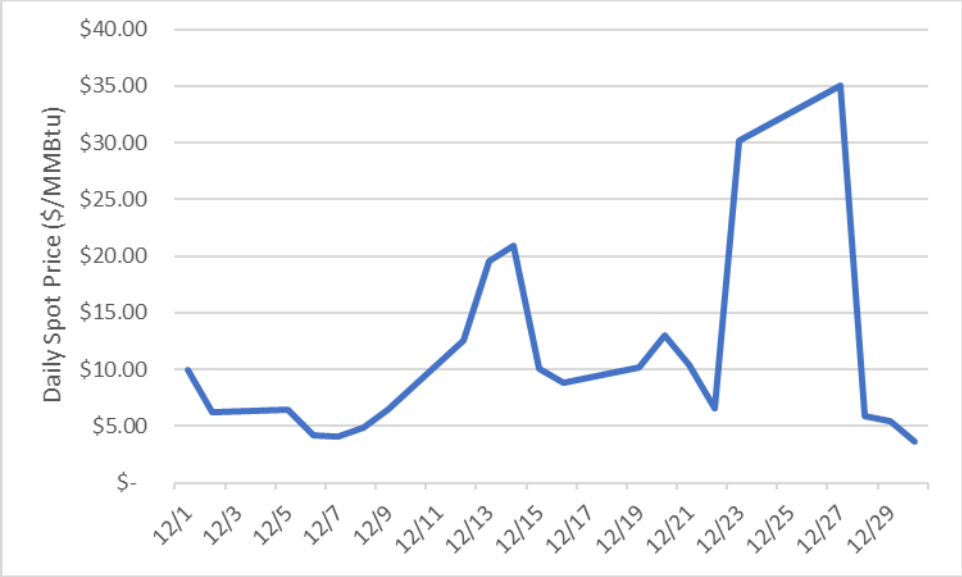
These factors, combined with Winter Storm Elliott, meant abnormally high natural gas prices in the Northeast. From Dec. 22 to 27, the spot price of natural gas at Algonquin Citygate rose from $6.54

[e] LNG arrives from abroad in New England through pipeline from an LNG facility in New Brunswick, Canada, and through two regasification facilities near Boston, Massachusetts: the Everett terminal and the Northeast Gateway deepwater port. Northeast Gateway imported just 2.8 billion cubic feet (bcf) in 2022 between January and February—direct competition from European LNG buyers brought about by Russia's invasion of Ukraine disrupted further shipments to the terminal. The war also impacted the Everett LNG terminal, which imported 20.7 bcf in 2022, with no shipments between August and November. For comparison, over the past five years, shipments to the Everett terminal alone averaged 33.3 bcf/yr for the same time period.

to $35/million British thermal units (MMBtu), then dropped below $3/MMBtu to close out the year (Figure 6).[36] As a result, dual-fuel capable power plants switched to fuel oil that—along with dedicated fuel oil-fired power plants and New England's last remaining coal-fired power plant coming online—enabled the region to meet power demand during that period.[37] Most notably, fuel oil accounted for as much as 40% of power generation during the storm. It should be noted that natural gas burns roughly 30% cleaner than fuel oil.[38]

Figure 6

Daily spot price of natural gas at Algonquin Citygate, December 2022[39]



This figure shows the change in daily spot price for natural gas at Algonquin Citygate in the Northeast for the month of December 2022. Note the large spike in prices during Winter Storm Elliott in late December 2022 as a result of restricted supply. Data from: U.S. Energy Information Administration, 2023.

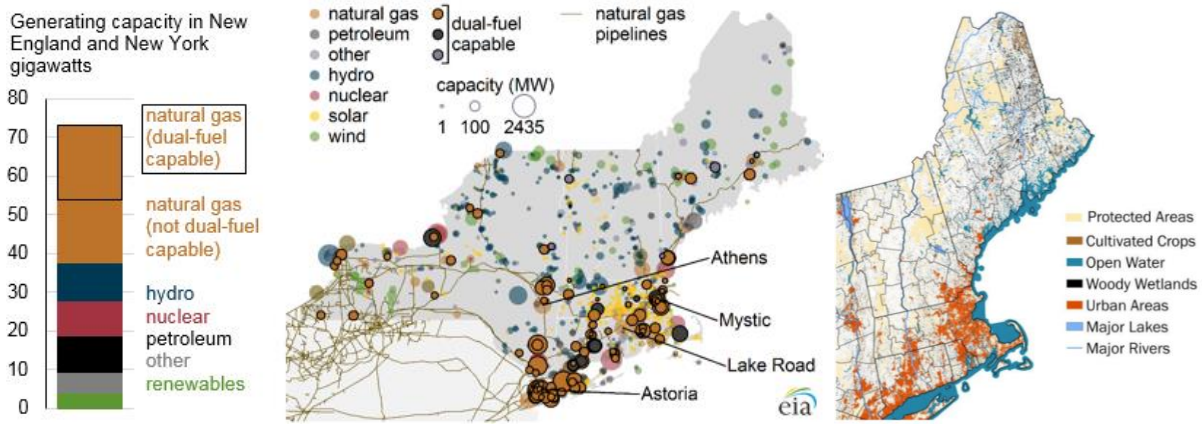
These regional conditions present an important example of the value of optionality and flexibility and for clean fuels that can provide low-carbon, reliable energy in the Northeast. The need to resort to fuels with higher carbon intensity highlights the limits of the region to access sufficient lower-carbon fuels for both power and heating applications in emergency scenarios. First, New England lacks indigenous fossil fuel reserves. As a result, the region requires fossil fuel delivery from elsewhere in the country and the world. Additionally, the region has a relatively small existing natural gas pipeline system that has not expanded to meet regional demands. The region's access to the rest of the U.S. pipeline network is limited as well.[40]

There are distinctive regional attributes that must be navigated during the transition to low carbon. Four of the seven Northeast states are among the top 10 most densely populated states in the country, and parts of the region are heavily urbanized.[41] Any new infrastructure would need to navigate around existing infrastructure clusters surrounding these large urban centers as well as major areas of protected lands in the less densely

populated parts of the region (Figure 7). In addition to these land constraints, energy infrastructure builds have typically faced opposition from local communities. Some examples include Hydro Quebec and Central Maine Power's New England Clean Energy Connect, a recent attempt to build a $1 billion high-voltage transmission line to connect the region to hydropower from Quebec that is funded by Massachusetts ratepayers. While this project stalled after a statewide referendum in November 2021—where Maine voters rejected the proposal but the referendum was deemed unconstitutional by Maine's Supreme Judicial Court in August 2022—a lower court ruled in April 2023 that the developer could proceed with construction.[42,43] Other examples: Through much of the early 2000s, offshore wind projects faced fierce opposition from coastal communities and industry, including fisheries, while solar developers experienced tensions with rural communities seeking to maintain natural landscapes.[44,45] Clean fuels will likely face similar reactions, especially with new pipelines, production facilities, and additional electricity support needed.

