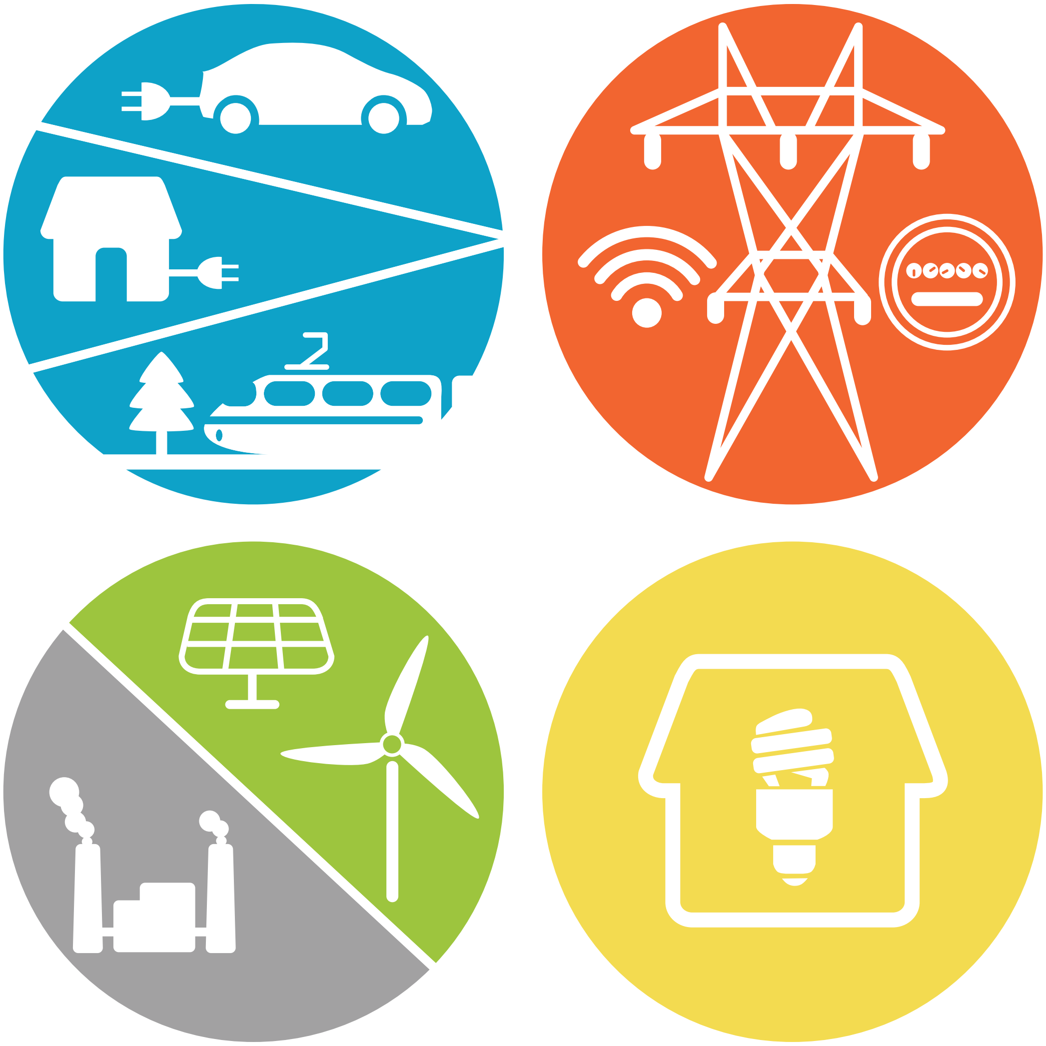
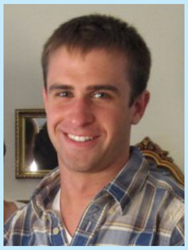


EnergyVision

A Pathway to a Modern, Sustainable, Low Carbon Economic and Environmental Future

ENE



Dedication to David LeClair

ENE dedicates EnergyVision to David LeClair, who tragically lost his life on June 14, 2013 in a bicycle accident during the Trek Across Maine, a normally joyful 3-day, 180-mile trip that attracts thousands of bicyclists in a fundraiser for the American Lung Association. David was riding with his employer group from athenahealth, a company that provides cloud based services in the health profession. David was known for his energy, enthusiasm and genuine kindness. As his friends and colleagues at athenahealth note, “David has shown us that caring is the greatest thing you can do in life – and he demonstrated what caring means in ways large and small.” ENE was deeply moved when David’s team at athenahealth selected ENE to receive a generous donation in his memory. We hope that EnergyVision, which sets forth an ambitious, positive pathway to a sustainable future, is a fitting tribute to David’s enthusiasm and optimism and his passion for the environment. We are honored to dedicate EnergyVision to David.

About ENE

ENE is a nonprofit organization that researches and advocates innovative policies that tackle environmental challenges while promoting sustainable economies. EnergyVision is part of a series of ENE reports that focus on how states and regions can address the challenge of climate while improving economic and consumer benefits. EnergyVision was produced by ENE staff, led by Jamie Howland, Director, ENE Climate and Energy Analysis Center with primary contributions from Abigail Anthony, Varun Kumar and Daniel Sosland. Thanks to Eleanor Kung for visualization designs and to Headwaters Writing & Design for layout.

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An EnergyVision Pathway to a Modern, Sustainable Low Carbon Economic and Environmental Future

ENE's EnergyVision presents an overarching framework to guide investment choices and reforms needed in our energy system. If fully implemented, the approach outlined here would achieve key goals for our economic and environmental future: more efficient energy use, accelerated economic development, cleaner air, greater control over consumer costs and steep reductions in greenhouse gas emissions. Focusing on four interconnected components of our energy system, centered on the electric power grid, EnergyVision describes a major shift in how we think about energy so as to improve economic productivity, reduce emissions, make the electric system more resilient, empower consumers to have more control over their energy future and take advantage of viable, exciting technologies to replace fossil fuel use in our buildings and cars. **EnergyVision integrates these four components**: (i) utilize market-ready technologies to **electrify buildings and cars**; (ii) **modernize the way we plan, manage and invest in the electric power grid** so that it facilitates new technologies, decentralized energy systems and consumer control; (iii) make continued progress toward a **clean electric supply** through increased investments in local renewable power; and (iv) **maximize investments in energy efficiency** so that energy consumption is as efficient as possible, while improving building comfort and reducing unneeded energy demands that waste consumer dollars and act as a drag on the economy.

ENE's EnergyVision represents a cultural shift in how we envision our energy infrastructure. No longer will our energy dollars be poured only into massive power stations and miles of wire. The **new grid is at our homes and businesses**, where users control energy use and improve energy efficiency; install smart appliances; generate electricity from solar and distributed energy sources; plug in our cars; connect to community wind, solar, and cogeneration; and earn incentives for using power when the grid is most available. We can begin to think of and manage our homes and businesses as our own "micro-utilities," handling many of the services currently managed by large power companies, and doing so with new, efficient and clean technologies.

Our core climate and energy challenge is to **construct a fully integrated, flexible, and low carbon energy network**. A smart and dynamic electric system, managed with the cooperation of utilities, power grid operators, consumers, and communities will be characterized by widespread clean energy supply and distributed generation, deep energy efficiency in increasingly electrified buildings and vehicles and incorporation of new energy resources, business and consumer incentives and community energy systems. Making the grid and regulations **"Renewable-Ready"** can meet our needs today and build the clean, electrified energy system of tomorrow.

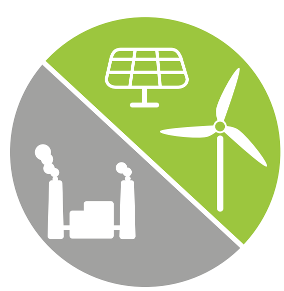
This is **a future that offers deep emissions reductions and widespread consumer benefits**. ENE has done the math, and the emissions savings add up. Consider this hypothetical: **if all gasoline powered vehicles and all buildings using fossil fuel for heat in the Northeast shifted overnight to electricity, GHG emissions from these uses would fall by 50%.** While there are many other steps that would need to occur to fully transition these sectors to electricity, new and emerging technologies are making this pathway more viable than ever before. With increasing investments in clean energy – energy efficiency, renewable power like wind, and distributed energy resources – the carbon profile of electricity will continue to decline. As detailed below, it is reasonable to forecast a scenario in which emissions from vehicles and buildings fall by over 75% by 2050.

