Challenges and Opportunities for Deep Decarbonization through Strategic Electrification under the Utility Regulatory Structures of the Northeast

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ABSTRACT

Electrification will be a key component of deep decarbonization when pursued in concert with energy efficiency and reducing emission on the electric grid. We define strategic electrification as powering end-uses with electricity instead of fossil fuels in a way that increases energy efficiency and reduces pollution while lowering costs to customers and society, as part of an integrated approach to deep decarbonization. This paper dives into strategic electrification in the seven Northeastern states and looks at how states and utilities are responding to this opportunity and challenge. We use the Multi-Sector Emissions Model, combined with stock turnover and market assessments, to show that rapid adoption of electric vehicles, heat pumps, and other electrification technologies would be necessary to meet the states' ambitious greenhouse gas emission reduction targets. We then discuss the electric grid and utility impacts of electrification, with particular emphasis on the importance of rate design and implications for resource planning. We conclude with a short survey of electrification programs in the Northeast, with particular focus on new and pending regulated programs in Vermont, New York, and Rhode Island, and an analysis of why electric ratepayer-funded programs have only recently come to the fore.

Introduction

New York and the New England states have adopted aggressive greenhouse gas (GHG) emission reduction goals. The deep decarbonization that will be required to achieve these goals is already well underway, as evidenced by the 18 percent drop in carbon dioxide (CO_2) emissions in these seven states between 2001 and 2015 (U.S. EIA 2018). However, there's still a long way to go: the region's collective objectives will require emission reductions of about 80 percent below 2001 levels by 2050. Electrification of end-uses currently fueled by direct fossil fuel use will be an essential component of deep decarbonization. This paper draws upon the analysis and stakeholder processes we conducted along with Meister Consultants Group (a Cadmus Company) in order to inform the *Northeastern Regional Assessment of Strategic Electrification* published by Northeast Energy Efficiency Partnerships (NEEP) in July 2017 and the subsequent *Action Plan* published in 2018.[1]

To date, the state and market actions that have resulted in most of the achieved GHG emission reductions in the Northeast have focused on the electric supply sector and on increasing energy efficiency. But enhanced energy efficiency and carbon-free electricity can reduce regional emissions by only about 40 percent by 2050—half the amount required. The remaining emissions result from direct fuel use in buildings, transportation, and industry. Consumers in New York and New England use about 4.2 quadrillion British thermal units (BTU) of fossil fuels annually for direct end-uses. On-road vehicles, space and water heating in residential and

[1] The authors particularly wish to thank and acknowledge Neil Veilleux, Philip Kreycik, and Jeremy Koo of Meister Consultants Group, a Cadmus Company, for their contributions to the *Northeastern Regional Assessment*.

commercial buildings, and industrial process heat and steam together account for 85 percent of this direct fossil fuel use. Reducing emissions by 80 percent will require transitioning direct fossil fuel combustion to electricity along with the deep decarbonization of the New England electricity supply or, when electrification is not practical, to other lower carbon fuels. Electric technologies with the potential to displace—and eventually replace—direct fossil fuel use are now commercially available, although at varying levels of maturity.

Electrification can work with efficiency and clean electric supply to drive deep decarbonization. Executing this transition will require careful planning and informed decision-making about how, when, and if end-uses are moved to electricity, as well as how the electric grid evolves and develops to meet new demands. Deep decarbonization will require mature markets for a wide range of technologies, each of which contribute one or more of the properties required: 1) low-carbon energy supply; 2) energy efficiency; 3) flexibility; and 4) electrification (see Figure 1). Some technologies may be favored because they contribute more than one of these properties. The transition requires *strategic electrification*: powering end-uses with electricity instead of fossil fuels in a way that increases energy efficiency and reduces pollution, while lowering costs to customers and society, as part of an integrated approach to deep decarbonization.

