Action Plan to Accelerate Strategic Electrification in the Northeast

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About NEEP

NEEP was founded more than 20 years ago as a non-profit to accelerate energy efficiency in the Northeast and Mid-Atlantic states. Today, it is one of six Regional Energy Efficiency Organizations (REEOs) funded, in part by the U.S. Department of Energy to support state efficiency policies and programs. Our long-term shared goal is to assist the region to reduce carbon emissions 80% by 2050 by accelerating efficiency on a regional scale. For more about our strategies and projects, visit www.neep.org.

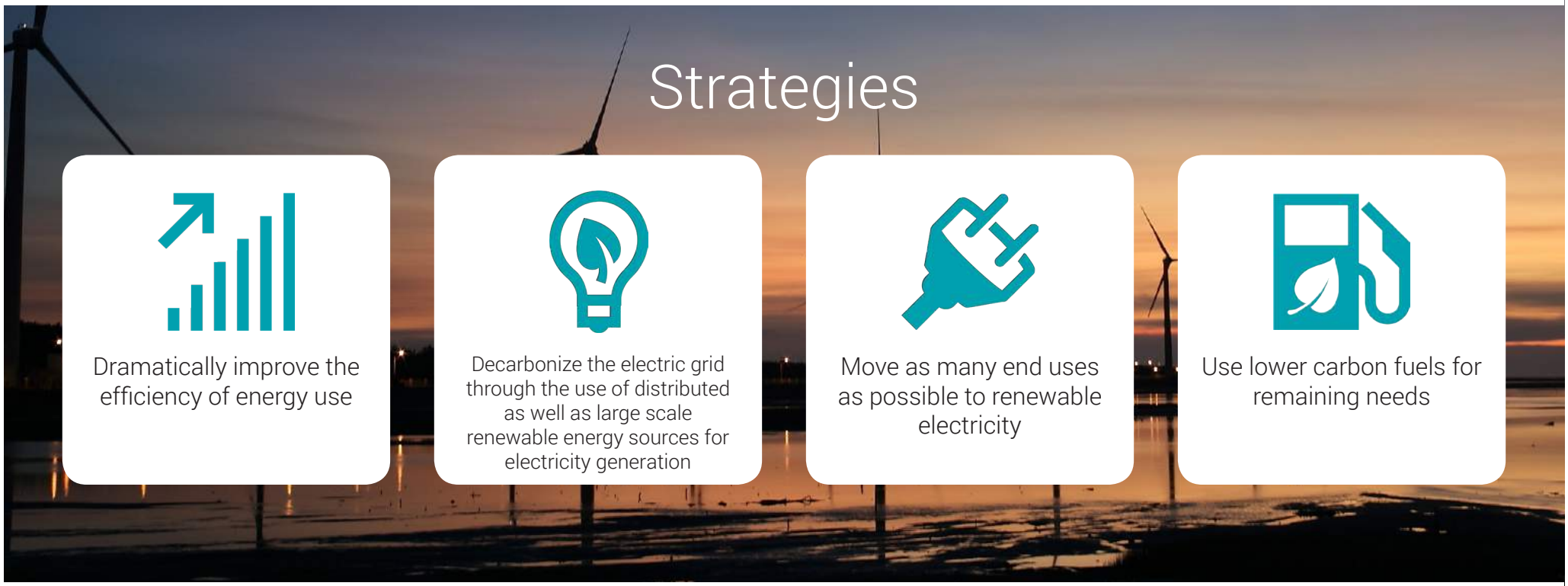
Disclaimer: NEEP verified the data used for this white paper to the best of our ability. This paper reflects the opinion and judgments of the NEEP staff and does not necessarily reflect those of NEEP board members, NEEP sponsors, or project participants and funders.

Introduction

States and communities in the Northeast are adopting goals and implementing policies to aggressively cut carbon emissions by the year 2050 in order to reduce the impacts of climate change.[1] Given the urgency of climate stabilization, many states have also set more near-term carbon reduction goals. These ambitious goals, as shown in Table 1, require very significant changes in how we use energy in our everyday lives, as burning carbon in concentrated forms has been part of life since the industrial revolution.

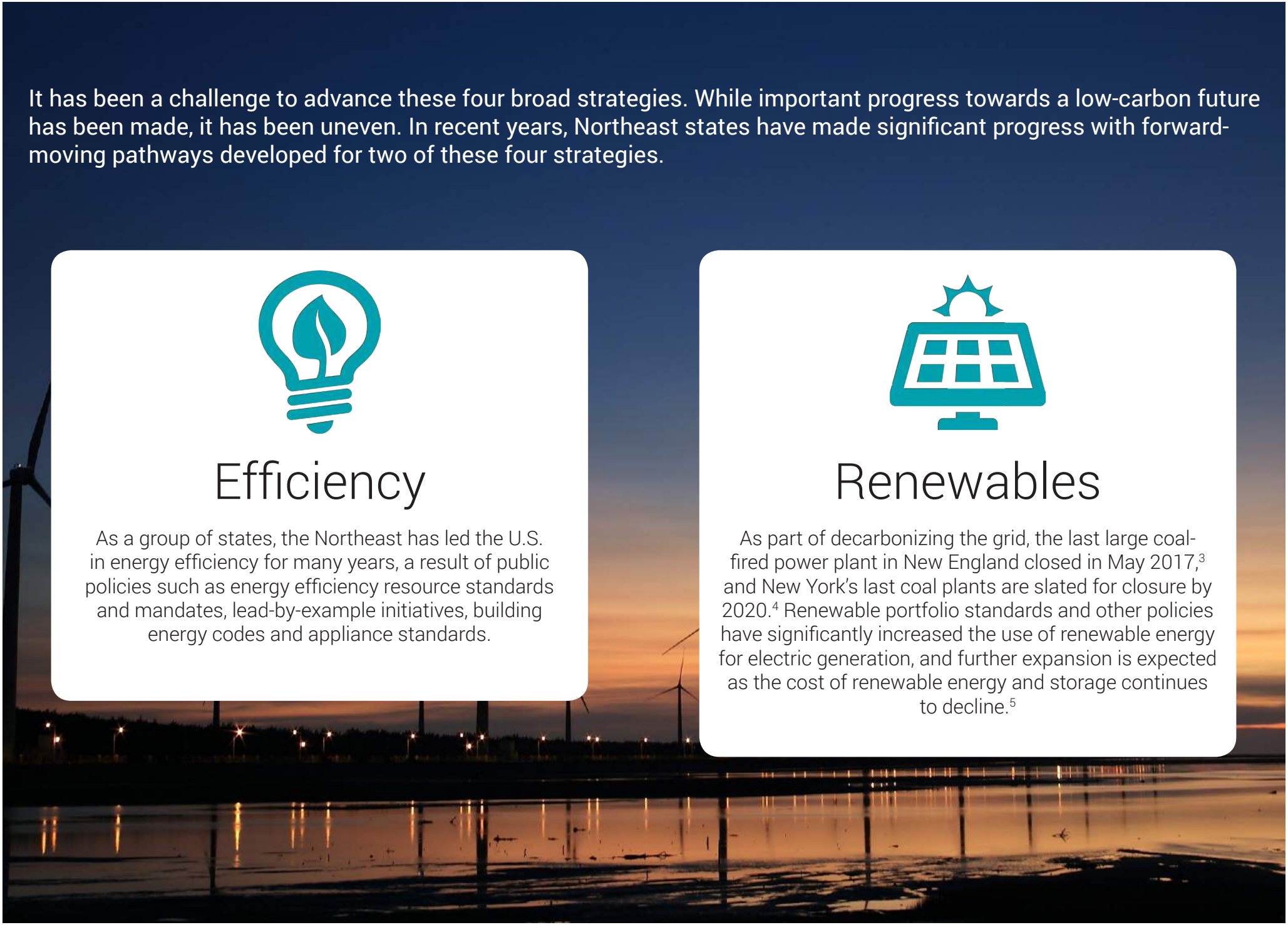
At the first level of analysis, 80 percent carbon reduction has been shown to be both possible and economic,[2] however, to avoid the worst impacts from climate change, we need to move more aggressively to build a low carbon economy. This includes taking advantage of the cycles of new construction, renovation, and the purchasing of large manufactured goods such as cars and appliances.

The broad strategies of how to achieve 80 percent carbon reduction are remarkably simple to articulate:



[1] Sourced from the Center for Climate and Energy Solutions, "Greenhouse Gas Emission Targets" at www.c2es.org/us-states-regions/policy-maps/emissions-targets. Note that state targets are not for energy only: they include emissions from waste, chemicals, agriculture, etc. This report addresses only energy-related emissions, and it assumes the same targets would apply to energy emissions alone.
[2] Williams, J.H., B. Haley, F. Kahrl, J. Moore, A.D. Jones, M.S. Torn, H. McJeon (2014). Pathways to deep decarbonization in the United States

It has been a challenge to advance these four broad strategies. While important progress towards a low-carbon future has been made, it has been uneven. In recent years, Northeast states have made significant progress with forward-moving pathways developed for two of these four strategies.



Efficiency

As a group of states, the Northeast has led the U.S. in energy efficiency for many years, a result of public policies such as energy efficiency resource standards and mandates, lead-by-example initiatives, building energy codes and appliance standards.