Figure 7

Infrastructure clusters and protected lands in the U.S. Northeast[46,47]



For urban areas in the Northeast, land constraints largely come from the majority of co-located electricity generation capacity and its associated infrastructure (left). In rural areas, protected lands represent the primary constraint on energy infrastructure development (right). Source: U.S. Energy Information Administration, 2019; Energy Futures Initiative, 2020.

This region will need to meet the "dual challenges of delivering adequate and reliable heating while also decarbonizing critical sectors of its economy," Kizer said. The goal of the workshop was to hear from panelists about how to navigate the related issues of planning, financing, and siting energy projects and enabling infrastructure to decarbonize heating. Panel 1 evaluated the different technology and infrastructure solutions for regional decarbonization, particularly focused on the role of low-carbon fuels in the context of the regional boundary conditions previously discussed. Panel 2 explored relationship building with front-line communities in project development and policy discussions. Panel 3 considered additional policy options for heating decarbonization in the context of recent concerted efforts at the federal level.

Panel 1: Evaluating the Role of Low-Carbon Fuels in the Region's Decarbonization

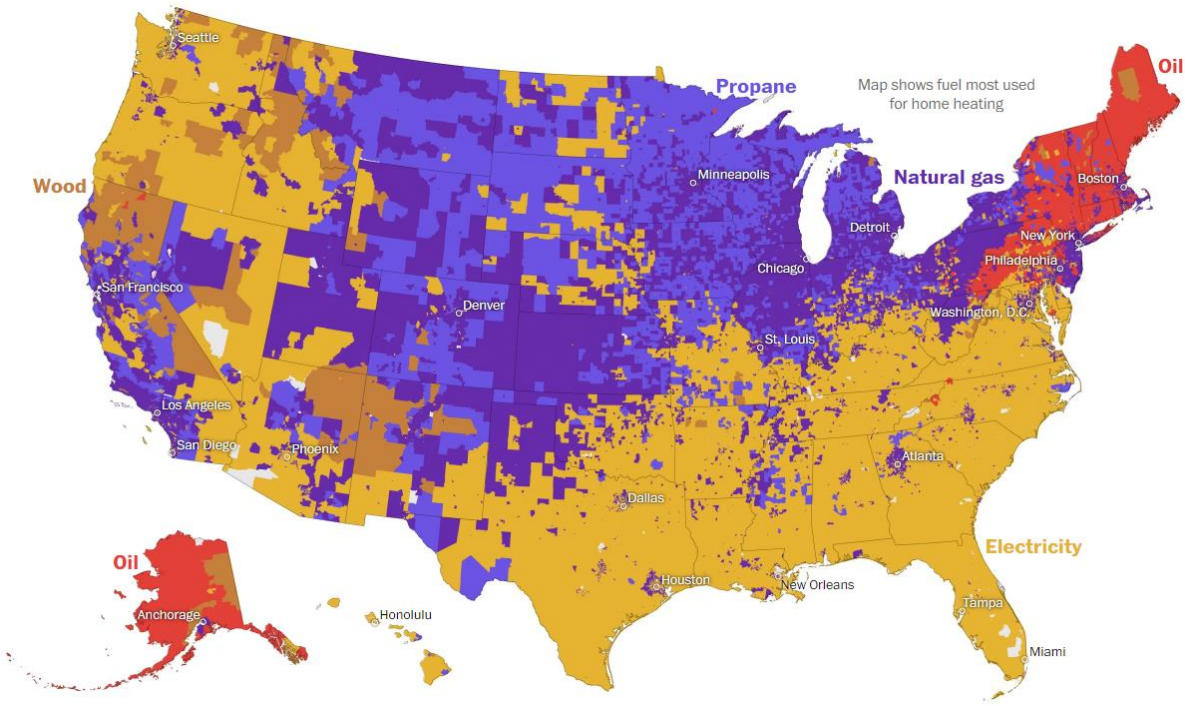
Several panelists suggested implementing a diversified approach with both clean fuels and electrification to substantially reduce heating emissions and promote regional energy security in the near term. Moderator Erin Blanton of GTI Energy focused much of the discussion on what implementation would look like in the Northeast, with a particular focus on infrastructure requirements for clean fuel technologies. To transition to a decarbonized heating system in the Northeast, Emre Gençer of MIT said, utilities and policymakers will need to identify appropriate applications for clean fuels where "electrification is not enough." Benjamin Miller of Guidehouse said that current models suggest "if you go 100% [in] one direction or 100% in another direction, you end up increasing costs across society for all actors." Using electricity and a clean fuel like hydrogen together could help reduce the energy storage requirements for the Northeast's grid as well, Gençer explained. In terms of no-regret opportunities for clean fuels in the Northeast, some panelists suggested replacing fuel oil with clean fuels in heating applications, using RNG directly in existing infrastructure, and potentially low levels of hydrogen blending, though there was debate surrounding the significance of these opportunities in terms of emissions reductions.