EnergyVision: Four Interconnected Areas

This EnergyVision presents a framework for the future that hinges on the replacement of fossil fuels with clean, low carbon emitting electricity to heat our buildings and power our cars. Focusing on the Northeast region, EnergyVision centers on the electrification of our entire energy system through reforms and advances in four interconnected areas: **Electrify Buildings and Transportation**; **Modernize the Grid**; **Clean Electric Supply**; and, **Maximize Energy Efficiency**.

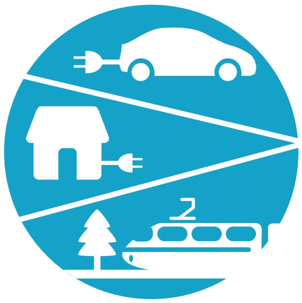
Electrify Buildings and Transportation

Modernize the Grid



Clean Electric Supply

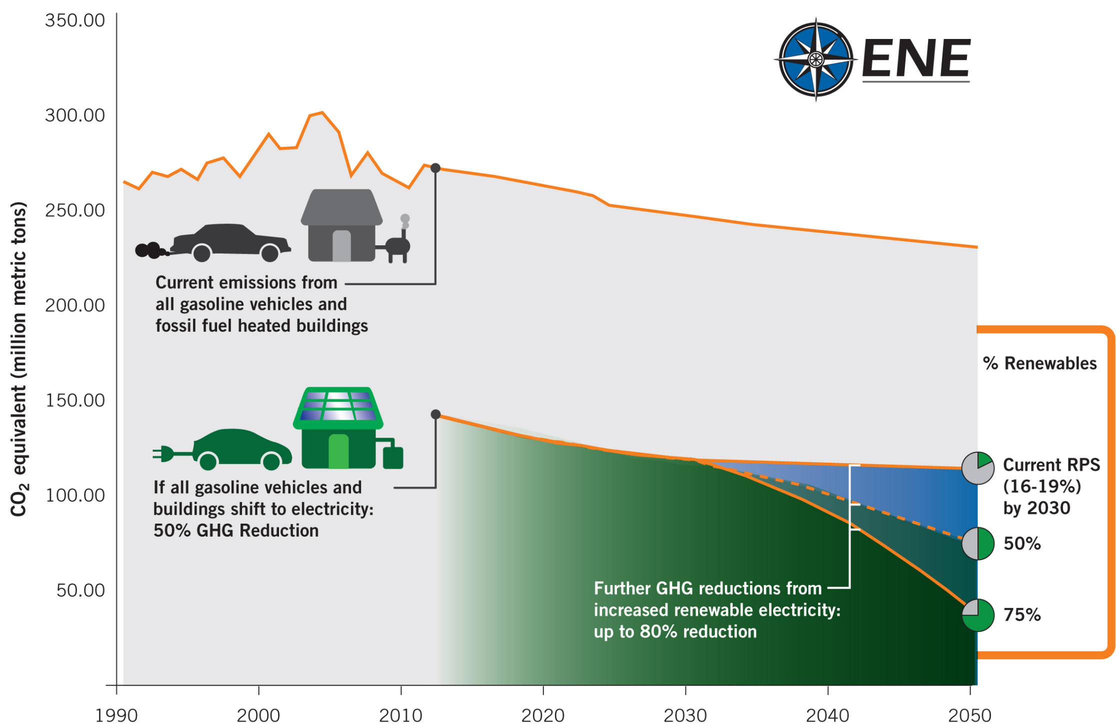
Maximize Energy Efficiency



I. Electrify Buildings and Transportation

Electricity can power many of the things that currently use fossil fuels. While it may challenge conventional wisdom, electrification can deliver lower costs and lower emissions today. The economic and environmental benefits of electrification will grow as the energy system transforms to include more renewables, distributed generation, and energy storage. If all gasoline powered vehicles and buildings using fossil fuels shifted to electricity technologies today, emissions would fall by nearly 50%:

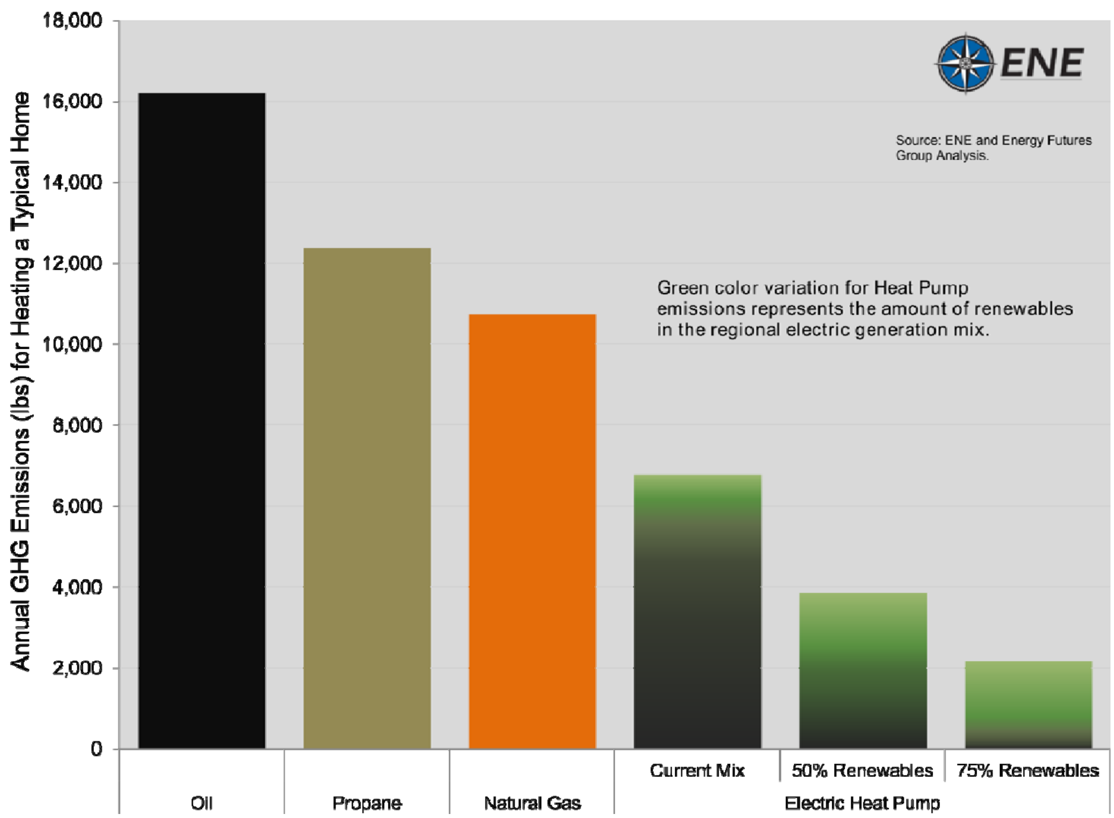
ENE Assessment of GHG Levels with Full Electrification