Renewables

As part of decarbonizing the grid, the last large coal-fired power plant in New England closed in May 2017,[3] and New York's last coal plants are slated for closure by 2020.[4] Renewable portfolio standards and other policies have significantly increased the use of renewable energy for electric generation, and further expansion is expected as the cost of renewable energy and storage continues to decline.[5]

[3] ISO New England, Retirements of Non-Gas-Fired Power Plants
[4] Governor Andrew M. Cuomo, 2016 New York State of the State and Executive Budget Address
[5] ISO New England, Integration of Renewable Resources and other New Technologies, web page accessed Nov. 2017

It is the third part of the strategy, "Move as many end uses as possible to electricity", that may be the most disruptive and poorly understood at this time. Achieving regional emission targets will require more than enhanced energy efficiency and emission reductions in the electric supply sector . It will require shifting from the direct use of fossil fuels in transportation, space and water heating, and industrial uses; moving these uses to an increasingly low-carbon electricity grid.

Broad electrification would undoubtedly increase the region's use of electricity with potential implications for increased use of power transmission and distribution facilities. However, approached strategically with energy efficiency, energy storage, and controls for demand response and grid integration, electrification has the potential to improve the use of existing grid infrastructure in a manner that may reduce electricity prices while consumers and the regional economy also reap the benefits of avoided or reduced fossil fuel bills. Fortunately, key electrification technologies – heat pumps and electric vehicles - have the ability to control, shift, and store energy, supporting grid modernization. Additional investments in thermal efficiency and storage could be a critical element in helping to minimize the need for costly grid expansions and upgrades in the longer term.

The Northeast imports nearly all of its fossil energy from other states if not other countries,[6] and is more dependent on fuel oil for space and water heating than other regions of the country.[7] Moving to regionally developed and distributed renewable electric resources and strategic electrification could create new business opportunities and significant job growth. Local air pollution could also be further reduced. Strategic electrification with increased weatherization can also improve home comfort, health, and safety. Policy leadership, new programs, and partnership development at the state and local government level, in partnership with industry actors, are the critical tools that can garner all of the benefits of a move to a low-carbon economy.

Decades of energy efficiency, and more recently distributed generation, policies, and programs have flattened electric energy use in the Northeast.[8]

[6] U.S Energy Information Administration, U.S. States Profile, State Profiles and Energy Estimates
[7] U.S. Energy Information Administration, Fuel Oil and Kerosene Sales 2015, Adjusted Sales of Distillate Fuel Oil by End Use, December 2016; https://www.eia.gov/petroleum/fueloilkerosene/
[8] ISO New England, Final ISO New England Energy-Efficiency Forecast 2020-2025, May 2016

Now, efficient electricity use needs to grow as part of a broader strategy to create a low-carbon economy with reduced dependency on fossil fuels. Northeast states need to carefully, yet rapidly, pick a pathway to strategic electrification that creates benefits for businesses and consumers and achieves the carbon reduction targets. This action plan presents a near-term set of strategies to get the region on that pathway.

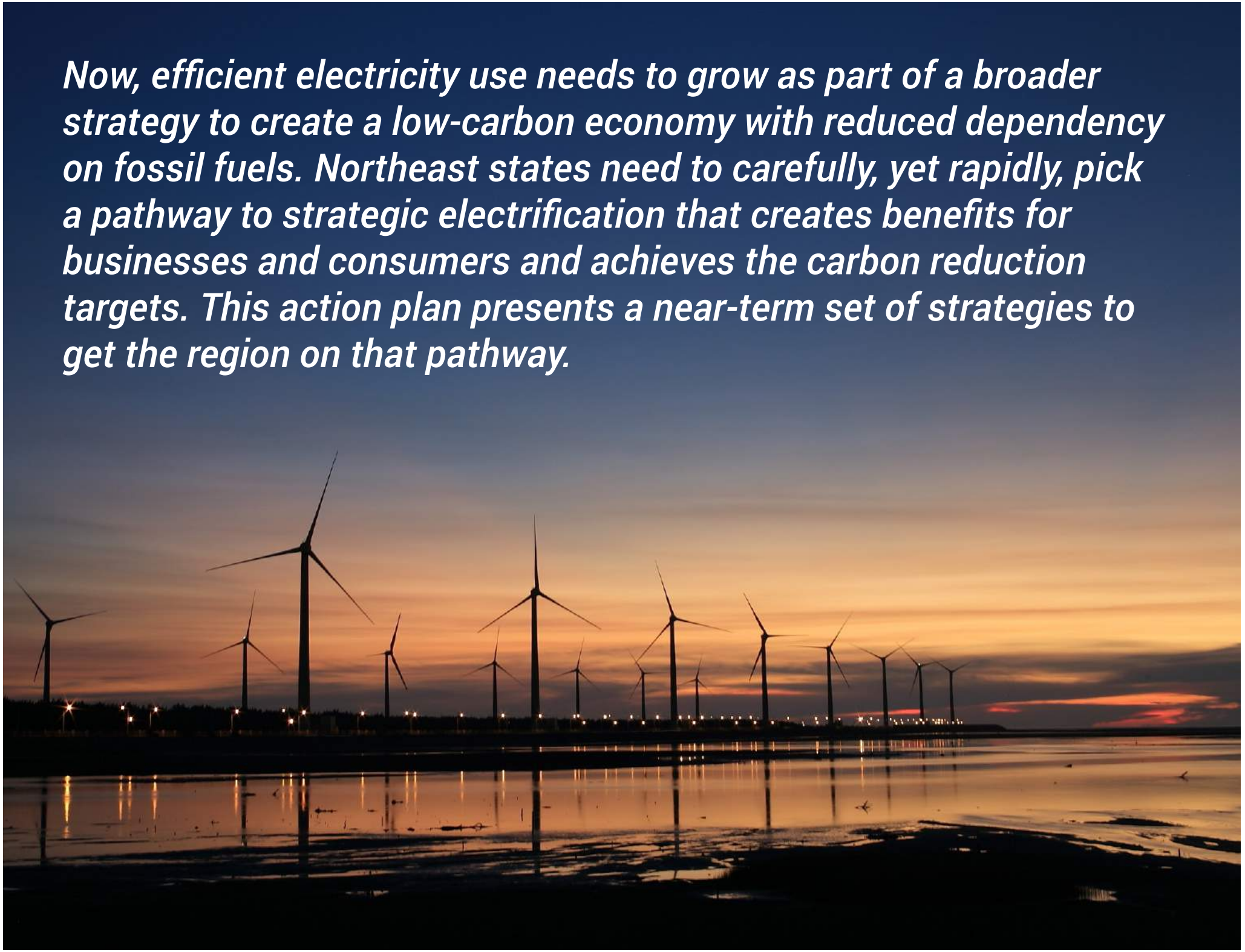
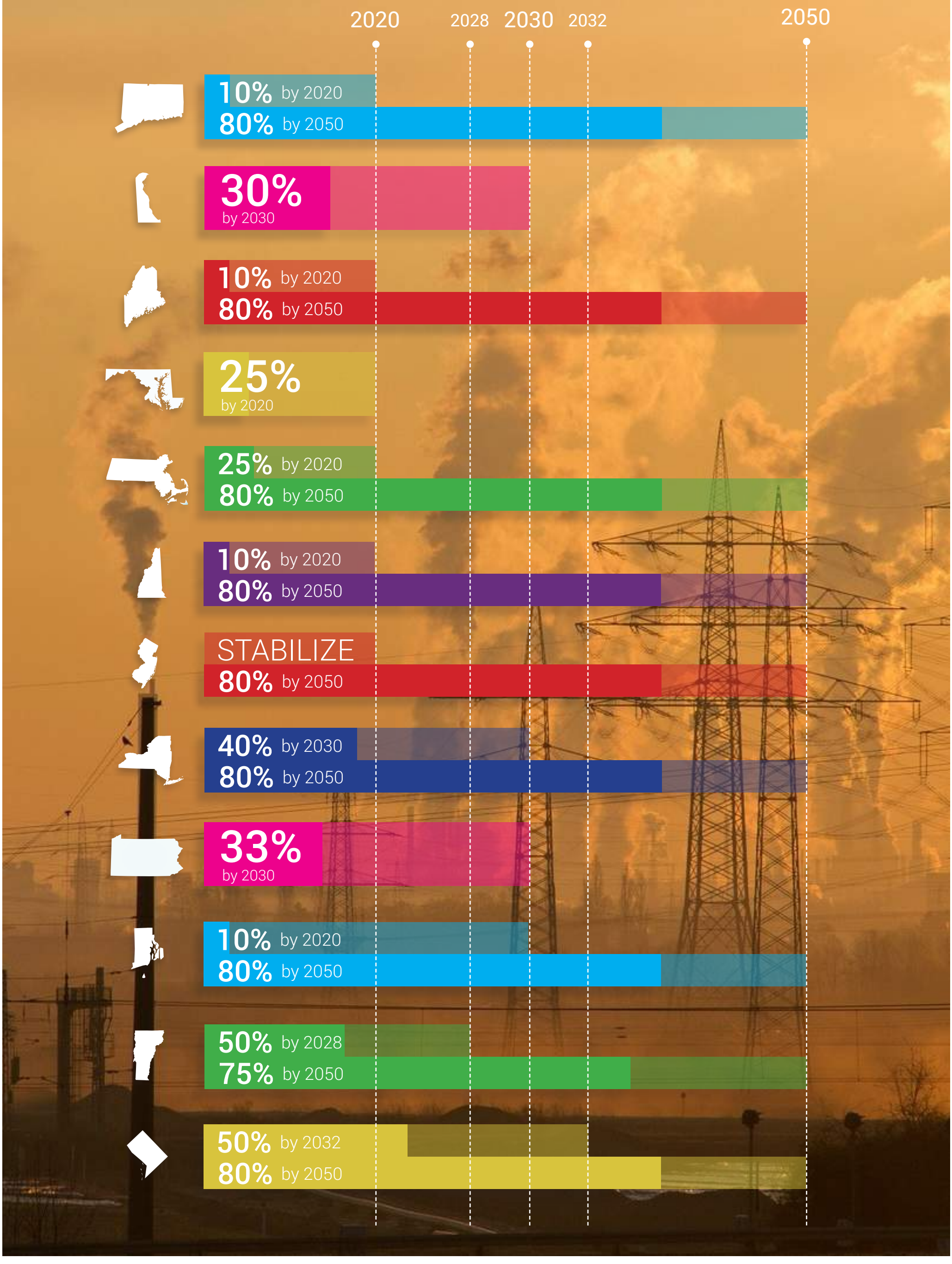