For residential and commercial heating, clean fuels will have the greatest application in hybrid systems using existing infrastructure of the Northeast. While clean fuels will be transformational for deep decarbonization, in high-priority, difficult-to-decarbonize sectors (e.g., heavy-duty transport, firm/dispatchable power, industrial heat) they may have limited applications in building heating decarbonization. Tory Clark of E3 highlighted hybrid systems (i.e., systems that use electricity for most heating but still can rely on clean fuels as backup) for residential and commercial buildings in the Northeast that face issues with winter peaking. In models that consider the total resource costs, customer costs, the workforce transition, and energy equity for heating decarbonization, the estimates suggest that a hybrid mix balancing cost-effective electrification with the "ability to rely on low-carbon fuels through the existing gas network" is most beneficial for customers, Clark said. One-third of the Northeast's buildings were built before 1940 and nearly half before 1960, which makes hybrid systems appealing because companies and homeowners face major cost barriers to fully electrifying such older buildings. In contrast, it is most cost-effective for new buildings to directly electrify during construction. Using clean fuels like RNG in "existing infrastructure is one of the big benefits" to avoid stranded assets while still achieving emissions reductions, said Peter Narbaitz of ICF. While the Northeast does not have sufficient RNG supplies to meet demand, it could import RNG from regions in the U.S. Midwest and Southeast that rely more heavily on electric heating (Figure 8).[48] However, there would also likely be regional and sectoral competition for this RNG. For instance, demand for RNG in California's

transportation sector has increased as a result of the national Renewable Fuel Standard (RFS) and the state's Low-Carbon Fuel Standard (LCFS).[49]

Figure 8

Comparison of primary home heating fuels across the United States[50,51]



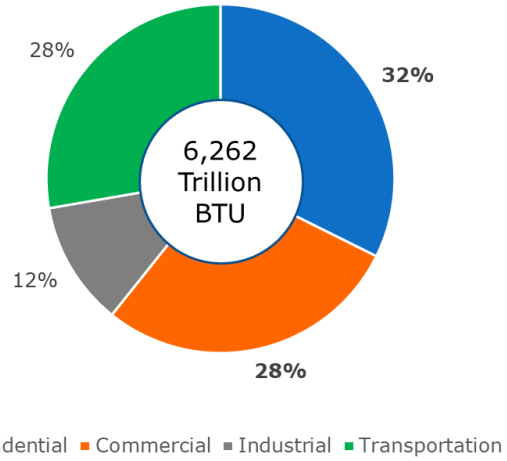
This map compares the main fuel source for home heating applications across the United States. These data are determined by the most common home heating fuel source in each census tract. Source: Muyskens et al., 2023; Data from: U.S. Census 2017-2021 American Community Survey.

For clean fuels, making accurate supply and demand projections in the Northeast's low-carbon transition are currently difficult. In many cases, modelers struggle to estimate these values because reference data input for models are difficult to find or may not exist. Miller said additional policies and regulations that encourage pilot projects and early adoption of clean fuel technologies would help provide real-world data to create stronger assessments of their importance in a low-carbon economy for the Northeast. For hydrogen, recent federal investment from the BIL for regional H2Hubs will encourage demonstration projects, Clark said, and multiple panelists cited the IRA's 45V hydrogen production tax credit as a "game changer" for clean hydrogen. However, 45V's importance for the Northeast remains unclear because it likely will have less of an impact on buildings compared to high-temperature industrial applications, a sector that represents a much smaller proportion of the regional economy than residential and commercial heating (Figure 9).[52] For all clean fuels under consideration, producers and regulators also face the

challenge of ensuring these fuels are low- or zero-carbon, particularly for the upstream emissions of “blue” hydrogen (i.e., hydrogen produced via natural gas with carbon capture and storage) and RNG production, where modeling is still at the “estimating, not measuring” phase, said Emre Gençer of MIT. Under these conditions, realistic projections for supply and demand are still unavailable because the main supply and demand vectors for clean fuels are five to 10 years down the road, Clark said.

Figure 9

Northeast energy consumption by end-use sector, 2020 (Trillion Btu)[53]



This chart depicts the proportion of energy consumption across residential, commercial, industrial, and transportation end-use applications in the U.S. Northeast. Data from: U.S. Energy Information Administration State Energy Data System, 2022.

Panel 2: Discussing Ways to Involve Local Communities as Partners in the Region’s Decarbonization

Leveraging community member input and expertise through strong public engagement will accelerate the overall clean energy transition. While community involvement in project development may appear to be a barrier to change, it can help the Northeast move from its current system to a clean “end state,” said Harvard’s Jason Beckfield. During the second panel, participants began the discussion by coming to common definitions of environmental justice, focusing on procedural justice (i.e., how to involve communities in clean energy transition decision-making). Kerry Bowie, of Browning the Green Space, said improving community engagement requires scheduling meetings at broadly accessible times, educating people on clean energy technologies, avoiding jargon in project communications, and accounting for potential language barriers, among others. The

energy transition can be frightening for many people because of the uncertainty it creates, particularly for members of the local workforce who worry about job security and financial well-being. Many energy sector workers, including executive-level energy sector workers, live in the communities near energy facilities and work to ensure customer reliability, satisfaction, and mutual trust. As a result, these workers also provide major sources of investment in their communities. John Buonopane of United Steelworkers said that without a just transition for those already working in the Northeast's energy sector, workers could lose their jobs and the subsequent workforce decline could negatively impact the rest of their community by reducing community trust and investment.

One method to strengthen community involvement is to acknowledge community members as local experts. When recognizing the varied opinions and priorities of different communities across the Northeast, it is essential that policymakers and developers "listen to what a community wants and serve their needs," said Sarah Jackson of The Nature Conservancy. It is essential that project developers acknowledge community members as partners in heating decarbonization to develop individualized plans that work for each community (e.g., choosing to fully electrify, utilizing clean fuels, or adopting a hybrid approach). Whether listening to fire and police chiefs, school board representatives, or small business owners, community members can act as local experts because they understand the nature of their community and what the general population values most. Alexandra MacLean of Leonine Public Affairs said it is important for clean energy projects to use this local knowledge to help build the project narrative around local values and priorities. Given that people who are experts on community issues may not necessarily be experts on climate and clean energy, it is also important to build trust among these different expert communities to facilitate project development. Increased community involvement also may highlight preexisting tensions between community groups, such as front-line communities and labor groups. Given the lack of representation from women and people of color in unions relative to front-line communities, it is essential that each of these perspectives is given a place at the table, Bowie pointed out.