Buildings and Electrification: Space and Water Heating

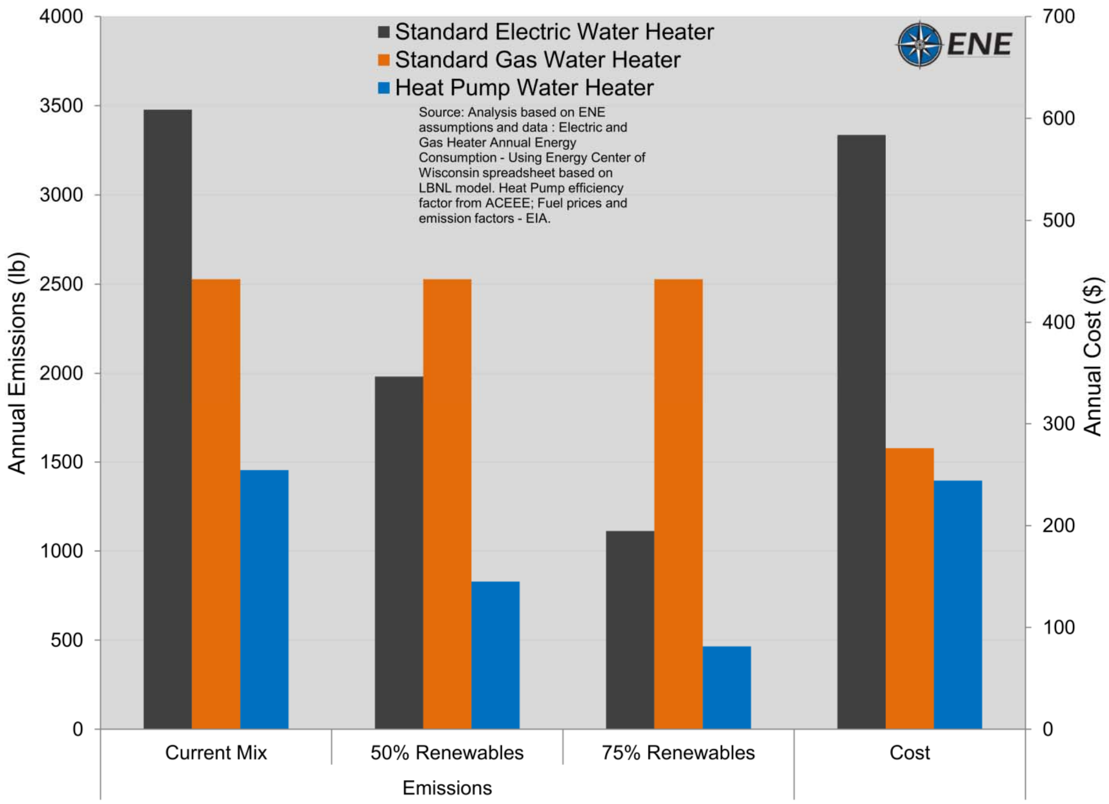
Recent technological advances have made **Efficient Electric Heating a compelling alternative to natural gas and oil for heating homes and businesses**. Although electric resistance heaters are widely recognized as one of the least efficient ways to provide space heating, electric heat pumps – a different technology – have been rapidly improving to the point where they deliver space heating about three times more efficiently than resistance heat. In addition, heat pumps can use the existing electric power grid infrastructure to heat homes and businesses at lower cost and with reduced greenhouse gas emissions compared to oil or natural gas. This means that heat pumps deliver immediate environmental benefits without locking the region into the added expense of over investing in natural gas distribution system expansions. As a greater proportion of our electricity comes from renewable resources, the environmental and climate benefits of heat pumps will increase; they will heat buildings with even lower emissions and reliance on fossil fuels. As the illustration below shows, switching building heating to high efficiency electric heat pumps offers clear economic and emissions benefits:

Emissions of Heating Technologies Compared



Similar advances in technology will allow electricity to be substituted for fossil fuels in other building energy end-uses. There are several other common uses for natural gas and heating oil in homes and businesses, which are a major source of emissions from buildings. Emerging and recently commercialized products can electrify these activities, providing benefits today and greater future emissions reductions as more renewable electricity comes online. Electric heat pump hot water heaters (HPHWs) can dramatically reduce cost and emissions compared to natural gas, oil, or traditional electric hot water heaters. Commercial deployment of HPHWs has begun. Dehumidifying clothes dryers, which are currently available in Europe, dry clothes without the excessive waste heat of traditional gas or electric dryers. This advanced technology can cut emissions from drying clothes by 50% today, and further reductions would increase as clean power is added to the grid. The figure below compares the cost and emissions of efficient electrification options for water heating.

Cost and Emissions Savings from Heat Pump Water Heaters



Nearly 35% of homes in the Northeast rely on heating oil or propane. The **high-cost and market volatility of these fuel imports makes this region an ideal candidate for widespread adoption of efficient electric space and water heating**. Increasing investments in high-efficiency electric heat also avoid the risk of over-reliance on natural gas and costly investments in added pipeline capacity.

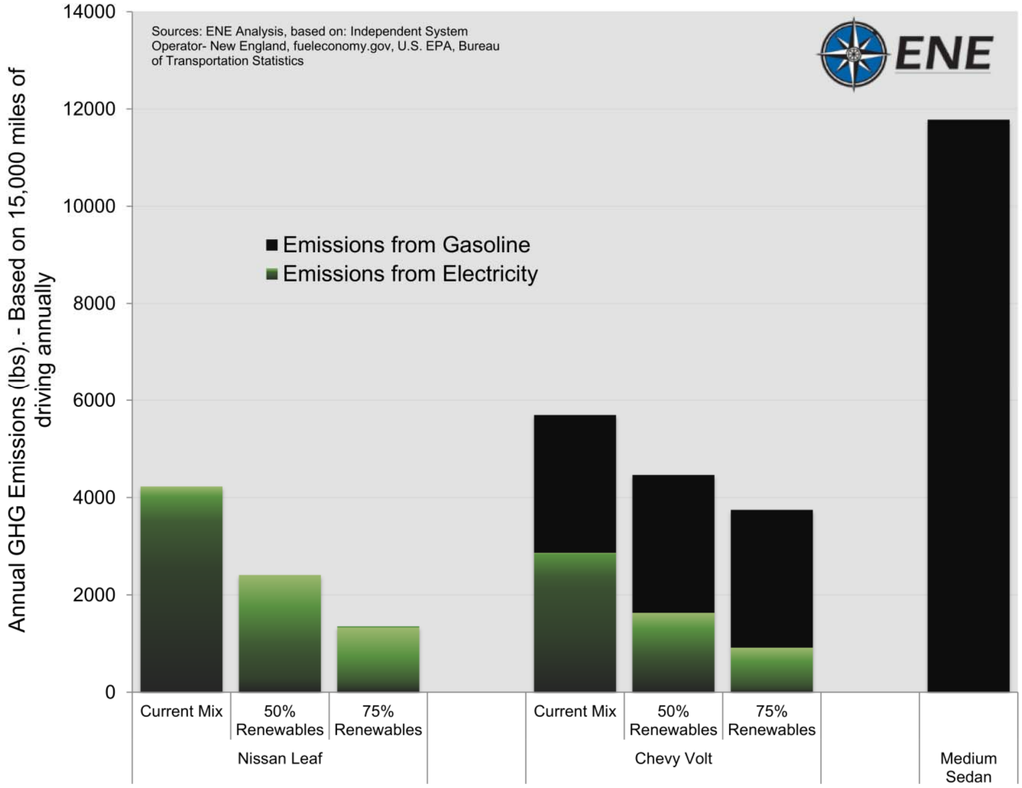
Natural gas may be viewed by some as an interim step for reducing emissions from heating oil use (provided fracking concerns over fugitive methane emissions and impacts to groundwater are addressed). However, there is no viable way to further reduce the GHG emissions from natural gas, and building extensive gas delivery infrastructure will not support or facilitate further deployment of renewable resources like wind and solar. Some states are proposing extensive and expensive incentives to expand natural gas infrastructure and switch building heating to natural gas. This approach risks overinvestment in natural gas and must urgently be reconsidered so that any support for fuel switching is better aligned with the future energy and environmental needs of the region. **States and consumers can either pay for natural gas infrastructure now and then again for a replacement system or start investing in the right combination of solutions now**.

Many state efficiency programs in the region recognize the value of cold weather heat pumps by offering incentives to replace inefficient electric resistance equipment with high-efficiency heat pumps for both space and water heating. These efficiency programs offer an ideal vehicle to encourage the broader adoption of heat pump technologies for greater market penetration needed to achieve widespread building electrification. Most efficiency programs and state policies need to be expanded in order to offer the right incentives to consumers to guide them to the product choices, in this case efficient electric heat pumps, that benefit the consumer and put the region on a path to a sustainable energy system.

Transportation and Electrification

As advances in electric vehicle technology continue, the benefits of a fully electrified passenger transportation system are becoming clear. Shifting our transportation system to electricity is critical. Electric vehicles can currently reduce transportation emissions by over 60% when compared to a traditional internal combustion engine (using the current New England power pool mix). Operating costs are approximately 64% lower: about 5 cents/mile for an electric vehicle in the Northeast compared to 14 cents/mile for a conventional medium sedan. As the carbon intensity of the regional energy mix decreases, the environmental and climate benefits of electric vehicles increase. The figure on the opposite page compares the emissions of an electric vehicle to gasoline-powered options.

Annual Vehicle Emissions From Electricity Compared to Gasoline



Electric vehicles have tremendous potential to reduce consumers' expenditures on imported gasoline and diesel and advance state clean energy and climate goals. **The twenty-first century electric grid needs to be prepared for large-scale electric vehicle adoption in a manner that enhances system reliability, minimizes costs, and protects consumers**. For example, time-varying rates can encourage off-peak charging and minimize costly distribution system investments. **Two-way power flow will also enable electric vehicle batteries to store electricity** and send it back to the grid during peak demand hours, providing grid stability resources through energy storage. Transportation and energy are inseparably linked, yet the policies surrounding each are often created in a vacuum. Policymakers in the region must pursue an integrated approach that appropriately values long-term benefits and will offer the right mix of incentives to consumers, utilities, investors, and market participants to ensure clean, flexible and affordable vehicle charging and a range of attractive vehicle choices.