Table 1: Regional Commitments

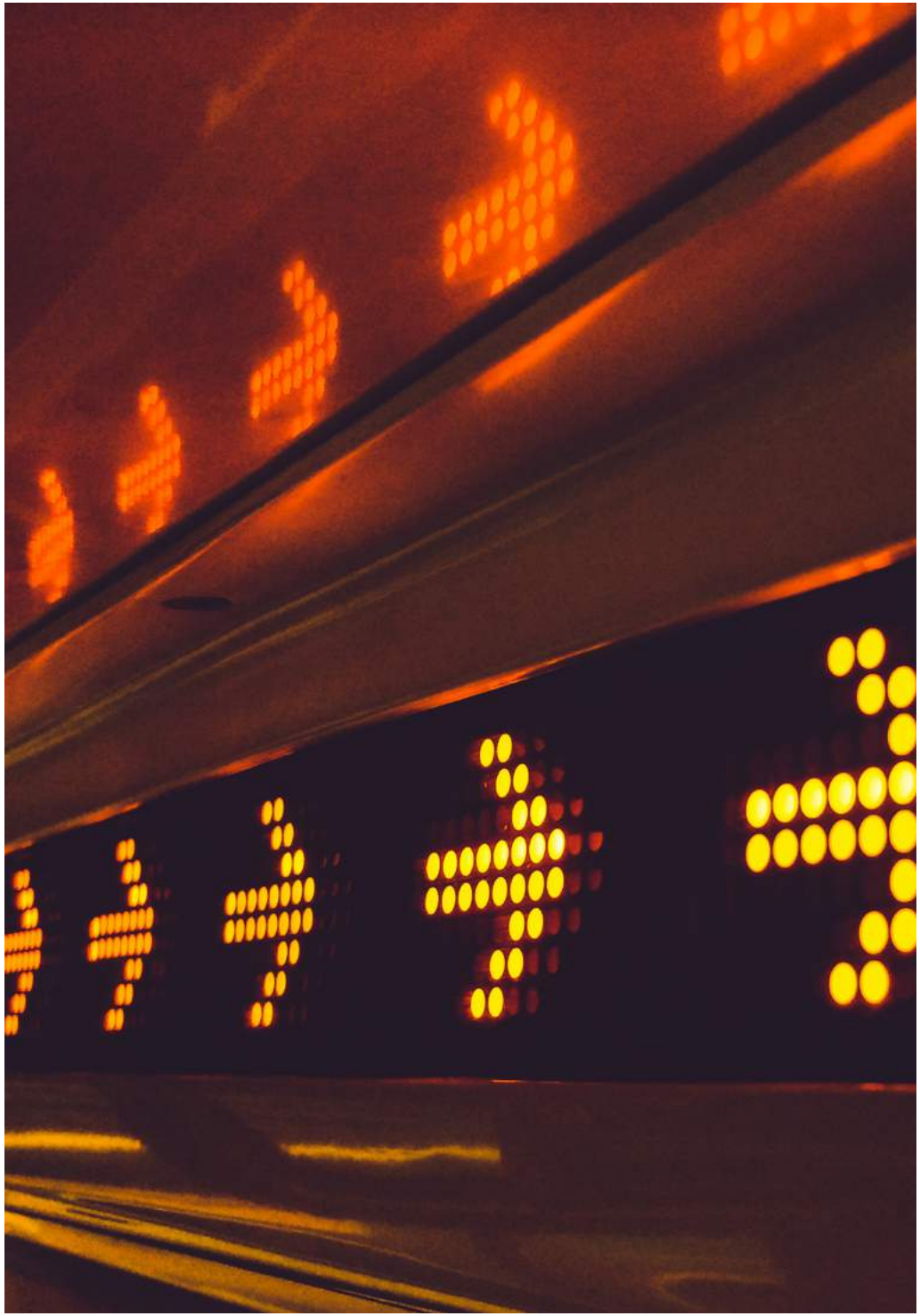


II. Pathways to Strategic Electrification

To catalyze action, NEEP has developed two new reports that support a better understanding of strategic electrification and map an initial pathway forward.

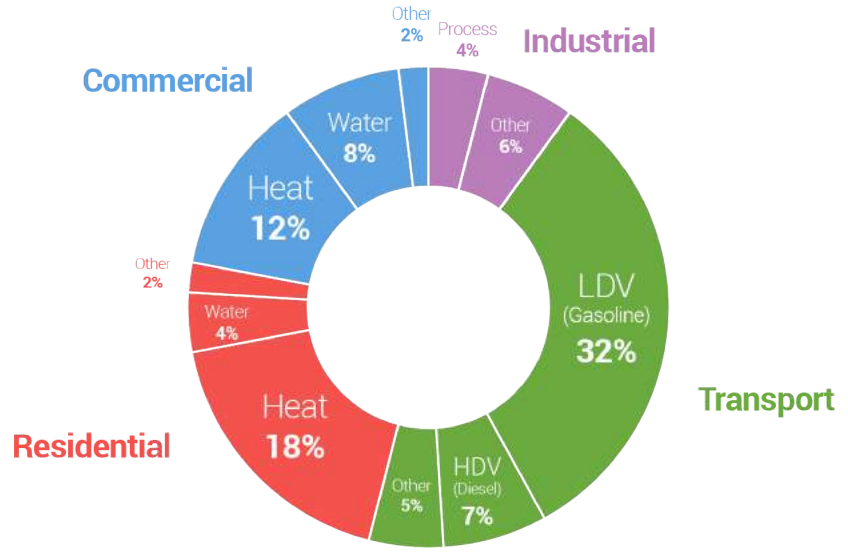
The first report is the "Northeastern Regional Assessment of Strategic Electrification" developed by Synapse Energy Economics and Meister Consultants Group in July 2017. This report covers the current landscape of electrification policies, technologies, market status, and market barriers; models the amount of electrification needed in the Northeast and the grid impacts of that change; and considers the consumer impacts of strategic electrification.

The second report is this "Action Plan" document that focuses on near-term (next five years) actions to more aggressively move strategic electrification forward in the Northeast. It organizes the proposed actions into nine strategy and research areas, and is informed by participant input at NEEP's Strategic Electrification Summit held in June 2017.