When it comes to diversity, equity, and inclusion (DEI), it is crucial to not be "transactional" or extractive, but rather "relational," constructing meaningful partnerships between developers and communities, Bowie said. Panelists agreed that, while there has been a greater focus on incorporating DEI concerns into energy projects in recent years, many companies and developers are "just checking the box." Beckfield presented this topic of discussion in the context of conflicts and contradictions, focusing on how inadequate cohesions and representation among different community stakeholders could occur if a big economic transition plays out in the wrong way. When projects simply go through the motions for approval—as opposed to building relationships and trust with community actors—they exacerbate DEI issues and are more likely to face development challenges.

Effective engagement for any energy development must be based on "trust, communications, [and] mutual respect," Bowie said. He introduced the idea of the "golden triangle," which depicts the three necessary pathways of interaction between government, industry, and communities during project development. Projects are most

successful when strong, trusted lines of communication are established between each of these parties, he said. While government commonly interacts with both communities and industry (and vice versa), previous exploitation and injustice have eroded the trust and engagement between industry and communities. To complete the golden triangle, dialogue between industry and communities must be re-enforced and enhanced.

While it is necessary for communities to trust industry, an effective partnership will require that industry trust communities as well. As previously discussed, industry-community partnerships will depend on crafting a project narrative and engaging community leaders who have a strong sense of their community's primary concerns to meet communities "where they are at," given that most members of a community lack the information or time to contribute fully, MacLean said. On the one hand, project developers should work with impacted communities to better understand the practical implications of abstract concepts such as climate change and energy security, because energy companies "can't just walk in and say, 'I'm here to build clean energy,'" Jackson pointed out. Industry needs to include community engagement as part of its value proposition, which would require a more proactive approach from regulators as well. On the other hand, shifting narratives is not an easy task, given that the timescale to build relationships is often greater than that of the project. "Being proactive and going in early" will help alleviate some community concerns, MacLean said, but industry and developers should recognize that some level of conflict is unavoidable. Box 2 highlights examples of community engagement in energy projects in the U.S. Northeast.

Box 2

Community Engagement Case Studies From the U.S. Northeast

As previously discussed, community stakeholder conflict represents one of the major boundary conditions impacting the success of clean energy development in the Northeast. While there have been many failed attempts to build out regional energy infrastructure, there are success stories that provide important guidance on the conditions and types of engagement that allowed for mutually beneficial project development. One study compares the stakeholder engagement conditions that contributed to four projects in the region that range from completed to under development to failed: Hydro-Quebec Phase I/II, Northern Pass, Cape Wind, and Vineyard Wind. As detailed below, the Hydro-Quebec project and Vineyard Wind in particular provide examples of how clean energy project development can move forward in the Northeast.

The Hydro-Quebec project began in 1984 and became operational by 1990. The project developed a high-voltage direct current transmission line bringing hydroelectricity from Quebec, Canada, through Northern New England. The amount of electricity transmitted by this transmission line is equivalent to adding 2,000 megawatts (MW) of capacity in the region. While there were some conflicts with stakeholders regarding visual impacts and public health concerns related to electromagnetic fields, the project was ultimately successful because it promoted interstate fairness. Grassroots organizers in northern New Hampshire negotiated with developers to reroute the project to avoid serious environmental impacts.[54] The "host" states (Vermont and New Hampshire), which bore the majority of the environmental impacts with less energy demand, received a greater proportion of cost savings distributed directly to ratepayers.[55] Additionally, interviews with a variety of stakeholders suggested that the siting process was widely viewed as fair, largely through well-coordinated community outreach that engaged with nearly every landowner and town impacted by the development.[56]

Vineyard Wind is a project developing an 800 MW wind farm off the coast of Rhode Island and Massachusetts that would provide renewable electricity to New England's grid. In 2021, the project received final federal approval for construction and operation, with a plan to begin producing electricity by the end of 2023 and to reach full operation by 2024.[57,58] In the early phases of the project, Vineyard Wind chose to build submarine transmission cables based on strong stakeholder comments that highlighted how to avoid potential environmental and economic conflicts. Similarly, the project negotiated an agreement with local environmental groups to avoid harming the endangered right whale population. Local stakeholders in Barnstable and Martha's Vineyard, Massachusetts, viewed their engagement with Vineyard Wind positively as a result, compared to the failed Cape Wind project that many locals opposed.[59] Vineyard Wind also benefited from technological advances, allowing the project to produce more energy from fewer turbines much farther from the coast.[60] However, Vineyard Wind's negotiations with the Rhode Island fishing industry were largely regarded as insufficient by both sides. While a compensation agreement was reached, the industry viewed the engagement process negatively, and Vineyard Wind acknowledged its error of not addressing the fishing industry's needs earlier in the project design.[61] As of March 2023, Vineyard Wind faces four lawsuits challenging the project's federal environmental permit. Plaintiffs claim that the U.S. Bureau of Ocean Energy Management's (BOEM) environmental review inadequately accounted for impacts on the fishing industry and the right whale population.[62]

When it comes to the use of clean fuels and additional energy development in the Northeast, it will matter that engagement and development are done "the right way," Jackson said. For any clean energy projects in this region, policymakers should emphasize that, regardless of the technology, adapting to and mitigating climate change will likely require new construction and infrastructure. However, while new infrastructure is necessary, it is not necessary for construction to occur in overburdened communities. It is essential for policymakers to emphasize that infrastructure siting proceed equitably and beneficially for front-line communities. Buonopane said that in order to produce positive outcomes, local partnerships between communities and developers must keep all options open, such as pilot programs with clean fuel technologies, and highlight that long-term energy safety and reliability for Northeast customers will depend on these pathways to some degree.