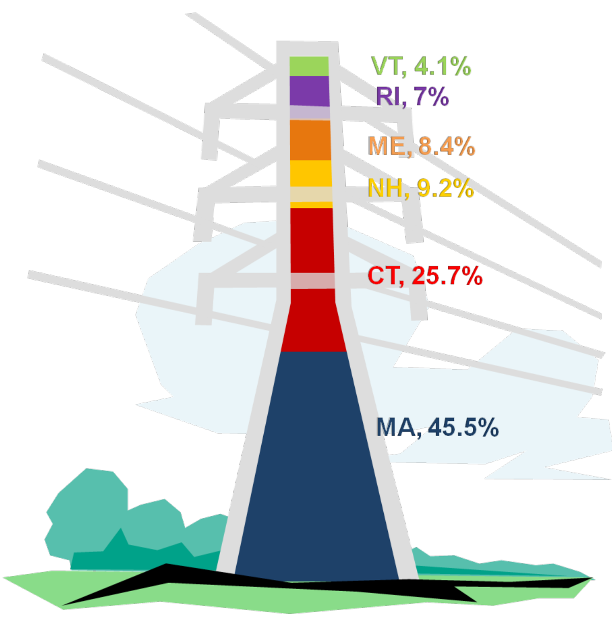
Most modern mass transit systems are increasingly powered by electricity. **Increasing the availability of electric buses, light rail, commuter rail and high-speed rail in the region will lead to additional emissions reductions in the transportation sector. Updated approaches to town planning, zoning and permitting are needed** to facilitate more transportation options, improve the livability of towns and help control energy and transportation costs. Building codes must also be updated to incorporate charging infrastructure.

II. Modernize the Power Grid

To achieve our climate and energy goals, we must reform the region's transmission and distribution (T&D) grid to create a Renewable-Ready Energy Delivery System.

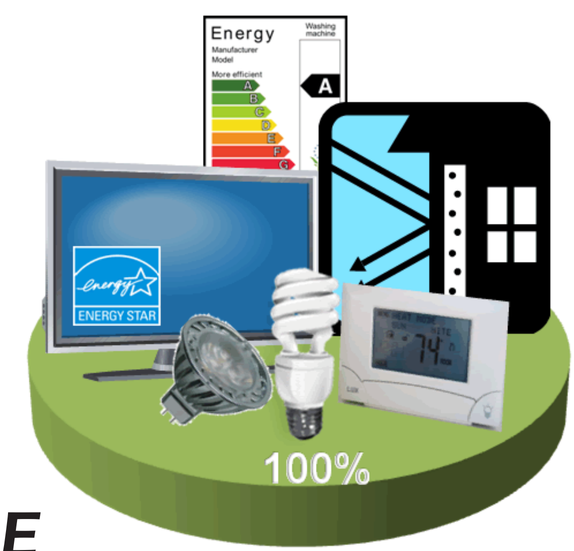
The planning and investment policies that govern our power grid were developed in an earlier era, when large fossil-fueled power plants were constructed to energize population centers. Longstanding policies skew decisions in favor of legacy power grid investments over newer, often less expensive and more advanced solutions. For example, the costs of paying for transmission projects are "socialized" in many regions of the country. This approach spreads the cost of transmission projects to ratepayers in all states in the power pool, while lower cost local options are rarely considered and are not eligible for this type of socialized cost recovery. These rules need to change so that viable, often lower-cost alternatives to large-scale transmission projects – such as energy efficiency, clean distributed generation, energy storage, and demand response – are not excluded when considering investments to maintain and improve power reliability. Such alternatives can replace or defer the need to construct more grid infrastructure, immediately delivering economic and environmental benefits.

Transmission Costs Paid Proportionately by Consumers in All Six States in the ISO-NE Grid



VS.

Non-Transmission Alternatives Costs Borne Entirely by Consumers in One State



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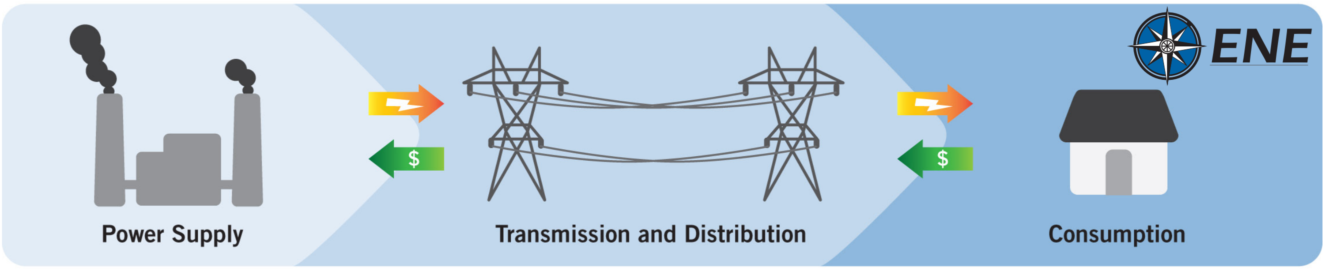
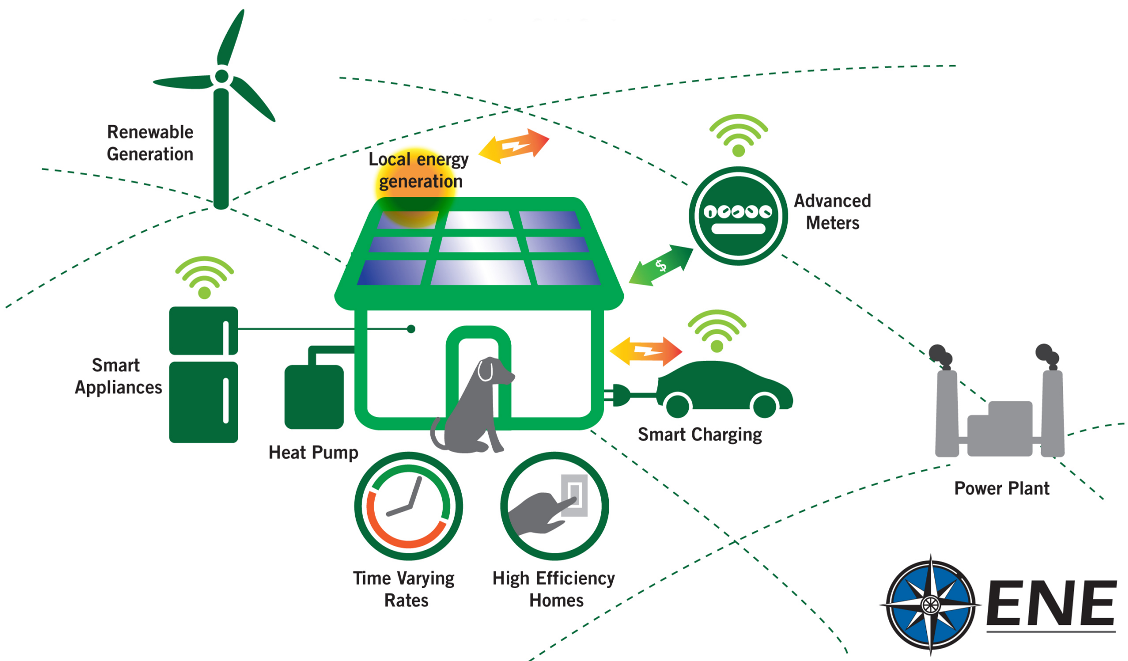
Old Power Grid System



To maximize consumer and economic benefits, improve system resiliency to storms and other disruptions, and reduce GHG emissions, **we need to reshape the vision of our power delivery system. The "Old System" is a one-way route from power plants to homes and businesses. The Modern Grid System is a multi-directional path using an array of technologies to meet our energy needs**:

Modern Grid System

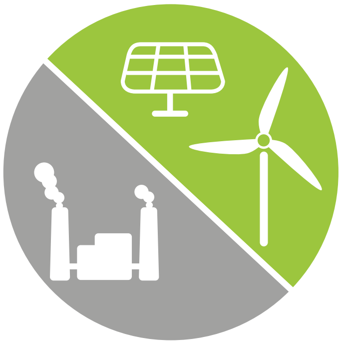


In the Modern Grid System, the home and business become the centerpieces of the energy system. Consumers will have greater control over energy use within and around the buildings they occupy through technologies such as rooftop solar water heating and photovoltaic systems, advanced meters that help consumers control and monitor power usage, and technologies such as smart appliances and heat pumps. Community energy systems – local windpower, solar arrays, and combined heat and power – will also play an important role in a decentralized power grid. Energy efficiency, already a "first fuel" that increases consumer savings and reduces energy consumption, becomes a "first resource" through targeted deployment that offers a cost-effective alternative to building more poles and wires to supply additional power.