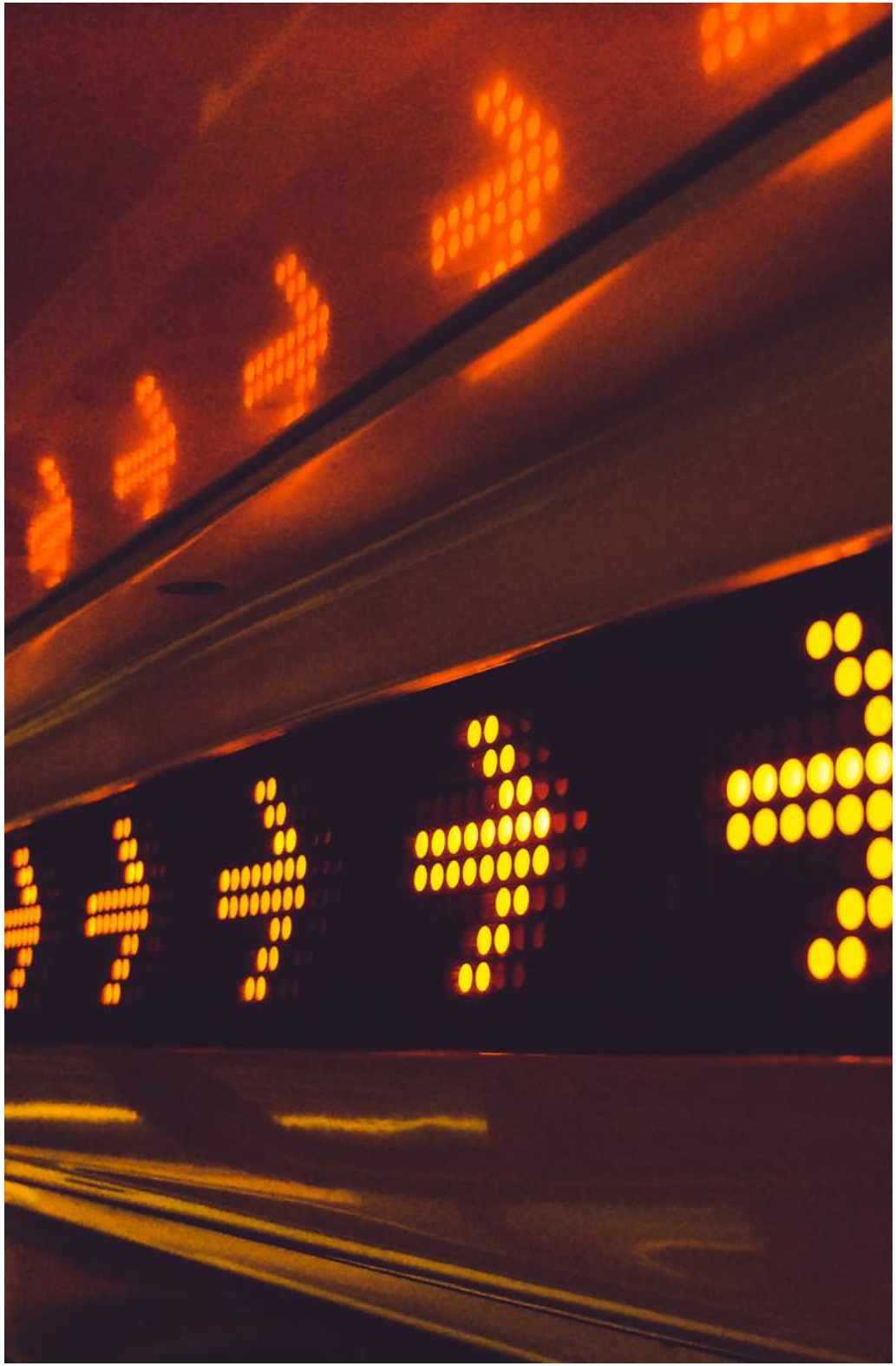
Fundamental to developing the action plan is understanding how fossil fuel is currently used in the Northeast. Direct uses (i.e. not used for generating electricity) are primarily in the buildings (46 percent) and transport (44 percent) sectors.[9] The remaining 10 percent are industrial uses. Within the buildings sector, space and water heating account for the vast majority of fossil fuel uses, while in transport, light-duty vehicles (gasoline-powered cars and light trucks) are the dominant end use, larger trucks accounting for most of the rest. The end uses of powering transportation and space and water heating account for 85 percent of direct fossil fuel use. Integration of these end uses into the electric grid is the only documented way to achieve state and local carbon emission reduction targets (assuming that deep decarbonization of the electric grid continues).

Figure X. Direct fossil fuel use by end use and sector in New York and New England. (Northeast Regional Assessment of Strategic Electrification, Northeast Energy Efficiency Partnerships, July 2017)



Electric vehicles (EVs) have received strong support through national incentives, state and local policies, and manufacturer product development. Despite that support, the EV market is still in early development, accounting for less than one percent of annual regional vehicle sales.[10] A slightly larger market for electrification is replacement of the fossil fuels used to provide heat and hot water in homes and businesses. Super-efficient HVAC technologies

[9] Northeast Regional Assessment of Strategic Electrification, Northeast Energy Efficiency Partnerships, July 2017
[10] Northeast Regional Assessment of Strategic Electrification, Northeast Energy Efficiency Partnerships, July 2017



such as ground source heat pumps (GSHP) and cold-climate air-source heat pumps (ccASHP) are advancing in market availability and recognition. New variable refrigerant flow (VRF) products offer important new efficient approaches to replace fossil fuels to heat and cool commercial and multifamily buildings.

Accelerate Large-Scale Market Transformation for Strategic Electrification

To meet the aggressive long-term carbon reduction goals established throughout the region, serious work to transform our energy systems and markets must ramp up quickly. In the near term (next five years), state/local policy and program initiatives are needed to help spur rapid, large-scale market development. These initiatives will need to address market barriers for electrification technologies such as high upfront costs/low fossil fuel prices and consumer education. Informational and analytical gaps related to electrification must be filled including uncertain electric grid impacts, uncertain business/economic impacts, and the potential economic development opportunities. Incumbent technologies such as fossil fuel burning cars, trucks and space and water heating technologies benefit from the inertia of "the known and familiar". Planning and acting today for a major transition to a low-carbon energy system, at a time of low fossil fuel prices, will require significant will on the part of policymakers and stakeholders. Implementation will require public and private sector leadership, better understanding of several key issues, and a range of market and infrastructure development initiatives.

Three Key Strategies

NEEP's analysis points to three critical elements to a strategic electrification pathway that benefits consumers, businesses and the environment. These are:

Advanced Electric Technologies

Deep Energy Efficiency

Grid Integration

Advanced Electric Technologies

A handful of mass-market **advanced electric technologies** will account for the bulk of strategic electrification. While a number of important technology applications exist for the buildings, transport, and industrial sectors, three technologies will likely form the backbone of most program and policy efforts to replace direct use of fossil fuels with renewable electricity:

Electric vehicles (EVs) for personal transportation and commercial use.

Heat pumps, including cold climate air-source heat pumps (ccASHP), variable refrigerant flow (VRF), and ground source heat pumps (GSHP) for heating (and more efficient cooling) in residential and commercial buildings.

Heat pump water heaters (HPWH) for both residential and commercial water heating.

Additional Benefits

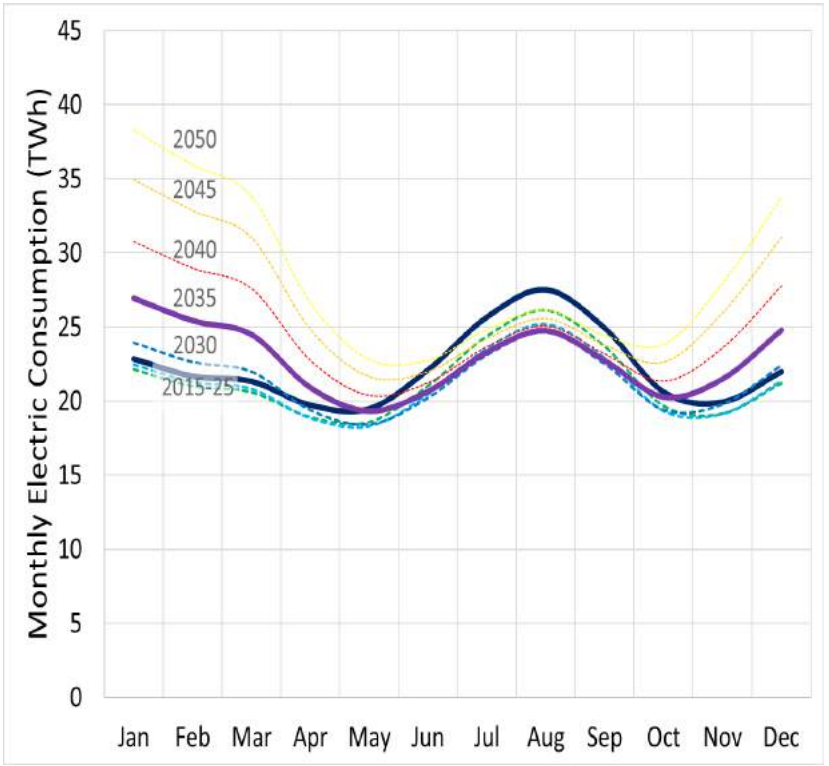
Besides offering tangible alternatives to today's common transportation, space and water heating technologies, these advanced electric technologies have the potential to ultimately provide better, more affordable, and cleaner options to consumers, the grid, and the planet.

These advanced electric technologies may also offer other benefits that consumers and stakeholders value, including reduced operations costs in some scenarios, reduced maintenance costs, increased safety, and lower pollution levels in the home and neighborhood. Despite having many key advantages, significant barriers impede the transition to electrification. The technologies are unfamiliar and "unproven" to consumers, the initial purchase prices are typically higher, and the lack of broad charging infrastructure is a particularly difficulty barrier for EVs. States and communities must work closely with businesses and consumer groups to educate the public, and expand markets with appropriate consumer protection and equity.

Grid Benefits and Impacts

Electrification of key end uses provides an exciting opportunity to improve grid utilization in the near term and potentially reduce rates for consumers. If electrification is successful, however, there are potential impacts that may cause longer-term challenges. Even with moderate efficiency, NEEP projects that winter heating months may require twice as much electricity in 2050 relative to current requirements.[11] Figure X illustrates this, as well as the shift to winter being the dominant electricity-consuming season around 2035.