Panel 3: Reviewing Policy Tools to Foster Low-Carbon Fuel Supply and Demand

Recent federal policies, including the BIL, IRA, and CHIPS and Science Act have catalyzed regional and local policy development on clean fuel technologies. The IRA in particular sends a strong message to state-level decision-makers that there is national movement on decarbonization, said Peter McPhee of the Massachusetts Clean Energy Center. Taken together, these policies alter the speed and scale of decarbonization and encourage greater private investment, said Judith Judson of National Grid. Across the country, policies such as the 45V hydrogen production tax credit could bring clean hydrogen to cost parity with natural gas much quicker than private industry activities alone, William Akley of Eversource Energy pointed out. In the Northeast, these policies have already

initiated partnerships and project development around clean fuels. Patrick Woodcock of Massachusetts' Department of Energy Resources pointed out that the BIL's H2Hubs program encouraged seven Northeast states to collaborate on a regional hydrogen hub, which would not have occurred without federal incentives.

The discussion underscored the importance of technology-agnostic policy opportunities, given the relative lack of decarbonization policy and regulation in the Northeast to date. McPhee explained that, regarding technology neutral policies, there is a tradeoff between maintaining optionality and centralized decision-making. Many states are grappling with these challenges, trying to minimize costs and maintain reliability, McPhee said. They are reaching year-to-year decisions on multi-billion-dollar investments without knowing which technologies will be a "winner," Akley added. These decisions are at the forefront of decarbonization policy in the Northeast, where sectors such as building decarbonization have lacked supportive policy and regulation, especially regarding methane emissions, McPhee said. As with the building sector, decarbonization regulations of the Northeast's gas system are still in their infancy.

To expand decarbonization guidance for buildings and heating applications, the panelists discussed clean heating standards and pricing mechanisms that could further encourage clean fuel supply and demand in the region. For the Northeast's gas system, a renewable portfolio standard (RPS)—a power sector policy that requires utilities to purchase a certain quantity of renewable electricity—could establish the foundation for a long-term regulatory structure of clean fuel procurement, Woodcock said. Similarly, a clean heat standard could enable large customers to use clean fuels in their boiler systems and help rapidly reduce emissions in hard-to-electrify sectors, Judson said.[f,63] RPS policies broadly have had success encouraging clean power development at the state level. Currently, 29 states and the District of Columbia have renewable and alternative energy portfolio standards.[64] Analysis conducted by the Lawrence Berkeley National Laboratory finds that roughly 50% of all the renewable electricity growth in the United States since 2000 occurred in states with an RPS, though this percentage has declined to about 23% of renewable electricity additions since 2019. Still, for regions such as the Northeast and Mid-Atlantic, RPS policies function as the primary mechanism for renewable electricity deployment.[65]

Regardless of the different mechanisms to encourage the supply and demand of clean fuels, the panelists agreed that these policies should incorporate a price on carbon. There was some disagreement, however, between the panelists and EFI's Ernest Moniz on the level at which the "social cost of carbon" (SCC) should be set (Box 3). Some research suggests that, while RPS programs increase renewable generation and reduce the electricity grid's carbon intensity, these policies also can increase average retail electricity prices. One study found that implementation of an RPS could equate to additional carbon abatement costs from \$130/metric ton of carbon dioxide ($MtCO_2$) to \$460/$MtCO_2$.[66] These

[f] In May 2023, the Vermont legislature passed the Affordable Heat Act—a clean heat standard—to help the state achieve its midcentury climate goals. The marketplace for this policy will encompass any clean-heat measure employed since the beginning of 2023 but likely will not take effect until 2025 due to the legislative process to implement the measure.

costs are passed on to consumers—with the study finding an 11% increase in retail electricity prices just seven years after passage of an RPS—because few states have carbon pricing mechanisms and current SCC estimates are too low to balance these associated abatement costs.[67] For comparison, the Biden administration issued an executive order that set the federal SCC estimate at $51/MtCO$_2$, and the Regional Greenhouse Gas Initiative (RGGI) cap-and-trade market in the Northeast auctioned carbon credits for $12.50/MtCO$_2$ in March 2023.[68,69] Implementation of a carbon pricing mechanism would not immediately reduce electricity costs for consumers. Over the longer term, however, carbon pricing could encourage clean and renewable energy sources that avoid carbon emissions and costs and would lower prices in the future. Ultimately, local, state, and federal governments should incorporate the most accurate SCC estimates into clean energy policy, not only to level the playing field and find the most competitive technologies, but also to allow utilities and energy providers to better forecast decarbonized operations in long-term planning, Judson said. In addition, to increase its efficacy, a carbon tax should be integrated with energy efficiency programs that would lower overall energy use and, as a result, lower costs to the consumer. To address tax regressivity, the revenues from the carbon tax should be redistributed equally per capita as dividends to benefit overall citizen well-being while also reducing poverty and inequality.[70]

Box 3

The Social Cost of Carbon

By definition, the social cost of carbon (SCC) is a dollar-value estimate of the economic damages resulting from an additional metric ton of CO_2 being released into the atmosphere. In policy, the SCC is used in a cost-benefit analysis that compares the economic benefits resulting from a given mitigation policy to the total economic costs. If emissions occurred under a specific policy, policymakers would multiply the expected emissions (or emissions increase) by the SCC to find the total estimated costs of the policy. If a particular policy removes emissions, the emissions reduction would be multiplied by the SCC to capture the full benefits of the policy.[71] One of the primary components to calculate an SCC is the near-term discount rate that reflects the value of future impacts on benefits experienced today, given the assumption that people tend to value near-term benefits more than long-term benefits. A higher rate indicates a lower dollar value is assigned to future impacts, and a lower rate attributes more value to future impacts. An SCC also usually incorporates “damages functions” that are used to translate changes in global temperatures to dollar values.[72]

Most recently at the federal level, the Biden administration issued an executive order in January 2021 to set the federal SCC estimate at $51/MtCO$_2$. The federal Interagency Working Group (IWG) on the Social Cost of Greenhouse Gases proposed this interim value, based largely on recommendations from the National Academies of Science, Engineering, and Medicine’s (NASEM) 2017 SCC analysis.[73] This estimate is approximately the same value used under the Obama administration but is substantially higher than the $1/MtCO$_2$ used under the Trump administration.[74] Although the SCC contributes to the measurement of economic damages from CO_2 emissions, uncertainty in its estimation also must be acknowledged, communicated clearly, and considered whenever possible. For example, in 90 of every 100 simulations in the IWG estimation, the SCC falls between $2.25/MtCO$_2$ and $152/MtCO$_2$, which highlights the considerable uncertainty under current estimates.[75]