Electric power grid planning and financing has not kept pace with changes in energy technologies and environmental and consumer goals to Integrate Clean Energy Resources. Demand side energy resources like energy efficiency; energy storage; small scale, distributed renewable generation; and on-site combined heat and power systems do not rely on power being transmitted but rather on using energy more efficiently and generating more power on-site. The new system must facilitate development of new clean power sources and energy efficiency – whether these resources are located at a wind farm, inside the steam pipes of a paper company, or as an energy management app on a consumer's phone. To achieve these goals, outdated regulations governing energy resource ownership must be revised, new rate structures must be considered, and clear rules need to be adopted that reflect the appropriate role of the utility in an increasingly decentralized system.

New technologies are dramatically increasing the ability to Optimize Energy Consumption in the electric system. Traditionally, the solutions to problems such as overloaded facilities, low voltage, stability response, contingencies, loss of load, and system losses have been T&D capital projects: new circuits, new substations, or larger conductors. As technologies improve, the range of alternative solutions has grown: demand response, direct load control, advanced metering, time-varying electricity rates and automated appliances, and electric vehicles that can also serve as energy storage are all cost-effective tools for reducing peak demand and optimizing grid performance. Deploying these cost-effective resources to reduce peak demand and optimize grid performance can potentially defer or avoid grid investments and provide significant consumer savings.

The existing regulatory policies that guide utility planning and investment decisions limit new technology and risk perpetuating the status quo. The traditional rate-making methodology that guides distribution utilities' decision-making focuses on certainty: allowing a utility to recover its investment plus a rate of return set by regulators. This practice was established decades ago and premised on investments in a largely stable and proven infrastructure of power plants, substations, poles and wires. Currently, there is a lack of clarity as to how new technologies and grid modernization strategies, which do not fit neatly into the old rate of return model, will be treated by utility and grid regulators. This uncertainty can discourage utilities from deploying advancements like time varying rates, load control, or voltage regulation and limits utility approaches to smarter grid options. New technologies can deliver substantial benefits, including increased reliability and efficiency, lower costs and bills, increased consumer control and choices, and lower greenhouse gas emissions. **Reformed regulatory models are needed to remove current uncertainties and align utilities' financial incentives with the states' clean energy, carbon reduction, and economic goals**. Because major new market opportunities exist for electricity, it is critical that utilities' interests are aligned with the steps needed to modernize the grid.



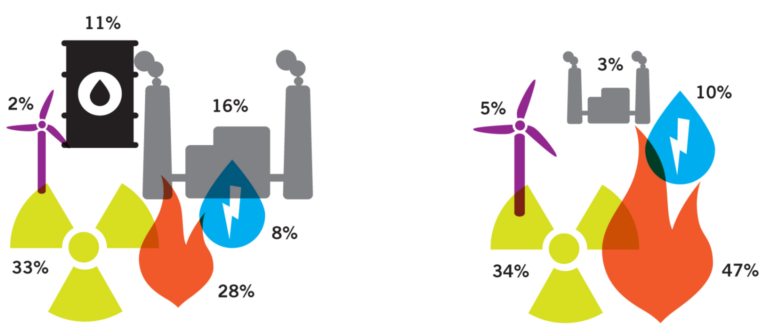
III. Clean Electric Supply

In the past five years, large shifts to natural gas for generating electricity have led to dramatic reductions in emissions as coal and oil plants have been idled or closed. As coal and oil plants decline, the opportunity for additional emissions reductions from fuel switching also declines (and there remain concerns regarding the lifecycle emissions of natural gas supplies). Deployment of more grid-scale renewable power can provide the next phase of emissions reductions in the region.

As the following figures show, **there has been a dramatic evolution in the sources of energy used to generate electricity in the Northeast**. From 2001 to 2012, the share of electricity generated by oil and coal generating plants has fallen from 27% of all electric generation to less than 3%:

Transition of Electric Generation Fuels from 2001 to 2012

Power Generation



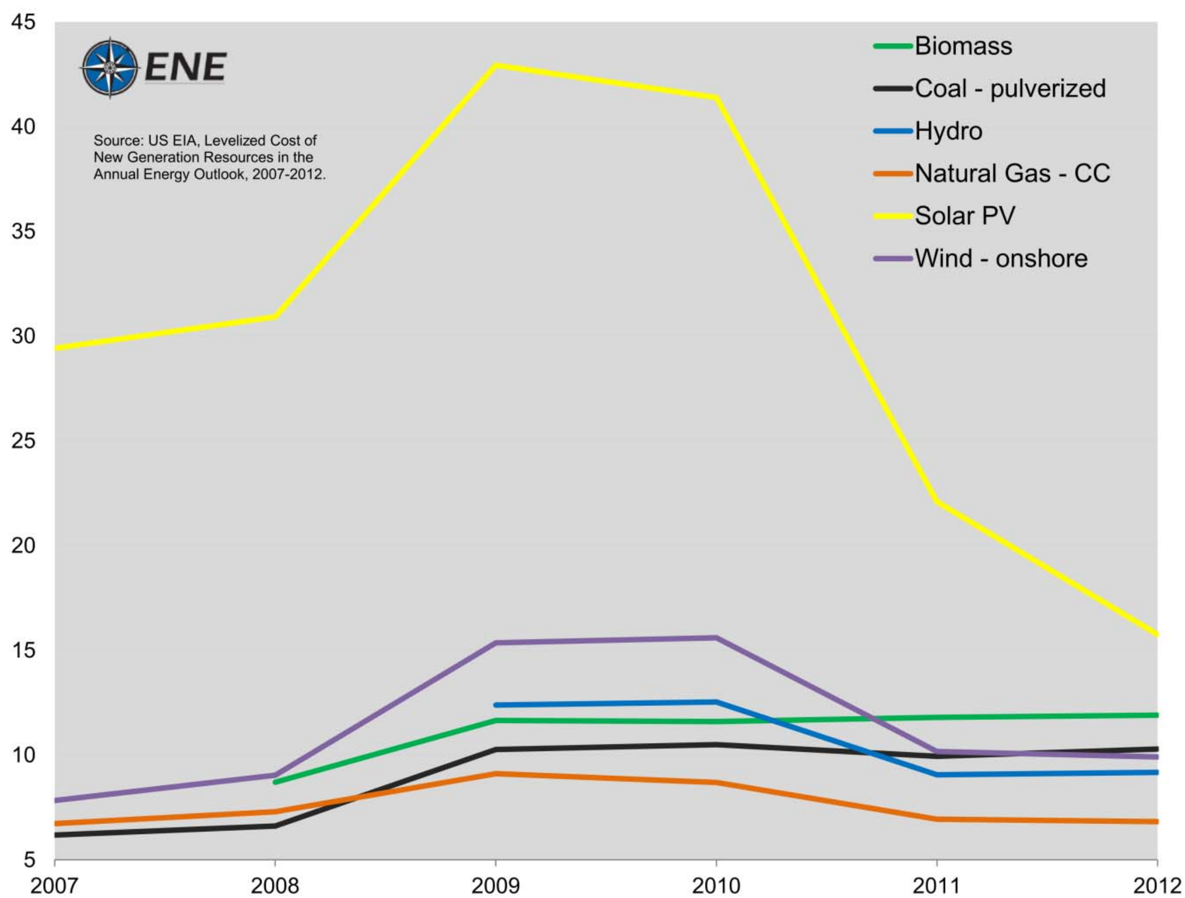
2001 Generation Mix **2012 Generation Mix**

	2001	2012
Oil	11%	0%
Coal	16%	3%
Hydroelectric	8%	10%
Natural Gas	28%	47%
Nuclear	33%	34%
Renewables (non-hydro)	2%	5%

Increasing the region's use of wind, solar, and other renewable resources will reduce power sector emissions and provide significant economic benefits. Advances in technology, declining costs, and market-based strategies have helped increase the number and variety of clean energy resources in the region. Use of clean energy in the region has increased by about 25% since 1990. To meet our economic and climate challenges, it is critical that we build on this progress with sustained commitments to clean power. Policies that encourage the growth of renewable energy and require fossil fuel-based energy sources to reflect the cost of pollution tackle this problem head on.