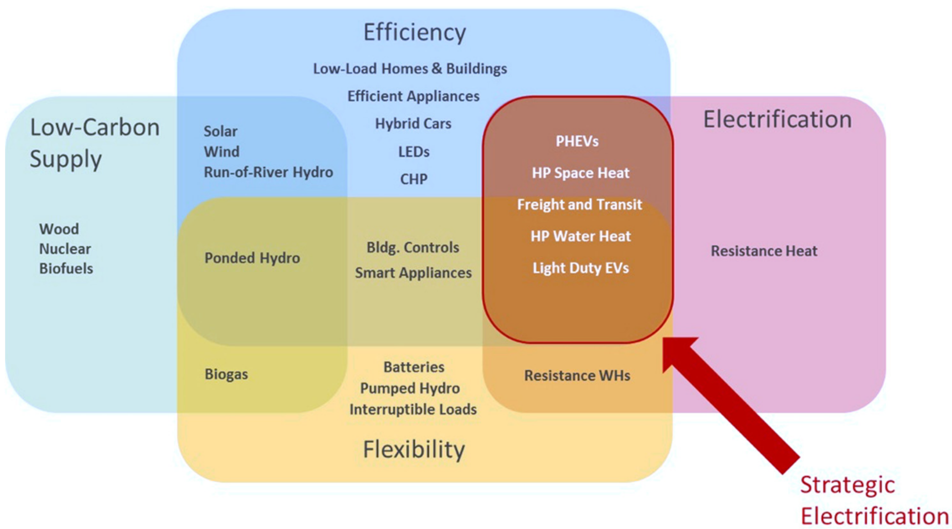

Figure 1. Strategic electrification takes place at the overlap of efficiency and electrification.

The need for substantial and prompt market change

To achieve deep decarbonization via strategic electrification, there are several technologies that are both available and capable of meeting the vast majority of the consumer needs currently met by direct fossil fuel use in the Northeast. These include:

- For **space heating**, air source heat pumps (ASHPs) are the primary option. Ductless mini-split and ducted heat pumps available today can provide a coefficient of performance (COP) of more than 1.75 at 5ºF, and thus meet the NEEP cold climate heat pump specification. Ground source heat pumps are also an option, particularly for new construction, and commercial variable refrigerant flow (VRF) heat pump systems can also be cold climate capable.

- For **water heating**, heat pump water heaters (HPWHs) can meet most consumer needs.
- For **light duty transportation**, electric vehicles (EVs) provide a rapidly growing and diverse set of options to consumers, including both battery EVs and plug-in hybrid EVs.
- For **medium- and heavy-duty vehicles** there are electric options that are emerging and, in some cases, available to serve specific market niches, such as local freight and transit.
- **Industrial process heat and steam** needs can be met in some cases with electricity, although most electric options beyond electric arc furnaces are either inefficient (electric resistance boilers) or novel (induction heating).

Achieving the goal of 80 percent GHG emissions reduction by 2050 using electrification would require achieving a "maximum electrification" (Max Electric) market path, which would also require enhanced energy efficiency and a nearly decarbonized electric supply for the Northeastern states. We used Synapse's Multi-Sector Emissions Model (M-SEM) to model and track emissions in different scenarios and consistently treat the increasing electric consumption resulting from electrification.[2] The Reference case is based on the 2017 EIA Annual Energy Outlook. We modeled scenarios of rapid market transformation for new electric technologies, combined with the expected pace of equipment replacement, and found that a 77 percent GHG reduction can be achieved through "maximum electrification" of the dominant direct fuel uses (space and water heating, on-road vehicles, and process heat and steam), coupled with a transition to more than 97 percent carbon free electricity. The remaining three percent reduction would need to be acquired from the other, smaller end-uses.

Recognizing that markets may not be able to transform as quickly as the Max Electric scenario would require, we also modeled a "Plausibly Optimistic" scenario. Figure 2 shows the rapid market transformation modeled in the markets for residential space heating and light duty vehicles (cars and light trucks) under the Max Electric and Plausibly Optimistic scenarios. In the Max Electric scenario, both natural gas and delivered fuel markets are rapidly electrified; in the Plausibly Optimistic scenario, the natural gas transition is delayed by a decade or so. We modeled water heating and commercial space heating as electrifying at a comparable pace to residential space heating, with heavy duty transportation lagging ten years behind light-duty and concentrated in shorter-range (intra-urban) freight. We modeled heat pumps as generally requiring a backup fossil fuel heating system, with the portion of heat provided by that backup system falling over time as heat pumps and building shells both improve.