Still, much analysis suggests that the current SCC value does not adequately capture the full cost of emissions. In late 2022, the U.S. Environmental Protection Agency (EPA) proposed using a SCC of $190/MtCO$_2$ from its own draft technical report.[76] The EPA’s proposed value more closely aligns with

findings from the literature—incorporating damage functions related to human mortality from heat, agricultural productivity, energy expenditures for heating and cooling, and rising sea levels—that estimate a SCC of \$185/$MtCO_2$.[77]

Conclusions and Next Steps

The U.S. Northeast region maintains important capabilities to help meet its decarbonization targets. This workshop discussion brought together nearly 50 regional stakeholders to discuss their views on important next steps to translate the region's potential into tangible action on heating decarbonization. Shifting the region's residential and commercial heating sectors to low carbon is challenging because of the region's distinct boundary conditions, though it is necessary to reach the region's goals of more than 80% emissions reductions economywide by midcentury. Leveraging the existing infrastructure, industrial players, state and local policy, major research universities and institutions, and a robust workforce will be needed to unlock the Northeast's full potential. One vital area of concern for the participants is the need to build new infrastructure in the region. Each panel discussion described the current challenges of project siting and permitting today, offering specific insights that may help spur progress. Given that the buildings sector is particularly difficult to decarbonize in the Northeast, it is essential that developers consider how existing and new infrastructure could support future hybrid systems using a variety of clean fuel pathways. Decarbonizing heating in the region will depend on this technology optionality and flexibility alongside effective engagement with major stakeholders, particularly front-line communities and the energy workforce, to ensure that clean heating infrastructure development proceeds in a way that supports the needs and goals of the local community as well as climate goals. While heating decarbonization may look different across the U.S. Northeast, all of these pathways will need to guarantee energy security and reliability in addition to emissions reductions.

Appendix: Biographies of Speakers and Moderators

Note: All biographical information denoted below represents titles and positions held at the time of the workshop in December 2022.

William Akley

President, Gas Business | Eversource Energy

William J. Akley is President of Gas Operations for Eversource Energy. He is responsible for the overall operations of the safe and reliable delivery of natural gas to approximately 887,000 customers in 190 towns and cities in Connecticut and Massachusetts. Akley has more than 35 years of leadership and management experience and is a seasoned veteran of the utility industry in all facets of natural gas transmission and distribution. Prior to joining Eversource, he was Senior Vice President of U.S. Gas Operations for National Grid and responsible for field operations including construction, maintenance, and meter service throughout the company's service territory in New York, Rhode Island, and Massachusetts. Prior to National Grid, Akley spent several years at KeySpan Energy in New York, Massachusetts, and New Hampshire. He earned his MBA from Adelphi University and his bachelor's degree in Mechanical Engineering from Clarkson University.

Jason Beckfield

Robert G. Stone Jr. Professor of Sociology | Harvard University

Jason Beckfield is the Robert G. Stone Jr. Professor of Sociology at Harvard University, where he is also the Associate Director of the Center for Population and Development Studies. He holds a PhD in Sociology in 2005 from Indiana University in Bloomington and later taught at the University of Chicago before joining the Harvard faculty in 2007. His research and teaching are in the areas of social stratification, political sociology, population health, and climate change. Currently, he is investigating the sociology of energy transitions, with a focus on the petrochemical-rich region of the U.S. Gulf Coast.

Erin Blanton

Managing Director, Zero Emissions Systems | GTI Energy

As the Managing Director of Zero Emissions Systems, Erin Blanton leads GTI Energy's methane emissions mitigation solutions strategy and focuses on the role of natural gas infrastructure in facilitating energy transitions toward a net-zero future. Blanton joined GTI Energy from Columbia University's Center on Global Energy Policy, where she led the Natural Gas Research Initiative and the center's environmental, social, and governance research. She has extensive experience advising financial professionals on energy markets and investments. Blanton holds a master's degree from Columbia University's School of International and Public Affairs and a Bachelor of Arts in economics from Cornell University.

Kerry Bowie

Founder, President, and Executive Director | Browning the Green Space

Kerry Bowie is the Browning the Green Space (BGS) Co-Founder, President, and Executive Director, and has 25 years of experience in private, public, and nonprofit management. Bowie previously served as Director of Environmental Justice at the Massachusetts Department of Environmental Protection (MassDEP) in both the Patrick and Baker administrations; worked as a manager in Facilities, Environmental, Safety, and Health at Texas Instruments' Research & Development Lab in Dallas, Texas, and grew up in a fenceline community in Alabama (Anniston). Bowie also serves as Managing Partner at Msaada Partners, a Boston-based consultancy providing technical assistance to promote social impact in communities of color. Bowie also co-founded the Majira Project to address the lack of diversity in the traditional entrepreneurial ecosystem and the disparity in resources available that he observed while working in various entrepreneurship programs across Boston. Bowie holds an MBA from the MIT Sloan School of Management as well as a Master of Science in environmental engineering from the University of Michigan, and a Bachelor of Science in environmental engineering science from MIT.

Tatiana Bruce da Silva

Project Manager & Contributing Senior Analyst | Energy Futures Initiative

Tatiana Bruce da Silva is a Project Manager and Contributing Senior Analyst at the Energy Futures Initiative. Bruce da Silva completed her doctorate in sustainable energy systems at Instituto Superior Técnico, Universidade de Lisboa. She also holds a Master of Public Administration from the University of Pennsylvania and a Bachelor of Arts in economics from the Federal University of Pernambuco in Brazil. Bruce da Silva is an experienced researcher with a demonstrated work history in the public and private sectors. She is skilled in energy policy, decarbonization of energy systems, energy transition, renewable energy, distributed energy resources, electric vehicles, new mobility technologies and services, and energy integration in Latin America.