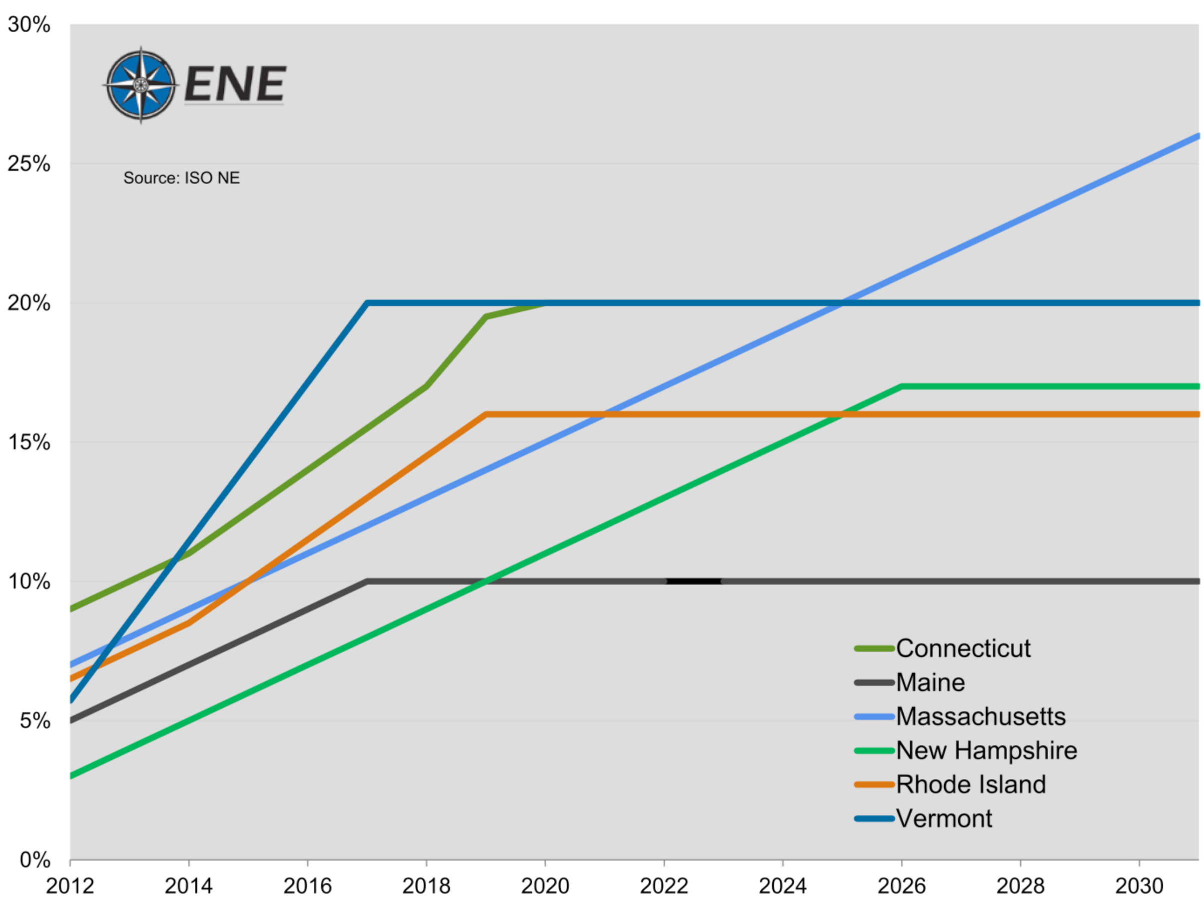
The cost of many renewable technologies has declined in recent years, making renewables more cost-competitive with conventional resources **highlighting the need to support and continued Clean Power Incentives to promote commercialization, innovation and market structures**. The following chart depicts the levelized cost of energy (LCOE), which reflects the "all-in" cost of generating electricity over the life of the plant (cents/kWh), taking into account costs for capital, operations and maintenance, and fuel.

Electric Generation Cost Trends



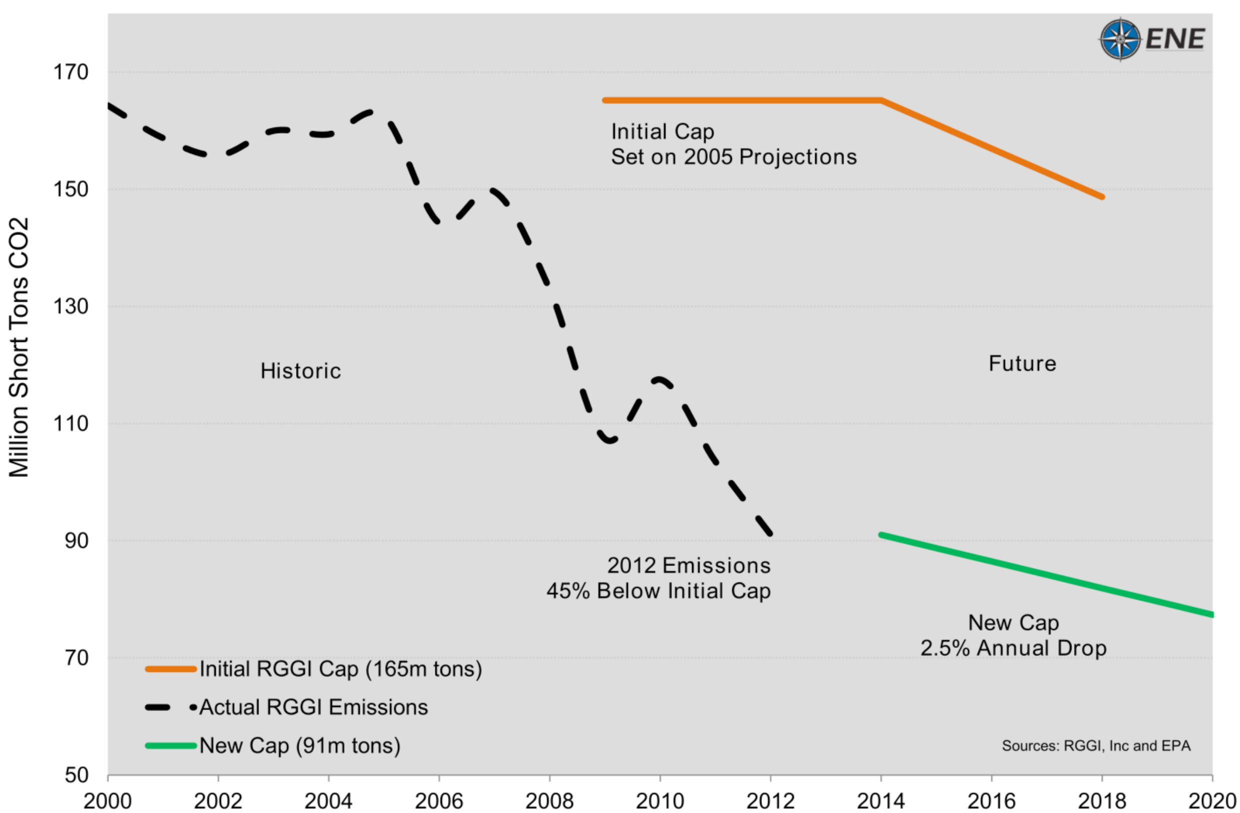
Renewable Portfolio Standards are a catalyst to spur increased generation of renewable power. Eight Northeast states have established Renewable Portfolio Standards (RPSs) or equivalent policies that support increasing amounts of clean power. Requiring utilities to steadily increase purchases of renewable energy provides key financial support for emerging renewable technologies such as wind and solar, which are competing against incumbent generation from fossil fuels that have long benefitted from public subsidies and emit harmful greenhouse gases with minimal cost or penalty. While the current levels of RPS standards shown in the figure below are an impressive start, higher levels of renewable generation will be needed in the clean energy system of the future.

Class I RPS standards in the New England States



The Regional Greenhouse Gas Initiative (RGGI) should lock in lower emissions and deliver further reductions. In order to secure significant progress reducing emissions, states participating in the RGGI – the region's power sector cap and trade program – recently **agreed to reduce the emissions cap by 45% and deliver continuing reductions through 2020**, as shown in the figure below. States must build on this progress by extending RGGI targets beyond 2020. Long range goals are needed to send clear market signals that will deliver the investment needed to further reduce greenhouse gas emissions from our electric system. States should also establish carbon controls for other sectors of their economies – such as industry, transportation, liquid fuels, and natural gas – in order to drive cost-effective emissions reductions across the regional economy, and raise funding for complementary clean energy programs that boost in-region economic growth.