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



[11] Northeast Regional Assessment of Strategic Electrification, Northeast Energy Efficiency Partnerships, July 2017

Deep Energy Efficiency

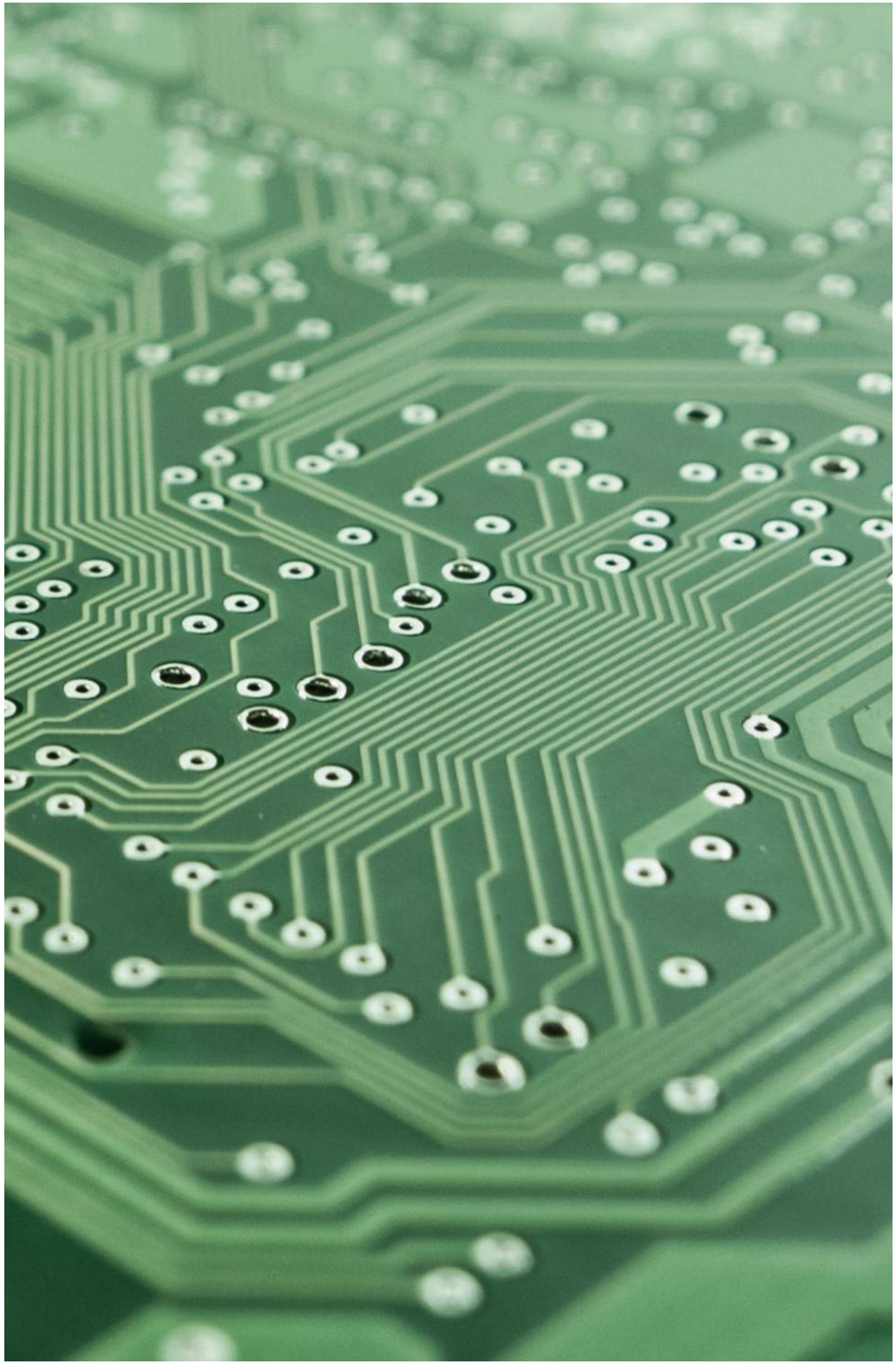
Deep energy efficiency provides a strategy to manage these potential impacts effectively, and supports resiliency during energy emergencies. **Deep efficiency** is going well beyond current levels of energy efficiency improvements, particularly in the space heating and cooling areas (aka. thermal efficiency). Space heating is the dominant energy user in buildings, making up roughly 50 percent of energy consumed in both the residential and commercial sectors.[12] The largest remaining energy effciency opportunity in the region is reducing these thermal loads. This comes as no surprise as 70 percent of homes and buildings in New York and New England were built prior to building energy codes set minimum efficiency requirements.[13]

Deep efficiency is a near and long term imperative to ensure that costly new winter peaks are not created by a broad adoption of advanced electric technologies. Putting highly efficient heat pumps into inefficient, leaky homes and buildings may increase system cost and operational costs while creating unnecessary large, new demands on the grid. Coupling installation of heat pumps with thermal efficiency improvements – particularly in existing buildings – is a key strategy to ensuring benefits to consumers, the grid, and the planet.

"Deep efficiency achieves 50 percent or more of the energy used on site in a home or building through improvements to the building shell, including insulation and air sealing, and often through upgrades to high-efficiency heating, cooling, and hot water systems suited to the smaller energy load."

[12] EIA 2009 Residential Energy Consumption Survey- Table CE.3.2 and EIA 2012 Commercial Buildings Energy consumption Survey- Table E7A

[13] EIA 2009 Residential Energy Consumption Survey- Table HC2.8 Structural and Geographic Characteristics of Homes in Northeast Region, Divisions, and States, 2009



Grid Integration

The third critical element to the strategic electrification pathway is grid integration. The technologies that provide the opportunity to move from the direct use of fossil fuels to increasingly renewable electric power can also help provide more flexibility to the grid, because they can be operated or recharged during “off-peak” hours when the demand for electricity is very low. The vast majority of EV owners charge their vehicles at home during the night, and heat pump water heaters offer flexibility when it comes to timing of “charging” or operation and when hot water is actually called for. Thermally-efficient homes and buildings with controls can maintain comfort for limited periods while shifting electric heating loads during local or system peaks. This flexibility, storage capacity, and controllability can be a great asset to grid management as well as resiliency.

Strategic electrification will be most effective when paired with increased grid modernization, flexible generation assets, and distributed energy resources (DER) such as community and building solar electric installations, storage, combined heat and power, and micro grids. Electrification technologies can work with two-way grid communications to allow price-based operational adjustments in real time, load shifting, and demand response. Time of use rate structures that recognize market pricing can provide benefits to customer who adopt electrification technologies and services, even to the point of providing an incentive to adopt those technologies if peak-use price signals are strong and participation is simple.

III. Strategies, Actions, Research to Advance Strategic Electrification

The following series of actions are near-term (one to five years) steps to accelerate long-term market transformation for efficient electrification to displace the use of carbon intensive fuels. While regional carbon emission targets are set for 2050, it is critical to develop and implement near-term actions to build traction, develop new strategies, and achieve successes to build upon. The proposed strategies and actions will build awareness, increase market share, and reduce costs. These actions and related research create the early pathways that will maximize benefits to society and initiate broader market action.

Establish Goals, Policies, and Programs for Strategic Electrification with Deep Efficiency

Build Public-Private Relationships to Accelerate Strategic Electrification Activities

Protect Consumers

Support Market Development for Key Electrification Pathways

Encourage Local Leadership

Prioritize Low-Income Consumers as a Near-Term Focus

Advance Strategic Electrification with Thermal Efficiency in Homes and Buildings

Provide Public and Consumer Outreach and Education

Address Grid Preparedness to Effectively Manage New, Dynamic Loads

Strategy #1: Establish Goals, Policies, and Programs for Strategic Electrification with Deep Efficiency

State leadership, at both the legislative and executive levels, needs to develop more specific goals and plans to reduce fossil fuel usage with efficiency and electrification. Long-term carbon reduction goals must become more specific and actionable, and incorporate energy efficiency, electrification technologies, and grid integration for transportation and buildings to create a state economy that is much less dependent out-of-state fossil fuel resources.

Strategy #1 Actions

- **Expand the use of explicit targets, goals, and mandates for electrification to create market certainty.** Set specific targets for carbon reduction for key markets such as light- and medium-duty vehicles, residential efficiency/fuel switching, and commercial building efficiency/fuel switching. Set energy performance goals for buildings that enable innovative approaches.
- **Lead by example with deep efficiency, electric vehicles in fleets, electric transit, and heat pumps in public buildings.** Government entities should rigorously assess and demonstrate the viability of these newer electrification technologies and related best practice approaches. They should also create a conversation within their communities. Both will help build market demand and capacities for quality products and installation services.
- **Use state and local authority to adopt building energy codes that require electrification and related deep efficiency in new construction and major renovation.** Tools such as stretch codes can also be used support early market adoption. Charging infrastructure can be incented or required in newly constructed commercial and multifamily buildings.
- **Create mechanisms to support local government actions to reduce carbon.** Local governments have provided much of the leadership in carbon reductions, but need additional financial resources and technical assistance to enact programs and change existing community infrastructure.
- **Develop new metrics for clean energy programs (including energy efficiency, demand management, electrification, energy storage, and renewable energy) that include the value of carbon reduction, other environmental benefits, measurable economic impacts, and benefits to the grid.** The determination of cost-effectiveness to guide program efforts, especially program administrator efforts, has been limited by narrowly-defined economic alternatives.