The Plausibly Optimistic case achieves a 69 percent GHG emissions reduction with energy efficiency, clean electricity, and electrification. From 69 percent to 80 percent could be achieved with sufficient supplies of low-carbon biofuels, such as biodiesel, bioheat, and renewable natural gas.

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[2] M-SEM provides a comprehensive picture of future emissions across all energy sectors and enables analysis of the impacts of technology shifts, policies, and other cross-sector interactions within states and regions. See http://www.synapse-energy.com/MSEM for a full description.

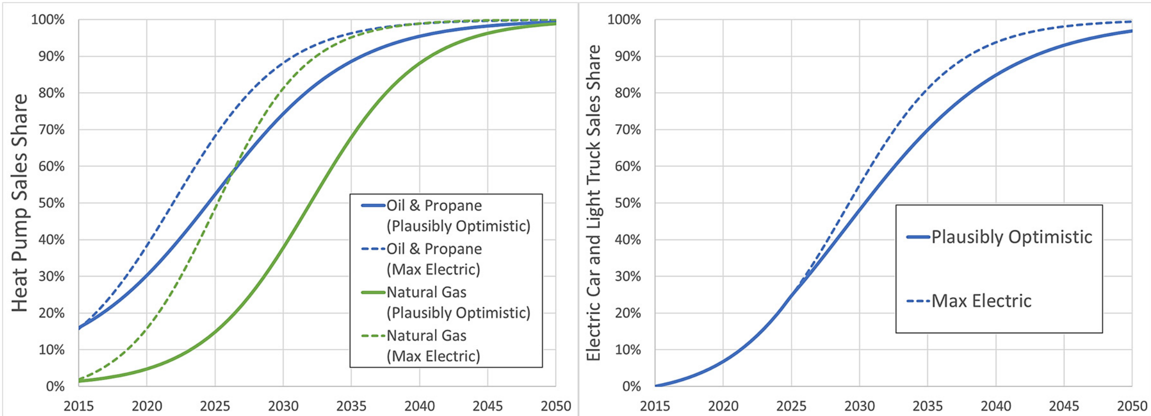

Figure 2. Sales shares for residential heat pumps and electric cars and trucks under the "Max Electric" and "Plausibly Optimistic" scenarios. Heat pumps displace oil and propane faster than they displace natural gas in both scenarios.

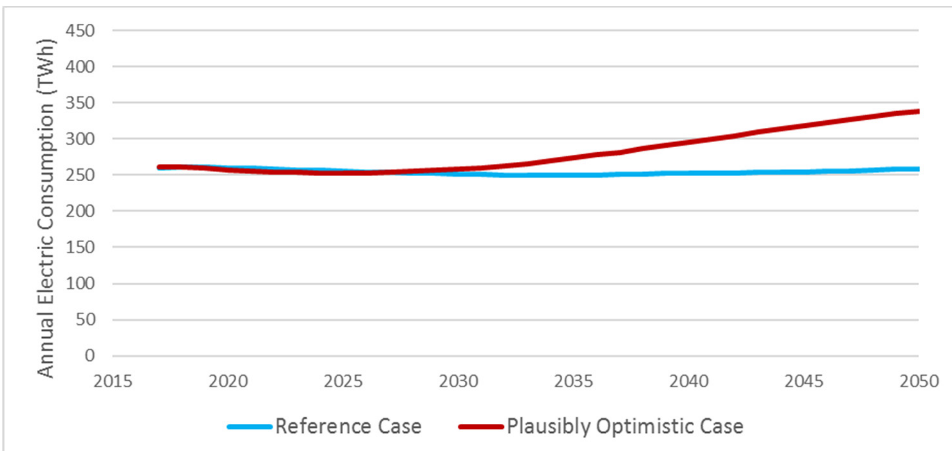

Figure 3: Regional electric sales in the Plausibly Optimistic scenario, compared with the reference case