John Buonopane

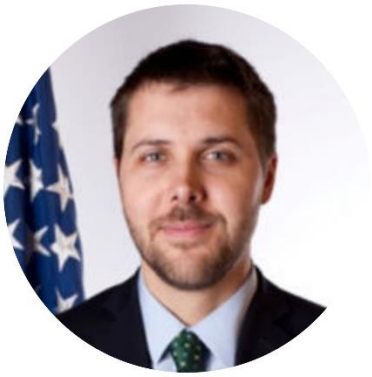
Staff Representative | United Steelworkers Union

Buonopane joined the United Steelworkers Union in 1987 when he began his employment with the Boston Gas Co. Buonopane worked in the field as a Gas Service Technician for more than 30 years. During Buonopane's employment, he has held several local union positions, from Shop Steward to Local Union President. Buonopane began working with the United Steelworkers Union as a full-time Staff Representative in 2019. As a Staff Representative, he represents several people employed in a diverse group of industries, including transportation, manufacturing, municipal/state employees, and gas utility workers. Buonopane has served on the board of the New England Gas Workers Alliance (NEGWA) since 2017. For over 30 years, NEGWA has been an advocate for safe and reliable gas networks. NEGWA has also been heavily engaged with attaining alternative energy work for gas workers, such as geothermal and renewable natural gas /hydrogen.

Tory Clark

Senior Director | Energy and Environmental Economics

Tory Clark leads projects focusing on U.S. state-level climate policy, energy infrastructure planning, and low-carbon technologies for Energy and Environmental Economics (E3). She provides clients with rigorous technical modeling as well as practical, accessible translations of complex analyses to inform energy and climate policy. Clark has extensive experience helping states chart policy pathways to reach long-term greenhouse gas reduction goals, both within and outside the electricity sector. Two recent projects identified measures to reduce transportation sector emissions in line with state targets for the Minnesota Department of Transportation and illustrated the role of Minnesota's electricity sector in decarbonizing the state's economy as part of Xcel Energy's 2019 Integrated Resource Plan. She has also led E3 projects for the California Air Resources Board, Maryland Department of the Environment, New York State Energy Research and Development Authority, and Oregon Department of Environmental Quality, among others.



Brian Deese

Director | National Economic Council

Brian Christopher Deese is an American economic and political advisor who is the 13th Director of the National Economic Council, serving under President Joe Biden. In this position, he additionally serves as the inaugural chair of the White House Competition Council. He previously served as a senior advisor to President Barack Obama. Earlier in the Obama administration, Deese served as the Deputy Director and Acting Director of the Office of Management and Budget. Deese also served as Deputy Director of the National Economic Council. Deese served as the Global Head of Sustainable Investing at BlackRock.

Sarah Jackson

Climate and Energy Policy Manager, Northeast Region | The Nature Conservancy

Sarah Jackson is the Climate and Energy Policy Manager for the Northeast Region at The Nature Conservancy. In this position, Jackson leads strategy on climate and energy policy from Maine to West Virginia. Jackson serves as a subject matter expert, adviser, and point-person on regional clean energy and climate issues and provides strategic guidance on specific policy engagement strategies at the state and regional levels. For more than five years, Jackson worked as a Senior Associate for Synapse Energy Economics, a research and consulting firm specializing in energy, economic, and environmental topics, where she analyzed the economic and environmental implications of energy and environmental policies on the electric industry. Prior to working at Synapse, Jackson was a Research and Policy Analyst at Earthjustice.

Emre Gençer

Principal Research Scientist | Massachusetts Institute of Technology

Dr. Emre Gençer is a Principal Research Scientist at MIT Energy Initiative with more than 10 years of experience in sustainability, energy transition, software development, and clean energy technologies. His current research is focused on providing analytical capabilities to accurately estimate the environmental and economic impact of national and corporate energy choices. He attended Purdue University where he earned his PhD in Chemical Engineering.

Judith Judson

Head of U.S. Strategy and Head of Hydrogen | National Grid

Judith Judson is the Head of US Strategy and Head of Hydrogen at National Grid. Judson is a results-focused energy industry executive with an exceptional combination of policy, regulatory, project, and business strategy experience. She has a proven track record of growing and developing clean energy projects and markets, with nationally recognized expertise in energy storage. Proficient in all aspects of bringing innovative projects from concept to market, Judson is highly successful at leading and advocating for market rules, regulations, and legislation at the state, regional, and federal levels.

Alex Kizer

Senior Vice President of Research and Analysis | Energy Futures Initiative

Alex Kizer is the Senior Vice President of Research and Analysis at the Energy Futures Initiative (EFI). He develops and manages projects on cross-cutting issues related to technology, policy, and innovation in energy sectors at home and abroad. An expert in developing and managing major analytical initiatives, Kizer supports funders and sponsoring organizations with advice on navigating the interaction between technology disruptions and legacy markets and systems. At EFI, Kizer oversees all qualitative and quantitative analysis for EFI reports, including “Optionality, Flexibility & Innovation: Pathways for Deep Decarbonization in California,” “Advancing the Landscape of Clean Energy Innovation” (for Bill Gates’ Breakthrough Energy), “Investing in Natural Gas for Africans” (a project sponsored by the Africa50 infrastructure fund), and white papers on blockchain technology applications for energy, an examination of the U.S. nuclear enterprise and the role it plays in national security, studies on large-scale carbon management, and a variety of budgetary analyses.

Peter McPhee

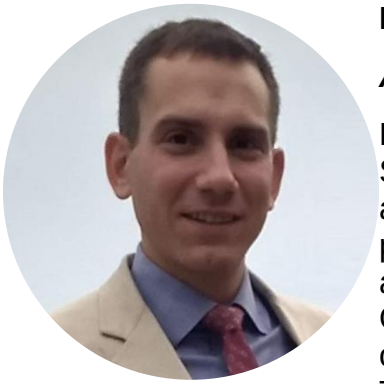
Senior Program Director | Massachusetts Clean Energy Center

Peter McPhee is a Senior Program Director at the Massachusetts Clean Energy Center (MassCEC), where he leads the development and execution of MassCEC's strategy to help facilitate the decarbonization of the Commonwealth of Massachusetts' buildings. In his previous role as the Director of Clean Heating & Cooling, McPhee spearheaded a $60 million suite of programs to develop emerging clean energy industries in the heating and cooling sector and support the commonwealth's transition from traditional, fossil-based heating to renewable alternatives. He has spent his career as a clean-energy professional working at the intersection of technologies, markets, and policy from optimizing utility efficiency programs to designing wind energy projects. He holds a Bachelor of Science from the University of Massachusetts Amherst and a Master of Science from the Johns Hopkins University, both in mechanical engineering.