Emissions Trends and Cap: RGGI

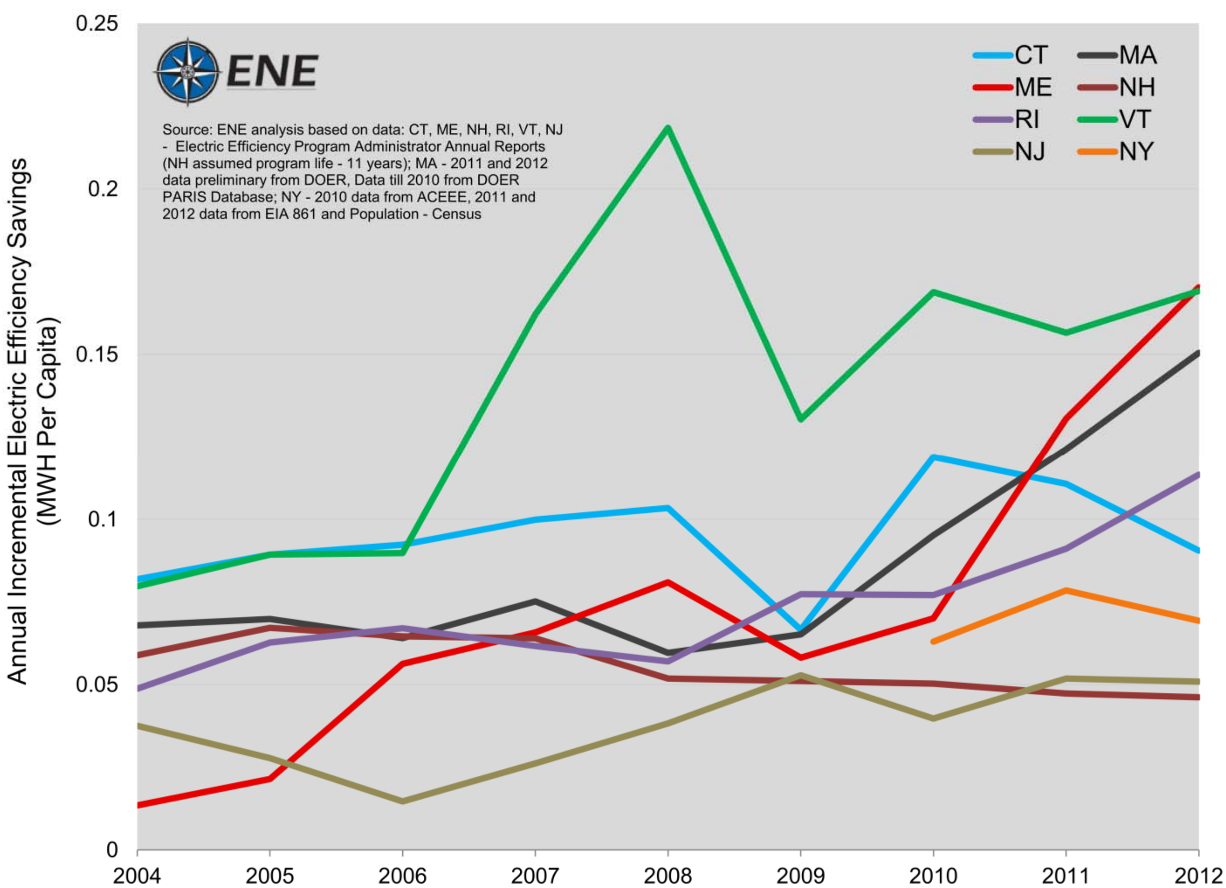


IV. Maximize Energy Efficiency

Energy efficiency is the cornerstone policy to reduce emissions and complements energy system transition strategies by reducing energy needs. Projects can also target specific infrastructure needs, such as providing an alternative to a transmission or distribution line upgrade, all while removing wasteful energy consumption and emissions.

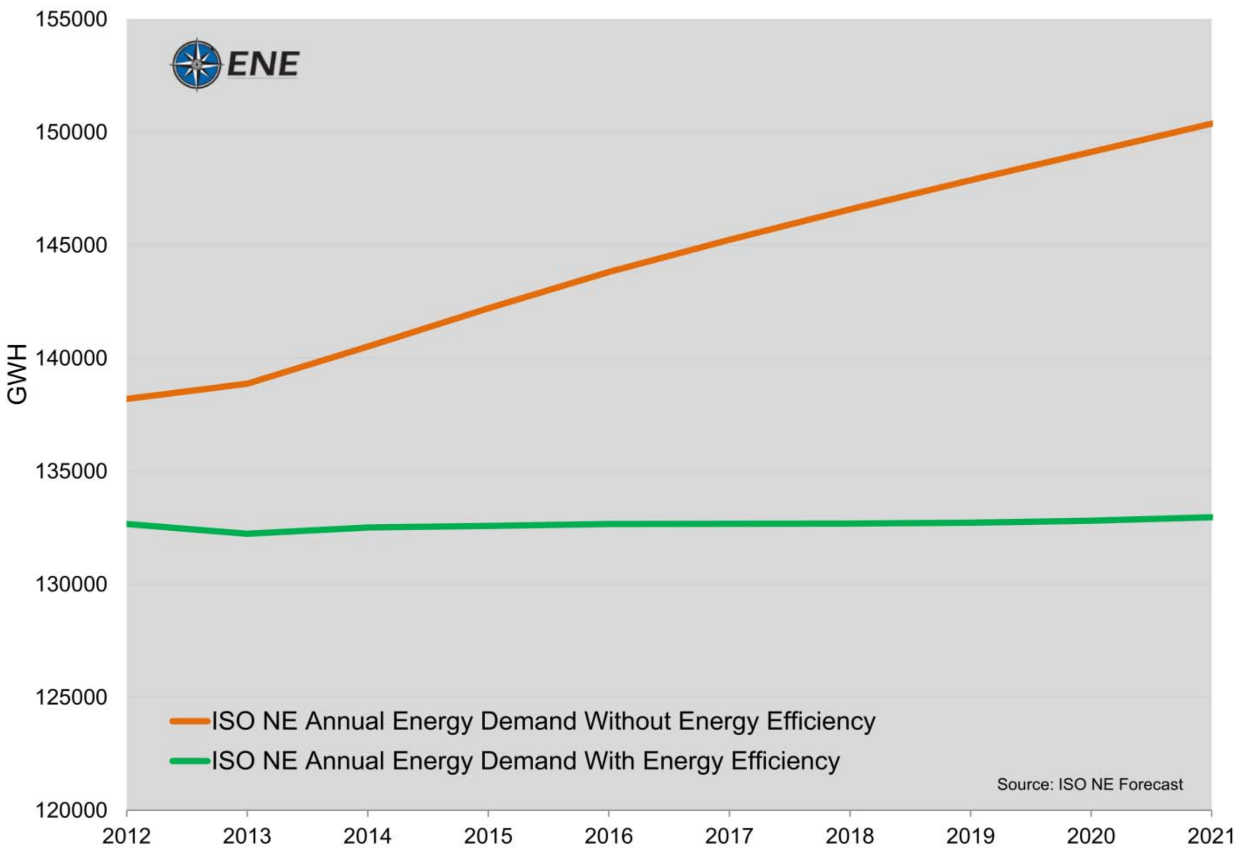
Energy Efficiency is the cheapest and cleanest "fuel," and states must support capturing All Cost-Effective Efficiency that is less expensive than supply. By adopting laws and regulations that prioritize energy efficiency, states are dramatically reducing consumption of fossil fuels, keeping more energy dollars at home, and driving economic growth. For example, the six New England states have invested over $3.3 Billion in energy efficiency that will save over 124,000 GWh. These energy savings will deliver $19.5 billion dollars in economic benefits and 51.3 million metric tons of avoided greenhouse gas emissions. Current and planned levels of efficiency investment in leading states are shown below.

Efficiency Savings Levels of Northeast States



In 2011, ISO-New England recognized the potential for states' investments in energy efficiency to defer and potentially avoid costly investments in the regional transmission system. As a result of the states' investments in energy efficiency, at least $416 million in planned transmission investments have been deferred and potentially avoided. This dramatic impact of efficiency on the energy needs of the region is illustrated in the figure below.