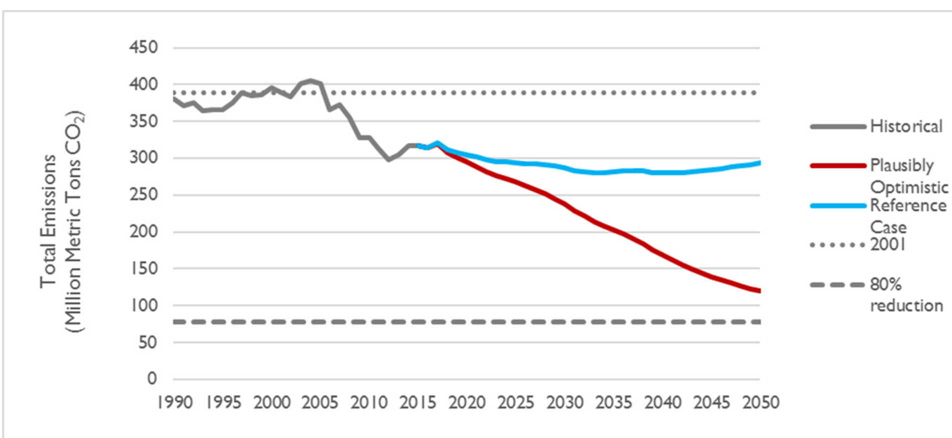

Figure 4: GHG emissions in the Plausibly Optimistic scenario, compared with the reference case

Utility and grid impacts will be substantial

Economy-wide shifts of transportation and heating from direct fossil fuels to electricity will result in dramatic changes in utilities' roles and responsibilities, as well as substantial changes in demands on electric supply resources. The following section describes at a high level the impact of strategic electrification on utilities and the grid. This includes a brief discussion on rate design and electric rate impacts, implications for electric supply resources, and implications for natural gas utilities.

Electric rates and rate design

If the demand from newly-electric ends uses is managed well, strategic electrification has the potential to increase electric energy sales (kWh) more quickly than it increases peak demand (kW). If the loads are not managed well, however, electrification could increase peak demand and drive costs for new transmission and distribution infrastructure. Rate structures may be a primary tool to shape these loads, although direct utility control and a monthly credit for participation may also be effective—especially where geographic variation matters. Rate design to both encourage and optimize electrification is therefore an important tool for lower rates.

Load management tools (whether in technology or in rates) can restrain peak growth and increase grid utilization (or prevent it from falling). Increased utilization of existing infrastructure can put downward pressure on rates because the sunk costs of the grid can be spread over more energy sales. EV and water heating loads can be coincident with summer peaks, so there is a near-term need to develop methods to encourage off-peak charging or control water heaters. Much of the Northeastern electric grid was built to handle summer peaks, so rising winter peaks from space heating should not create immediate costs to upgrade the grid. For example, a recent study conducted for Rhode Island, which analyzed rate impacts for a scenario with increased heat pumps and solar hot water systems, found negligible rate impacts due to the downward pressure on rates from increased electricity sales (RI DOER 2017).

End-uses central to strategic electrification—EVs and water heating—can act as distributed energy resources to increase operational flexibility on the distribution and transmission grids (Hledik et al. 2016). This flexibility would enable the shaping of the daily load shape, but it would not mitigate the seasonal shift in energy use. Water heaters and EVs are prime candidates for shaping dynamic loads because they each have storage built in: EV batteries and the thermal storage in water tanks. Heat pumps for space heating may also provide some flexibility through pre-heating, especially in higher-performance and higher-mass building shells. The options for harnessing these resources depend on how well this storage can be utilized.

Retrofits for buildings with existing fossil fuel heating systems with high efficiency electric space heating technologies also offer another kind of flexibility: using the preexisting fossil fuel heating system at winter peak. By keeping the legacy fossil fuel heating system in place as a back-up heating source, it is possible to install a smaller sized heat pump, thus reducing upfront costs to the consumer while also reducing electric system stress from increasing loads during periods of severe cold weather.

Northeastern electric utilities offer average rates that are among the highest in the country. If offered as a flat per-kWh rate, as they are to most Northeasterners, these rates have a negative effect on the customer economics of adopting EVs and heat pumps.[3] Time-of-use rates (or even more dynamic prices) in which the electricity price falls substantially during low-demand periods could provide EVs and smart electric homes the option to soak up energy at low-cost times, benefitting both the grid's and the customer's economics. However, time-of-use rates with substantial price variation over the course of the day are not widely available in the Northeast, for either supply or distribution service. Where utilities have not yet adopted smart meters, regulators could consider the ability to offer rate structures conducive to electrification as a benefit when determining whether to approve investment in meters.