Strategy #1 Research

- Track and disseminate best-practice examples of leading state and local government public policies to accelerate deep efficiency and strategic electrification to achieve carbon reduction and economic development goals.
- Research additional opportunities to support deep efficiency and strategic electrification through enhanced building energy codes.
- Develop and disseminate analytic tools that help state and local policymakers assess the energy, economic, health and environmental impacts of adopting specific efficiency and electrification policies.

Strategy #2: Build Public-Private Relationships to Accelerate Strategic Electrification Activities

State legislators, executive branches, and local government should work closely with their business community to develop electrification strategies. Businesses supply products and services as well as financing and new models for completing complex projects. Many local businesses and trades will benefit from replacing out-of-state fossil fuel purchases with local efficiency, electrification technologies, and grid integration activities (including the integration of renewable energy and storage).

Strategy #2 Actions

- **Bring diverse business stakeholders to the strategic electrification process.** The business community is very active in electrification, and can work with government in planning toward established carbon goals, utilities in their supported efforts, and the broader community to provide solutions that are more sustainable and better for the economy.
- **Develop public-private partnerships as part of the solution to financing efficiency and fuel switching of residential and commercial buildings and as part of government infrastructure projects.** New solutions are necessary to speed implementation.
- **Establish public-private partnerships to educate, train, and retrain skilled workers.** Strategic electrification will offer quality job opportunities, but these opportunities will require new skills to deliver energy efficiency, electrification technologies, energy storage, and grid integration solutions at scale. Retraining workers whose jobs are at risk from electrification – such as fuel dealers and the entire internal combustion engine supply chain – is a priority.

Strategy #2 Research

- Conduct detailed economic research on the regional impacts of strategic electrification on at-risk jobs, job creation, and the economy.
- Research and recommend models for workforce development and training to build market capacities as well as job opportunities for deep efficiency, strategic electrification, and grid integration.

Strategy #3: Protect Consumers

State utility regulators and consumer advocates should view strategic electrification as a mechanism to reduce electricity costs to all consumers through better utilization of the electric grid. Strategic electrification technologies have significant potential to utilize power during off-peak times as well as provide demand response capabilities. Electrification efforts should provide incentives and appropriate controls to consumers to support electrification growth and optimize grid integration. Increased thermal efficiency and reduced use of fossil fuels reduces fuel bills and can increase the health and safety of indoor environments.

Strategy #3 Actions

- **Align incentives to regulated utilities to support and achieve better utilization of grid resources, improved demand response capabilities, and ultimately, rate reductions through electrification.** Stockholder incentives for utilities should reward rate reductions that benefit all consumers.
- **Implement time-of-use (TOU) or dynamic rates to reduce the consumer costs of operating electric vehicles and heat pumps.** Most EVs are charged at home, where charging can readily be shifted to off-peak hours. Additionally, consumers could be rewarded for shifting heating and cooling outside of peak hours. The rate structure should be matched with advanced control technologies that respond to pricing and other grid signals that make vehicle batteries and heat pump operation a flexible grid resource. New rate structures must address the needs of low-income ratepayers, and avoid penalizing them for any inability to shift load.
- **Conduct a wide variety of pilots for DER, load management, micro grid, and related approaches integrated with electrification to better understand real-world performance impacts and costs.** Local solutions, such as community-scale solar with storage and zero energy buildings, can help manage peak demand. Distributed storage, including thermal storage such as ice and hot water, can reduce pressures on both generation and transmission and distribution. Solar and storage can be within customer facilities or at a community or micro-grid scale.

Strategy #3 Research

- Develop a report on best practices for rate designs that support electrification.
- Develop a report on appropriate utility incentives, including the exploration of “recoupling” policies and performance-based ratemaking. The report should also consider any relevant conflicts within utilities that provide both electric and gas services.
- Determine the value of electrification to the grid in terms of flexibility, timing, and location. This research should encompass a full range of DER resources.
- Research, pilot, and identify improved control technologies and applications for businesses and consumers that can optimize system operation to maximize customer benefits from electrification technology.

Strategy #4: Support Market Development for Key Electrification Pathways

State and local government should more aggressively develop and expand key strategic electrification markets in conjunction with state utility regulators, environmental quality regulators, key market actors, and other states across the region. Accelerated market adoption will only be achieved if key market barriers are adequately addressed through policy, program, and collaboration. Efforts that align strategies across state lines leverage greater market relevancy. Three technologies will likely form the backbone of most program and policy efforts to transform markets in the region. These technologies are:

1. Electric vehicles (EVs);
2. Advanced heat pumps including cold climate air-source heat pumps (ccASHP), variable refrigerant flow heat pumps (VRF), and ground source heat pumps (GSHP);
3. Heat pump water heaters (HPWH).

These technologies require focused efforts now to either “jump start” or rapidly expand the market beyond the earliest adopters.

Strategy #4 Actions

- **Use existing, more detailed regional market transformation strategies and action plans from NESCAUM and NEEP as guidance for EV and ccASHP markets respectively.** These two organizations have supported multi-state efforts to reduce technical and market barriers and increase adoption of specific technologies. Similar strategies and plans need to be developed for VRF, GSHPs, and HPWH technologies and markets. The Renewable Thermal Alliance provides a platform to advance renewable thermal technologies, including heat pumps.

- **Launch or support marketing campaigns to increase customer and installer awareness of the key electrification technologies and their benefits.** Familiarize the market with the products, from both the install and purchase perspective. There is additional value in targeting specific markets that have particularly strong value propositions (i.e. targeting delivered fuel and electric resistance customers for ccASHP).

- **Support and expand state, city, and/or utility incentives for EVs, heat pumps, and HPWHs to reduce upfront costs.** Since these newer technologies currently cost more than their fossil-fired equivalents, reducing first costs is critical to getting early market traction. As scale and competition increase, costs will likely drop. Procurement programs (such as Solarize) for cities, states, and groups of consumers are also a proven strategy to reduce first costs and increase sales.

Strategy #4 Research

A market transformation framework can identify more detailed strategies as well as key interim goals for costs, industry participation, and consumer acceptance. Key pieces in developing these frameworks include:

- Continued data collection, analysis, and testing to characterize and improve the performance and installed cost of heat pumps, heat pump water heaters, EVs and EVSE.

- More detailed market research and action plans to support GSHP, HPWH, and commercial-scale heat pump technology adoption in conjunction with industry.

- Research on the consumer costs of retrofitting heat pump systems for common New York and New England housing stock, including related efficiency improvements.

- Review of existing electrification programs in the U.S. and elsewhere to determine “bright spot” concepts, applications, and markets that can move more rapidly.

Strategy #5: Encourage Local Leadership

Cities and towns should provide leadership through their actions to achieve their aggressive carbon goals. Strategic electrification, in conjunction with efficiency and renewable energy development, is a critical step to achieving carbon goals. Local government should provide leadership through their own actions to show what is possible, create a conversation with their communities, and begin creating a stronger market for strategic electrification products and services.

Strategy #5 Actions

- **Local governments lead by example with deep efficiency, electric vehicles in fleets, electric transit, and heat pumps in public buildings.** Government entities should demonstrate the viability of these newer technologies as well as create a conversation within their communities. Local governments should work with others to create a public charging infrastructure for EVs within their communities, as well as promote cold climate air source and ground source heat pumps with thermal efficiency to reduce fossil fuel use to heat homes and buildings.
- **Use zoning authority to incentivize or require electrification and related deep efficiency in new construction, major renovation, and redevelopment projects.** Tools such as density bonuses can support early market adoption of electrification technologies. Charging infrastructure can be incented or required in newly constructed commercial and multifamily buildings.
- **Update urban land-use plans, including comprehensive plans and transportation system plans, to include support for electrified transportation options and DER infrastructure.** Electrified transit and personal transportation choices can be influenced over time through urban planning activities. Activities could include specifically referencing and setting targets for the use of electric options in development and redevelopment projects. Distributed renewable energy and storage should be incorporated in urban planning to enhance economic development and resilience.

Strategy #5 Research

- Model existing urban building stock to determine the best pathways to retrofit buildings for energy efficiency and electrification.
- Research the multiple benefits of electrification at the city level to support and communicate a future vision of the city.
- Research examples of “non-pipeline” solution projects that successfully meet new energy needs (i.e. need for new natural gas distribution system expansion) through alternative means, including electrification, distributed generation, energy storage, etc.
- Research electrification of district-level options including heat from waste streams, community-scale renewables, and integrated infrastructure projects.

Strategy #6: Prioritize Low-Income Consumers as a Near-Term Focus

State and local government and energy, housing, and transportation programs should ensure that strategic electrification reaches all consumers, including low- and moderate- income households, disadvantaged communities, hard-to-reach tenants, and small businesses. Programs that serve low-income consumers can also provide the opportunity to build initial scale, such as working with affordable housing developers on electrification efforts or deploying heat pump technology through weatherization programs that also provide thermal efficiency improvements.