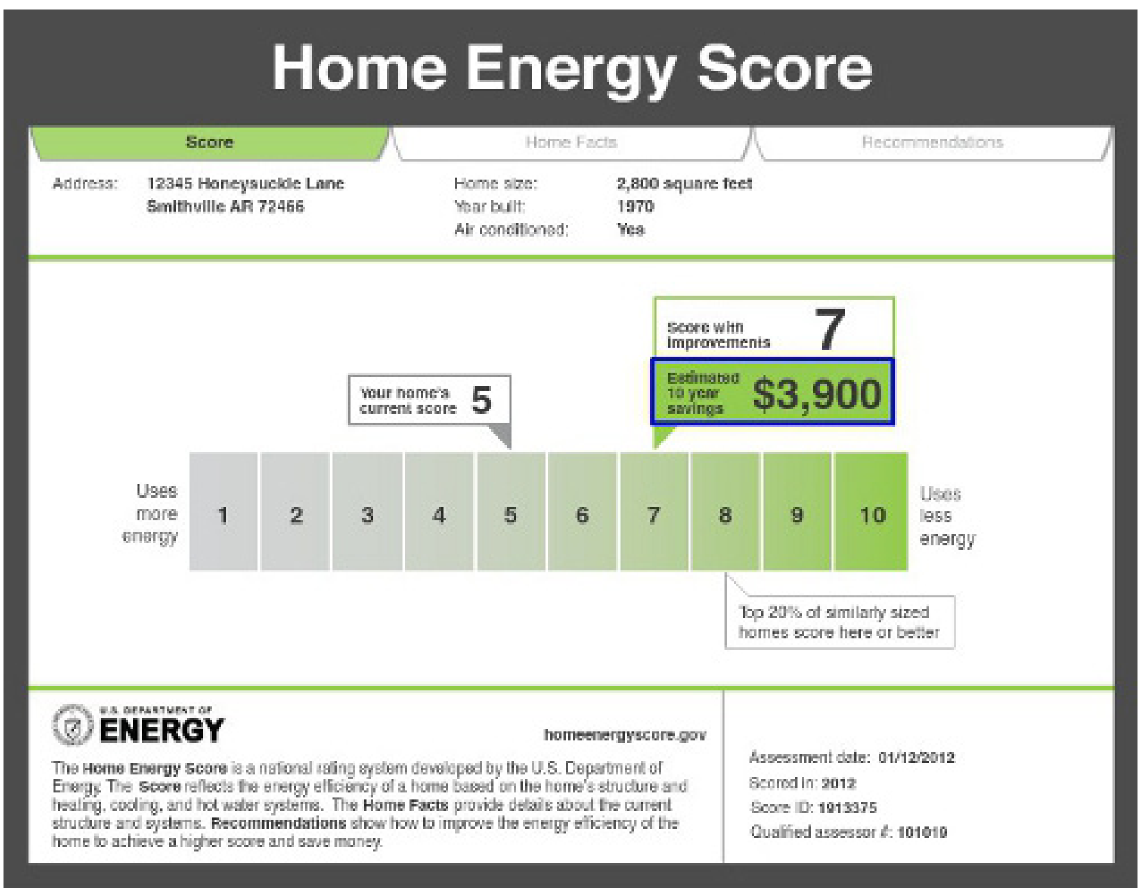
New England Energy Demand Forecast



Energy Efficiency Investment Programs will need to evolve to meet the changing needs of the energy system of the future. While these programs will continue to provide the incentives and education needed to ensure consumers and businesses invest in the most efficient products, new areas are emerging that will also play an important role. The more flexible electric grid of the future will provide more control to customers and allow them to become "micro utilities" with their own distributed generation, storage through electric vehicles, and demand control through intelligent appliances and building systems. Energy efficiency programs will need to play a key role in the adoption and diffusion of new demand side technologies and products. Expanding Zero Net Energy building programs established in many of the northeastern states will educate both industry and the housing market on how energy efficiency can be maximized and deployed.

As policymakers, homeowners and others continue to struggle with the inefficiency of the existing building stock, an increasing focus must be placed on Building Weatherization. Efficiency programs need to continue to evolve to address this difficult segment of the market through improved program design, continued education of the building trades, and access to affordable financing. Providing the information businesses and consumers need to appropriately value energy efficiency through Building Energy Labeling can enhance energy efficiency efforts. Several states have begun to take steps towards uniform building rating and labeling systems. Labels (see example below) that are provided as part of a real estate listing service can provide potential buyers or lessees with the information they need to more fully understand the energy costs of a building. This information will drive participation in weatherization programs by helping to ensure that investments in energy efficiency by a property owner can be recouped in the future, which in turn will expand the amount of efficiency that is captured.

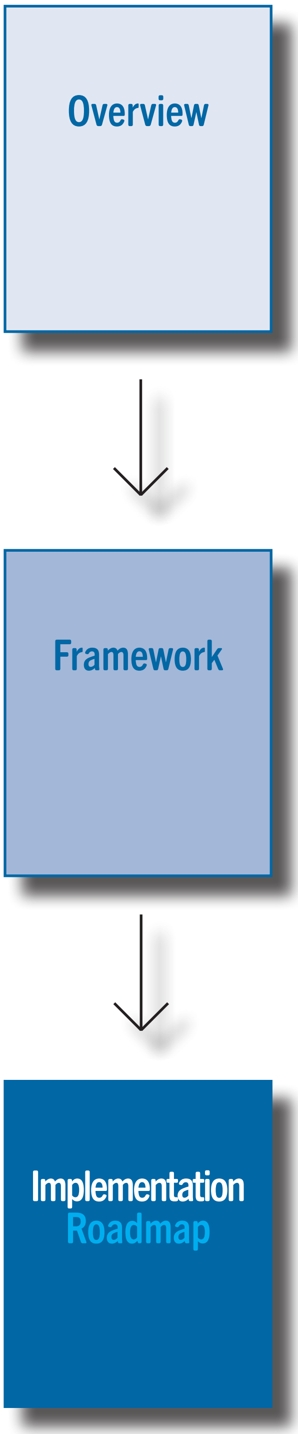
Example Building Energy Label



For new construction, major renovations, and many building systems, Building Codes and Product Standards can be the most effective way to improve energy efficiency. States need to constantly improve their baseline building energy codes to ensure new buildings are as efficient as possible. These codes will need to evolve to meet the needs of a modernized grid and energy system by ensuring new buildings either require or can be easily upgraded to support two-way vehicle charging, rooftop PV, and other components of the future energy system. While some improved federal product standards have been promulgated in recent years, there remains tremendous opportunity to adopt stringent efficiency standards for products not subject to federal preemption. In cases where there is a clear need for regional standards that are more stringent than federal standards, states should coordinate and seek joint exemptions to federal preemption.

Development patterns and land use decisions must evolve to recognize and support Locational Efficiency in order to reduce transportation energy needs in the future. The physical layout of the built environment has a dramatic and long-lasting impact on transportation energy needs and the amount of carbon sequestration provided by forests and soil. Planning and zoning regulations must fully account for these impacts and encourage new and infill development that creates communities that require less driving through better access to public transit, shorter commuting distances, and increased opportunities for walking and biking. This type of development will create more livable communities that will complement a local and community centered energy system.

Making the Vision Real: EnergyVision Implementation RoadMap



ENE's EnergyVision portrays a system that looks very different from the one we have today – one that would guide energy infrastructure investments and policies to a more consumer and technology friendly, decentralized system that can put us on the path to achieving deep reductions in greenhouse gas emissions.

The EnergyVision Framework sets forth a coherent path that ties energy supply, generation, and use together – offering clear goals for stakeholders and policymakers to work towards as they make policy and investment decisions related to our energy infrastructure, regulations and markets. The solutions we are looking to are viable. The technology is available and will continue to improve rapidly in the years to come.

While there is action occurring at the state and regional levels in many of the areas that the EnergyVision addresses, making the new energy system a reality will be a challenge. States, regional power systems and federal agencies incentives will need to adopt new policies, market incentives and regulatory reforms; change outdated approaches; uproot old technologies; and apply new ways of thinking about energy options.

ENE is dedicated to moving these changes forward through specific policy recommendations, advocacy action, and supporting economic and emissions analysis.

As an organization deeply engaged in state, regional and targeted national arenas to advance these goals, ENE sees significant interest among key stakeholders in addressing these issues. On-the-ground experience, networks and access provides important insights and buy-in to shape recommendations, expand research, and put plans into action. For these reasons, ENE will be working with stakeholders to develop an Implementation Roadmap that specifically outlines the research areas and policy reforms needed as next steps to advance the promise described in this EnergyVision.

Notes

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