Aggressive ratepayer-funded energy efficiency programs contribute one cent or more per kWh to many Northeastern electric bills—and these are flat rates as well. Policymakers considering electrification as part of a comprehensive approach to least-cost decarbonization may also consider using time-varying rate design of the system benefit charge itself to bolster their objectives.

Implications for electric supply planning

Meeting an increased demand for electricity will require additional supply resources, and these supply sources (as well as replacements for existing fossil resources) will need to be nearly zero-carbon to achieve decarbonization objectives. The new electric end-uses reflected in a strategic electrification portfolio will have their own seasonal characteristics. Heating loads are highly seasonal, but driving patterns also vary over the year. Figure 5 illustrates the expected changes in seasonal electricity consumption between 2015 and 2050 if the Northeastern region electrifies. Utilities and policymakers could consider these changes when making long-term plans. In the Plausibly Optimistic scenario, January consumption exceeds August consumption starting in 2032. We have not modeled the peak demand impacts in detail, although as discussed above they will be substantially affected by the effectiveness of the efforts used to shift demand away from peak times, as well as the overall increases in efficiency achieved across all end-uses.

Implications for natural gas utilities and consumer equity

If electrification reduces natural gas sales for heating in the residential and commercial sectors, the effective utilization of the gas distribution system will fall. The need to spread fixed costs over lower sales volume would theoretically increase rate pressure. To the extent that rates rise, it improves the customer economics for others to adopt electric space and water heating options, further exacerbating the challenge for the gas distribution network. The customers remaining connected to the natural gas system as this cycle progresses would be late adopters of technologies associated with strategic electrification. This phenomenon will likely raise important equity issues that will require careful planning. At the extreme end of a shift of building and water heat from natural gas to electricity, natural gas distribution systems could become stranded assets unless they are fully depreciated. Natural gas utilities could also compete to decarbonize through use of biogas, although the cost of this fuel could also exacerbate rate challenges. Gas utilities in California, where similar issues could arise, are speaking out in

[3] Using the U.S. DOE's "eGallon" calculator based on average electric and gasoline prices, Massachusetts EV drivers save only 27 percent on the cost of driving compared with an internal combustion vehicle, while Maryland drivers save 57 percent and California drivers 51 percent (U.S. DOE 2018).

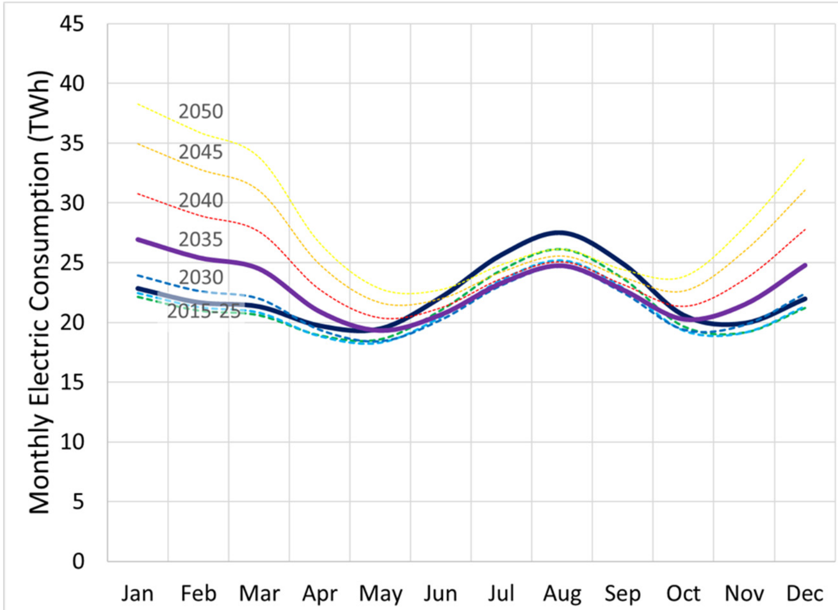

Figure 5: Approximate monthly electricity consumption, 2015–2050, as modeled under the Plausibly Optimistic scenario, showing the shift to winter use

opposition to electrification (Minter 2018). Public conversations around these issues have not yet begun in earnest in the Northeast.