Strategy #6 Actions

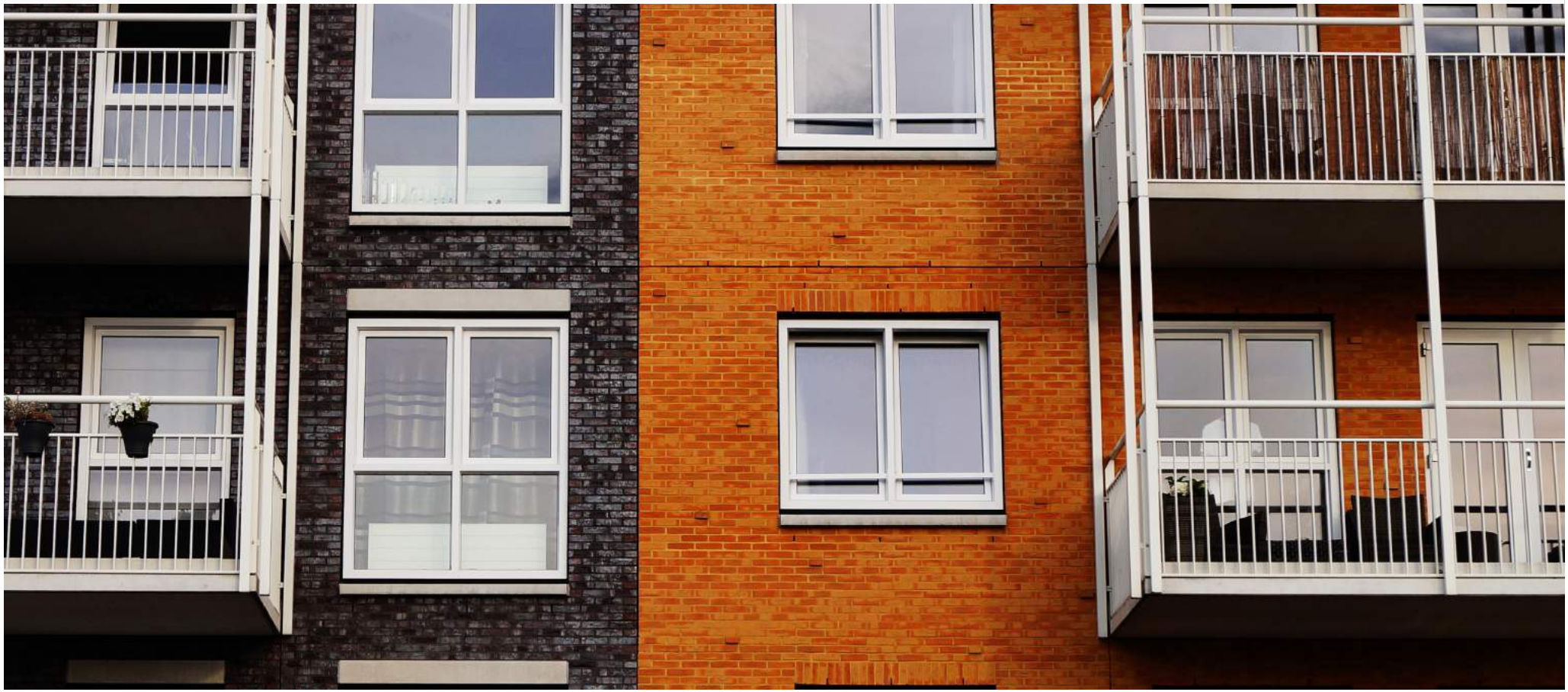
- **Develop initiatives to improve the availability of affordable, low-carbon transportation options for low- and moderate-income communities.** Electric buses for transit, purchase/lease of used EVs, and transportation-as-a-service option, such as ride and car sharing, are all possible strategies to reach these communities.
- **Work with existing community groups and networks to engage low-income consumers.** Community engagement can develop more effective program elements and marketing to serve specific communities. Connect with the health industry to cross promote the benefits of electrification- air pollution reduction, comfort, and indoor air-quality in low-income communities and at-risk populations.
- **Promote advanced efficiency in new constructions/major renovation using heat pumps, energy storage and, demand control in low-income housing policies and programs.** Build market capacities for comprehensive efficiency and electrification at scale by supporting programs and incentives that target multifamily, low- and moderate- income housing, and mixed use buildings. Work with weatherization programs to build market capacities to right-size and properly install heat pumps in weatherized homes.
- **Provide EV charging stations and/or EV car sharing in multifamily buildings.** Multi-family buildings provide challenges to the simple task of charging EVs, and require special attention to develop through utility programs, zoning requirements and building codes.

Strategy #6 Research

Electrification proposes some unique challenges and potential benefits for low-income consumers. The following are priority research areas to clarify and advanced the best programs and policies.

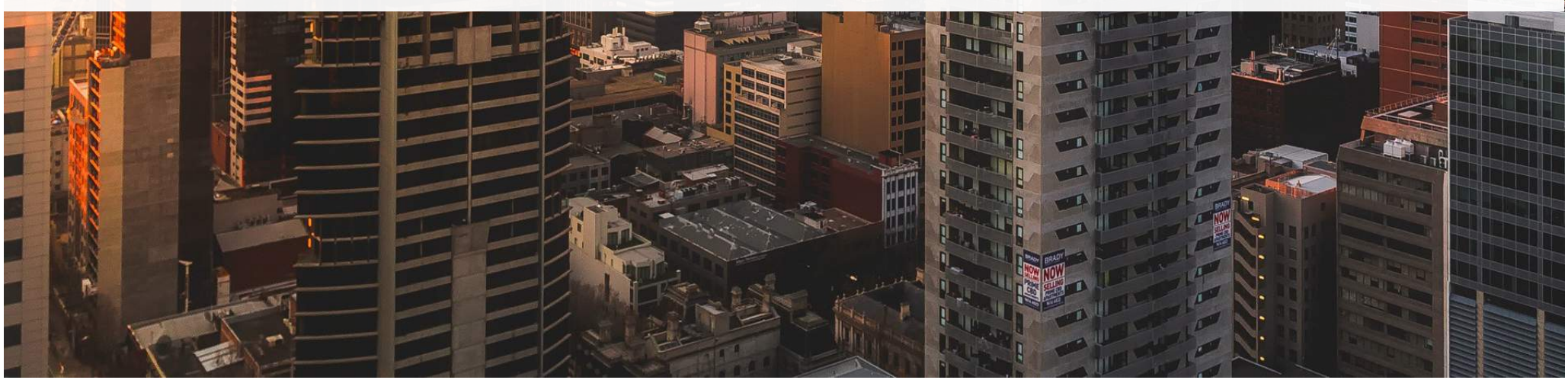
- Quantify the costs and benefits of electrification from a low-income consumer perspective, including the impact on total energy burden.

- Research and develop case studies of leadership successfully engaging and advancing low-income communities in electrification and DERs.



Strategy #7: Advance Strategic Electrification with Thermal Efficiency in Homes and Buildings

One key variable that will significantly determine the future needs for energy and capacity on the grid is the region's thermal load, or amount of heat needed to sufficiently condition the homes and buildings. How effectively we reduce thermal loads in homes and businesses will be a significant determinant of the scale of future electricity needs under a strategic electrification scenario. While solar PV is expected to grow considerably in the future, there will be large seasonal discrepancies between solar generation and electricity needs for heat pumps in the winter. To minimize energy and load growth to the grid and protect consumers from the impacts of significant growth, it is essential to match strategic electrification of homes and buildings with thermal efficiency improvements. The Northeast should build on its current infrastructure to fund and deliver thermal energy efficiency to consumers. Leveraging consumer familiarity with established programs to promote heat pumps with deep efficiency and controls can expedite consumer education and also assist in expanding market capacities to provide quality products and services.



Strategy #7 Actions

- **Couple fuel switching with efficiency in existing buildings. Fuel switching will create a new load on the electric grid.** In the near term, the growth in energy demand should be beneficial if current grid T&D capacities are more effectively utilized (i.e., improve T&D capacity factors). Longer term, with successful adoption of new electrification technologies, load may surpass existing system peaks. The size of that new load will be directly proportional to the efficiency of the existing building stock.

- **Support innovation in deep energy retrofits.** Enhanced envelope retrofit methods are needed to achieve significant region-wide thermal load reduction, but large scale deep energy retrofit business models have not yet been demonstrated. Investments need to be made in supporting innovative approaches, both technical and financial, that enable scaling of deep energy retrofits.

- **Expand low-cost financing and leasing options for consumers to support home heating equipment and water heating replacement options.** The initial costs of system replacement with a heat pump will be a significant expense, and programs must be available to reduce initial costs directly and/or to amortize costs over time for mechanical systems as well as related efficiency upgrades. Strong consumer protections should be in place for these options. Free and very low cost assistance for low-income households (e.g., the federal Weatherization Assistance Program, state EE programs) should be protected and expanded.