Alexandra MacLean

President of Public Relations | Leonine Public Affairs

Alexandra MacLean is the President of Public Relations and Strategic Relations at Leonine Public Affairs. MacLean grew up in Peacham, Vermont, and is a Partner and President of Strategic Communications at LPA. MacLean has designed and implemented numerous successful public relations efforts and campaigns. Throughout her career she has helped businesses, nonprofits, and political campaigns create and execute their strategic visions and achieve their public policy goals. MacLean brings her deep experience in public affairs as Vermont Gov. Peter Shumlin's Campaign Manager, Campaign Strategist and Deputy Chief of Staff to her work at Leonine Public Affairs.



Benjamin Miller

Associate Director, Sustainability | Guidehouse

Benjamin Miller is an Associate Director in Guidehouse's Energy, Sustainability & Infrastructure practice. Miller has spent more than a decade leveraging his background in modeling and analysis to provide data-driven recommendations for energy, environmental, and climate issues across the public and private sectors. Prior to Guidehouse, Miller worked at the Massachusetts Executive Office of Energy & Environmental Affairs, where he served as the Technical Lead for the Massachusetts 2050 Roadmap Study and led policy development for much of the Commonwealth's 2030 Clean Energy & Climate Plan. He worked closely with the Governor's Commission on Clean Heat and the 20-80 "Future of Gas" Docket. Miller holds a Bachelor of Arts from Harvard and a Master of Arts from Suffolk University. He resides with his wife and daughter in South Medford, Massachusetts.

Ernest J. Moniz

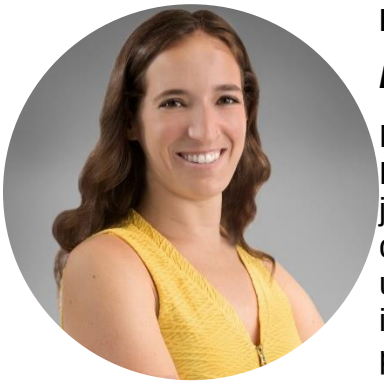
President and CEO | Energy Futures Initiative

Ernest J. Moniz is the President and CEO of the Energy Futures Initiative. He served as the 13th U.S. Secretary of Energy from May 2013 to January 2017. As Secretary, he advanced energy technology innovation, nuclear security and strategic stability, cutting-edge capabilities for the American scientific research community, and environmental stewardship. He strengthened the U.S. Department of Energy (DOE) strategic partnership with its 17 national laboratories and with the Department of Defense and the broader national security establishment. Specific accomplishments included producing analytically based energy policy proposals that attracted bipartisan support, implementing legislation, leading an international initiative that placed energy science and technology innovation at the center of the global response to climate change, and negotiating the historic Iran nuclear agreement alongside the Secretary of State. He reorganized a number of DOE program elements, elevated sound project and risk management, and strengthened enterprisewide management to improve mission outcomes.

Peter Narbaitz

Director, Energy Markets & Planning| IFC

Peter Narbaitz is the Director of Energy Markets and Planning at ICF. Narbaitz supports and advises natural gas and electric utilities with strategic planning related to decarbonization and climate policy. Drawing on a unique combination of technical, financial, regulatory, and industry expertise, he helps companies build plans and set targets for a lower-carbon future. In particular, Narbaitz works with utilities to develop electrification and decarbonization scenarios or pathways and assess their impact on energy demand, GHG emissions, risks, and opportunities for utilities. Narbaitz also partners with these companies to evaluate their GHG emissions, understand emission reduction options, and build roadmaps to achieve targeted reductions. Based in Ottawa, he helps organizations across the U.S. and Canada leverage ICF's expertise to make a difference for them—by building teams that can guide the decisions that matter most.



Madeline Schomburg

Director of Research | Energy Futures Initiative

Madeline Schomburg is the Director of Research at the Energy Futures Initiative. Schomburg's research focuses on energy justice, examining access and inclusion in policy processes, and decision-making. Most of her work has focused on domestic unconventional oil and gas development, investigating the role of interest groups in mobilizing constituents to participate in political processes, and the role of policy entrepreneurs in diffusing relevant policies throughout the United States. As an assistant professor of environmental policy at Colorado State University, Schomburg collaborated with scholars from numerous institutions and with community partners to advance social science research in energy and the environment. At Colorado State University, she also served on the steering committee of the Center for Environmental Justice, where she helped create new programs in environmental justice, built partnerships with grassroots environmental justice organizations, and secured the center's first external grant.

Patrick Woodcock

Commissioner | Massachusetts Department of Energy Resources

Patrick Woodcock was named DOER Commissioner in February 2020. Formerly, the Executive Office of Energy and Environmental Affairs' Undersecretary of Energy, Woodcock was named Acting Commissioner in December 2019 and served in this role until his current appointment. Woodcock joined the Baker-Polito administration in 2017 and served as the Undersecretary of Energy in the Executive Office of Energy and Environmental Affairs for over two years. In that position, Woodcock oversaw the Department of Energy Resources and the Department of Public Utilities. Woodcock serves on the Massachusetts Clean Energy Center Board and Investment Committee, represents Massachusetts on the boards of the Regional Greenhouse Gas Initiative Inc. and National Association of State Energy Officials, and is a member of the Energy Facilities Siting Board. Prior to his time in the administration, Woodcock was Director of the Maine State Energy Office, a position he held from 2013 through 2016. Previously, Woodcock worked for U.S. Sen. Olympia Snowe in her Washington, D.C., office. Woodcock graduated from Bowdoin College and holds a Bachelor of Arts degree in Government.

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