Electrification programs in the Northeast

Our analysis of the pathways to deep decarbonization in the Northeast shows that markets for electrification technologies, including heat pumps, heat pump water heaters, and EVs, need to grow rapidly and soon in order to develop the installed stock of these technologies in time to meet 2050 GHG targets. Utilities have unique and important roles to play in these markets—as the providers of the fuels on which they operate and the infrastructure over which they are delivered, and as the operators of large programs with experience helping customers select more energy efficient options to meet their needs. Utility efficiency programs signal more efficient product choices to homeowners, building trades, and contractors through labels, rebates, upstream price buy-downs, recommendations from energy audits, broader public education and advertising, and other actions. Utility programs can also serve as trusted validators for the performance and acceptability of new technologies. Each of these tools could contribute to advancing public policy by accelerating markets for efficient electrification in buildings and transportation at the pace required to meet decarbonization goals. This section examines the short history of electrification programs in the Northeast, tracing their development from the non-regulated sphere toward integration with regulated efficiency programs.

Initial northeastern electrification programs operated outside of the regulatory sphere

Until very recently, Northeastern states that have implemented electrification programs have done so wholly or largely outside of the sphere of regulated utilities. For example, the region's three largest electric vehicle rebate programs are operated by state governments and funded by sources not subject to ongoing oversight from utility commissions. The Massachusetts Offers Rebates for Electric Vehicles (MOR-EV) program and the New York Drive Clean EV rebate are both funded by proceeds from the Regional Greenhouse Gas Initiative (RGGI) (MA EEA 2017 and NYSERDA 2017). The Connecticut Hydrogen and Electric Automobile Purchase Rebate (CHEAPR) program is funded by utility shareholders via settlements from electric utility acquisitions and mergers (CT DEEP 2018).

State support for heat pumps has followed a similar pattern. Efficiency Vermont uses RGGI funds along with revenue from the forward capacity market (FCM) to fund heat pump incentives designed to encourage fuel switching (EVT 2017). The Massachusetts Clean Energy Center, which is funded by a surcharge on electric rates but not subject to utility regulation, also funds fuel switching heat pump incentives (MA CEC 2018). NYSERDA's programs are funded by a System Benefit Charge and Clean Energy Fund surcharge on electric bills but takes a fuel-neutral approach to advancing state energy policy with its total budget. The broad framework of NYSERDA's ratepayer-funded programs is approved by the New York Public Service Commission, but program design and metrics are not subject to regulatory approval. NYSERDA offers a heat pump incentive without the requirement to justify its program to a regulator.

Why have Northeastern regulated utilities not driven electrification?

Northeastern utilities and their regulators did not drive early efforts on electrification for a number of overlapping reasons. First among these is a long and well-established history of efficiency programs avoiding fuel-switching, especially between regulated fuels. This aversion has its roots in the paradigm of energy efficiency as a least cost supply resource. If supplying energy and capacity would cost 7 cents per kWh and efficiency can be provided for 3 cents, then all available cost-effective efficiency should be pursued to reduce customer bills. Revenue to fund energy efficiency programs in this paradigm takes the place of power supply expense, so it is critical to tie funding to the fuel that is being saved. Increasing use of the regulated fuel, rather than reducing it, has no place in this model.

The initial forays of regulated efficiency programs into incentives for heat pumps stayed true to the "least cost supply" model. In all seven Northeastern states, "market opportunity" incentives for heat pumps are funded with electric efficiency funds[4] (VEIC NRDC 2018). In these cases, the program assumes that the building owner has decided to purchase a heat pump, and the efficiency program is encouraging them to buy a more efficient product (including air conditioning savings). This is the same logic that justifies incentives for lightbulbs or refrigerators. While the availability of a rebate may incent a customer to consider a heat pump for fuel switching, the programs only use efficiency funds to claim savings of the regulated fuel.

Initiating support for emerging electrification technologies outside of the confines of regulated efficiency programs also means that those initial programs do not need to meet cost-effectiveness tests designed for ratepayer-funded programs. Under legislative or executive branch direction, state policy objectives to reduce GHG and local air pollutant emissions or to reduce oil dependence can take preference. As technologies and markets mature, more information becomes available to evaluate cost-effectiveness under regulatory rubrics.