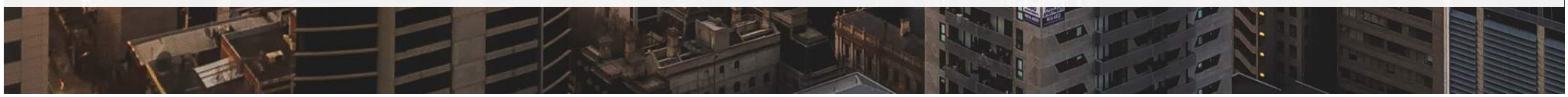
- **Allow ratepayer-funded efficiency programs to promote thermal efficiency and control technology in buildings that switch to heat pump technologies.** As homes and buildings switch to heat pumps to displace fossil fuels for comfort heating, electric efficiency programs should actively seek to make this new load both as efficient as possible and nimble enough to respond to grid needs to avoid new local or system-level electric peaks. This will likely require changes in policies and regulatory requirements for ratepayer-funded and low-income weatherization programs that, in many cases, do not proactively encourage fuel switching. Doing so will require the integration of carbon and other benefits in decision-making models and evaluation methodologies to guide cost-effective field implementation to achieve public policy goals (e.g., for carbon reduction and improved indoor health and safety.

Strategy #7 Research

- Assess how fuel switching is being treated/operationalized via energy efficiency programs in different states.

- Conduct detailed research into optimizing building energy efficiency retrofits to support fuel switching for space heating and grid integration of existing homes and commercial buildings.

- Research a performance standard that existing homes and buildings must meet as part of a rate-payer funded space heat electrification programs.



Strategy #8: Provide Public and Consumer Outreach and Education

State agencies and consumer advocates should work together to develop a communications strategy and delivery mechanism to educate consumers with consistent messages about the benefits of strategic electrification. Implemented effectively, strategic electrification has the potential to provide significant economic and health/local pollution reduction benefits. While the initial policy driver for electrification activities is carbon reduction, other tangible benefits such as rate reduction, job creation, improved indoor and outdoor air quality, and reduced energy burden are important in messaging to consumers and the public about the benefits of deep efficiency and strategic electrification.

Strategy #8 Actions

- **Develop educational campaigns that promote reduced consumer costs, less reliance on imported energy, increased local job creation, and regional business development to make electrification a non-partisan issue.** Work across stakeholder groups, including the supply chain, to take advantage of economies of scope and scale with regards to building awareness. Create and deploy a large, multidimensional campaign that can be promoted by all electrification stakeholders.
- **Work with community and business partners to incorporate multiple benefit streams in all electrification communication and marketing activities.** Electrification could help states, communities, and businesses meet economic development, resilience, environmental, and sustainability goals.

Strategy #8 Research

- Determine how to make the "stacked benefits" message resonate with policy makers.
- Determine which consumers are most receptive to electrification, and what are the key messages.
- Examine the economics of consumer decision making related to electrification.
- Examine new outreach modes to reach youth.

Strategy #9: Address Grid Preparedness to Effectively Manage New, Dynamic Loads

Flexibility of energy flow by electrification technologies offers a tremendous demand management benefit to the electric grid. In the near term this flexibility can assist in "filling in the valleys" and "shaving the peaks" of our current load shapes. In the future, peak electric demand is expected to shift to winter and we will need similar flexibility in effectively managing daily load shapes on the grid to prevent costly peaks. EVs can charge when demand is low and discharge when demand is high. Variable capacity heat pumps offer the ability to ramp usage down at times of high demand. Pairing with energy storage and highly-thermal efficient homes and buildings only broadens their "flexibility".

To fully capture the potential benefits of new electrification technologies, the electric grid must be modernized across the distribution network to handle and effectively manage these new dynamic loads as well as number of other distributed energy resources.

Strategy #9 Actions

- State agencies and energy regulators should work cooperatively with electric utilities to facilitate grid modernization initiatives that support the necessary grid infrastructure investments needed to support strategic electrification.
- State agencies and regional planners such as ISO New England and New York ISO should include strategic electrification in their planning to modernize the electric grid necessary for our region's evolving clean energy future.
- Develop consistent regional methodologies to help guide forecasting and planning related to deep efficiency, electrification, and grid integration of EVs, electrified buildings, industrial electrification, and DERs.
- Include local, distributed energy resources where they can serve as an effective complement to central generation. DERs need to be better integrated and optimized (including storage) to improve system diversity, reliability, resiliency, and safety. DERs can reduce the need for grid upgrades to serve increased loads at the certain locations.

Strategy #9 Research

- Assess the status and needs of states to comprehensively include strategic electrification in energy planning and forecasting under different scenarios, and identify resources to meet state needs to address this (e.g., methods, data) including joint efforts.
- Review the current hosting capacity of the distribution grid to accommodate wide-spread electrification.
- Assess the economics and benefits of electrification under a variety of load shape scenarios.
- Research new evaluation, measurement, and verification (EM&V) practices to fully capture the benefits of electrification to carbon reduction and system requirements.

IV. Regional Partnerships and Forums

This report is framed from a regional perspective because of the close connections in policies, economies, and markets of the Northeast states. All of the states and many of the cities and towns in the Northeast are moving on climate changes issues. Regional coordination and collaboration can speed the transition of ideas, successful actions, and critical research into a beneficial transformation of the regional energy and economic structures. It is a huge and complex undertaking that will take many years, but should also create many benefits.

Regional partnerships and coordination will be instrumental to the successful implementation of strategic electrification strategies and research. Ongoing communication and collaboration among government (state, city, town, and territory), the market (manufacturers, distributers, product and service providers, and trade associations) and other key stakeholders (regional institutions/organizations, environmental groups, consumer advocates, and other non-profits) will be required to fully engage both government and the marketplace in making these market transformation strategies work.

Fortunately, there are already a number of existing networks set up to support such collaboration. However, in some instances, further network building will help accelerate learning and support more aggressive public actions and market development.

Examples of existing regional networks that can help advance strategic electrification include:

- Existing regional energy policy and program forums such as New England Conference of Public Utility Commissioners (NECPUC), New England States Committee on Electricity (NESCOE), Northeast States for Coordinated Air Use Management (NESCAUM), the Regional Greenhouse Gas Initiative (RGGI), and regional meetings of organizations such as the National Association of State Energy Officials (NASEO). The topic of strategic electrification must be addressed in these critical regional forums.

- Existing state and regional forums for more general government scope, such as groups that serve cities or legislators including the Conference of Northeast Governors (CONEG), U.S. Conference of Mayors, etc.

- The Multi-State Zero Energy Vehicle Task Force, which includes several Northeast states committed to advancing EVs. Recommendations from this group are helping to inform state plans to use the Volkswagen TDI diesel settlement funds ($344 million allocated to New York and New England states) to accelerate zero emission vehicle investments.[14]

- NEEP's Regional Air Source Heat Pump Market Transformation initiative and stakeholder working group to overcome technology, market, and program barriers on a regional scale. In 2018, this group expanded to build on the residential work to also address commercial sector technology and market opportunities (e.g., variable refrigerant flow equipment).

- The Renewable Thermal Alliance based at Yale University, which focuses on issues that cut across various renewable thermal technologies such technology, standardization, evaluation, measurement and verification, and policy.

- Regional groups or initiatives that bring stakeholders together to advance high performance, low-carbon homes and buildings such as the Northeast Sustainable Energy Association (NESEA) and regional meetings of the Home Performance Coalition.

- NEEP's Advanced EM&V Forum, a regional platform to conduct or coordinate joint research on topics of common interest such as data and methodologies to include new and evolving efficiency and demand-side resources – such as strategic electrification – in planning, forecasting, program and capacity market EM&V.

[14] See https://vwclearinghouse.org/

Next Steps

Economy-wide electrification of the transportation sector, key thermal end uses, and key industrial processes certainly poses a significant challenge to the region. However, to put these kinds of transformations into perspective, it is helpful to remind ourselves of other major transitions/disruptions in our region in recent history. This is not the first time that electrification or fuel switching has occurred in the Northeast. To serve early refrigeration needs, the Northeast used to have a significant ice cutting industry to supply houses and businesses in the Northeast and down the Atlantic coast to keep food fresh. New refrigeration technologies, and new industries, were developed and the ice industry soon disappeared. We used to primarily burn wood, then coal to heat our homes. Then less polluting, more convenient fuels and heating systems became available. Now, we have the opportunity to move to clean, renewable fuels throughout our entire economy. With these examples, it is clear that the Northeast has succeeded with large, economy-wide transformations involving energy and technology.

The move to a more sustainable energy system that includes fuel switching is likely inevitable due to continued reductions in the cost of renewable electricity sources. However, there are compelling reasons, namely environmental and economic, to making a more rapid transition.

Leadership and cooperation is critical to advance strategic electrification across the multiple layers of government, industry, manufacturers, equipment and service providers, consumer and environmental advocates, academia, and other stakeholders. We encourage leaders across all these areas to make strategic electrification a priority, and to use existing forums and programs to advance solutions and conduct research to fill gaps.

For its part, NEEP will support leadership cooperation across these interests by inviting leaders from a range of perspectives to participate in a Regional Strategic Electrification Forum to highlight progress, share ideas, and develop connections that speed innovation and market transformation. We will also continue current programs and encourage cooperative efforts to advance the recommendations for action and research presented in this report.

We appreciate the thoughtful participation and recommendations of the many participants in our strategic electrification advisory committee and summit. Thanks to each member and participant for being part of this collaboration. Success in the Northeast to advance strategic electrification is critically important to meet state and local climate stabilization goals. It can also help catalyze similar efforts in the United States and the world to slow greenhouse gas emissions and climate change – the sooner, the better.