All of the large investor-owned utilities in the Northeast operate under some form of decoupling. This makes them indifferent to changes in sales between rate cases and means that

[4] Efficiency Vermont combines electric efficiency and RGGI funds to claim both fuel switching and electric efficiency savings in the same transaction.

shareholders would not see a direct boon from investing their funds in electrification. Where utilities have been able to provide the capital investment to support electrification, and increase their rate base, utilities have been more involved. As mentioned above, Emera Maine was able to use on-bill financing to support an early heat pump pilot. Vermont's Green Mountain Power leases heat pumps and heat pump water heaters (GMP 2018). On the EV front, Eversource recently proposed, and the Massachusetts Department of Public Utilities approved, an investment in electric vehicle charging infrastructure (MA DPU 2017); the New York Public Service Commission has also approved a similar program for National Grid (NY PSC 2018). Rather than own the chargers directly, Eversource will invest in the wiring and transformers necessary to prepare sites to serve EV chargers. In each of these cases, regulators and advocates have expressed concerns about utility market power and the appropriate bounds for monopoly utility investment; the few examples to date do not yet illustrate how this boundary will be drawn going forward.

Electrification also provides an indirect opportunity for rate base growth and, thus, increased profit for a decoupled utility. By driving a return to a paradigm of growing load, electrification has the potential to increase need for capitalized generation, transmission, and distribution capacity. However, a return to robust load growth is still some distance in the future for the Northeast. Regardless, if residential electrification technologies are adopted in clusters, in parallel to how the solar PV market grew, distribution utilities could see local peak loads exceed the limits of current service or substation transformers. This could drive localized investment in rate-based grid infrastructure. In this case, however, societal benefits and utility shareholder incentives may not be aligned: targeted energy efficiency, control systems, or rate structures could limit these local peaks and lower societal costs and—when combined with good distribution system planning—may reduce capital investment opportunities. Grid benefits from coupling electrification with time-varying rates, along with insights from meter data, align shareholders and policymakers on the need for advanced metering infrastructure or similar utility capital investments in places where smart meters are not yet deployed.

***Efficiency Plus*: Recent evolution in regulation and program design is resulting in more utility programmatic engagement**

Within the last three years, regulators, utilities and state policymakers in the Northeast have expanded their conceptions of the role of utilities in advancing state policies for GHG emission reductions through fuel switching. The resulting surge of new ideas for policies and regulatory structures has included both changes to cost-effectiveness screening and new kinds of utility performance targets and mandates. These new structures have implemented lessons from regulation of efficiency programs and are intended to work in concert with those programs to build on their experience transforming markets.

Cost-effectiveness screening. A single-fuel, least-cost-procurement approach to energy efficiency is based on the paradigm of the utility cost test (or program administrator cost test). Use of a total resource cost (TRC) or societal cost (SCT) test opens the door to fuel switching as cost-effective because it includes savings in other fuels. Further additions to the TRC test can reflect policy priorities. While Northeastern states have used TRC- and SCT-based tests for a number of years, there is one recent example of a state modifying its test in concert with explicit adoption of strategic electrification as a policy goal: The "Rhode Island Test" adopted in 2017 adds economic development and non-internalized GHG emissions to a standard TRC approach

(RI PUC 2017a). Under this new paradigm, National Grid has begun offering a cold climate heat pump program (National Grid 2017a).

New kinds of utility targets. Northeastern policymakers and regulators have established new kinds of targets and the opportunities for new kinds of rewards for utilities to engage in electrification in concert with, but not displacing, efficiency programs. These changes include new utility mandates building off of renewable portfolio standard structures, new shareholder incentives for electrification outside of efficiency programs that build on efficiency program incentives, and shifts in the performance metrics and incentives for the regulated efficiency programs themselves.

Tier 3 of Vermont's Renewable Energy Standard establishes a requirement for utilities to reduce the use of fossil fuels by their customers in an increasing amount each year. To meet this requirement, Vermont utilities have developed unique offerings that reduce fossil use through electrification in both the thermal and transportation sectors. One such offering is the GMP heat pump lease program discussed above. This program integrates an incentive from Efficiency Vermont, and the distribution utility and efficiency utility share the resulting credits toward their respective obligations. Vermont utilities have also offered an incentive to a local transit agency for the purchase of electric buses (BED 2017), discounted the cost of line extensions to maple sugaring and lumber operations that would otherwise use diesel generators (VEC 2017), and partnered with auto dealers to incentivize EVs (GMP 2017). Other RPS-based mandates where electrification measures can contribute, such as the Massachusetts Alternative Portfolio Standard and the renewable thermal path for New Hampshire Class I renewable credits, have to date not been as well integrated with utility efficiency programs because they are obligations placed on electricity suppliers, rather than on the regulated supply utilities which run efficiency programs.

Regulators across the Northeast are learning from and expanding the experience with shareholder incentives based on efficiency program, customer service, and reliability performance by bringing "performance incentive mechanisms" (PIMs) to bear on other utility goals and programs. The PIMs for electrification under consideration in recent cases have been closely aligned with and informed by efficiency PIMs. The Rhode Island Public Utilities Commission's Power Sector Transformation process calls for an explicit performance incentive for "beneficial heating" (RI PUC 2017b). In its current rate case in that state, National Grid has proposed two electrification PIMs: one for heating and one for EVs. Under the utility's proposal, it could earn up to 5.5 basis points of additional return if its electrification programs meet targets measured in tons of CO_2 emissions avoided (for heat pumps) and number of incremental EVs registered (above a forecast) (National Grid 2017b).

The Earnings Adjustment Mechanism (EAM) process in New York is also beginning to take this approach in current cases. Utilities can earn additional return by exceeding the New York Public Service Commission's (PSC) targets for their energy efficiency programs and beneficial electrification activities. Central Hudson Electric and Gas proposed a carbon reduction program that would include air-source and ground source heat pumps as well as EVs. A settlement among the parties that contains a slightly modified version of this proposal may be approved in the summer of 2018 (Joint Parties 2018). This EAM would offer a shareholder incentive of about $14 per ton of lifetime avoided CO_2 emissions (although the value per ton varies depending on the performance of the program) for programs executed between 2018 and 2021. The New York PSC recently approved a similar "environmentally beneficial electrification" EAM for National Grid, with reward based on the lifetime tons of CO_2 emissions avoided by EVs and heat pumps (NY PSC 2018).[5]

Adjusting how the performance of utility efficiency programs is measured can ease the co-existence of electrification and efficiency programs. Regulators in Vermont have made explicit allowance for the use of the RGGI and FCM funds to support electrification by not counting the electric use from a fuel-switch heat pump as a "penalty" against Efficiency Vermont's electric efficiency targets (VT PUC 2017). Massachusetts utilities have proposed using a fuel-neutral metric for total energy savings during the 2019-2021 performance period, and the state's Energy Efficiency Advisory Council has recommended that the plan include fuel switching strategies, including strategic electrification (Mass Save 2018, MA EEAC 2018).

Conclusion

Rapid advancement in markets for electrification technologies, including EVs, heat pumps, and water heaters, will be required for Northeastern states to meet their decarbonization objectives by 2050. This transformation will have substantial impact on utilities. It will demand careful and proactive planning at all scales of the electric utility system, from large-scale shifts in the required amounts and timing of electric supply to feeder-level planning for clusters of new loads. Regulators will also face a bevy of new challenges, including the appropriate roles for utility investment and market intervention programs to advance electrification, and managing competition between regulated electric and gas utilities.

Fortunately, utilities, regulators, and policymakers have a wide range of new and existing tools to bring to bear to meet these challenges. Initial and ongoing market development has been spurred by programs outside the regulatory sphere, which allows flexible program design in the early stages of market and technology development. By starting electrification outside the regulatory sphere, states have been able to move quickly to meet policy goals, but have also risked customer confusion due to uncoordinated programs and required separate sources of funding. Regulatory processes can be slow and restrictive, but once they are engaged they can be transformative. Building from the regulatory structures of energy efficiency programs, as in Rhode Island and New York and as developing in Massachusetts—or establishing parallel structures with an expectation of collaboration, as in Vermont—brings the expertise and market influence of efficiency programs to bear on the electrification challenge.

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[5] The EV savings are to be measured based on incremental additional EVs in National Grid's service territory compared with its neighbors. Heat pump savings will be based on the number of rebated systems.

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