EE
Technical Appendix

Energy Efficiency & Green Building

Local Solutions for the Strafford Region

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Authors:
Colin Lentz

Strafford Regional Planning Commission

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Purpose

As part of Local Solutions for the Strafford Region, Strafford Regional Planning Commission is completing an Energy Efficiency and Green Building Appendix. The purpose of this appendix is to discuss the challenge of continuing to provide energy for our daily travel, our homes, business, and local government, and offer guidance and strategies for how to prepare for a changing energy future. The burning of fossil fuels for energy and transportation is contributing to the progression of climate change by raising seasonal temperatures that result in more damaging storms. The energy sector is vulnerable to several climate change threats that may affect our communities directly. However, progress is being made. The New England region provides a national example of successful interstate cooperation to reduce greenhouse gas emissions. Federal, state, and local incentives are enabling municipalities, homes, and business to reduce costs, locally generate clean energy from renewable sources, and build resilient infrastructure. The final section of this appendix will present resources for continuing progress toward a more sustainable energy future for communities of the Strafford region.

Where We Are Now

The Regional Geography of Energy

In New Hampshire, electricity is generated from largely clean sources at a diverse range of facilities. Figure 2, demonstrates the proportions of generation by fuel source based on 2012 data[1,2]. While there are many hydroelectric dams in New Hampshire, they represent a small portion of total generation. A handful of natural gas facilities are responsible for 21% of total generated electricity. However, the natural gas we rely on for power generation is imported from other states and from Canada through pipelines. Coal represents a small and diminishing fraction of generation. The Seabrook Station nuclear plant is the only nuclear facility in the state, but it is the largest single power producer, accounting for 43% of power generation in 2012 (Figure 2) and 55% of net electricity generation in 2013[3].

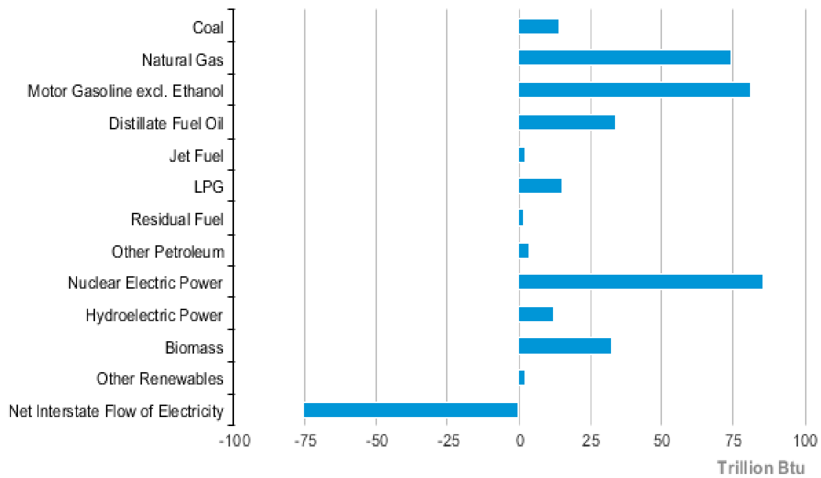

Figure 1 - New Hampshire energy consumption estimates for 2012. Data Source: Energy Information Administration, State Energy Data System.

Today's power grid is a complex network of power generators, distribution managers, regional stakeholders, and policy-makers. The end-users whose lives depend on reliable electricity – the homeowners, businesses, and communities – have very little influence in this complex system. While technology and policy are enabling more local electricity generation within New Hampshire, large plants still account for the vast majority of power generation. Such large plants generate power for a pool of electricity consumers which include the states of Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and Maine. Interstate power distribution is managed by Independent System Operators of New England (ISO-NE). Note that most of the electricity generated in-state is exported for use by other states in the regional grid (Figure 1). The power lines that move power within smaller regions and bring it to each municipality are owned and operated by utility companies. Additionally, existing roads usually offer the best route for power lines, so utility companies lease space along rights-of-way, which are either state roads (owned and maintained by the New Hampshire Department of Transportation) or municipal roads. New Hampshire communities have an extensive stake in how electricity is generated and distributed, but little influence in how electricity makes it from power plants to residents' homes and businesses.

See the *Local Energy Resilience* section for further discussion of modern power distribution alternative approaches that could give municipalities more control and resilience in their electricity needs.

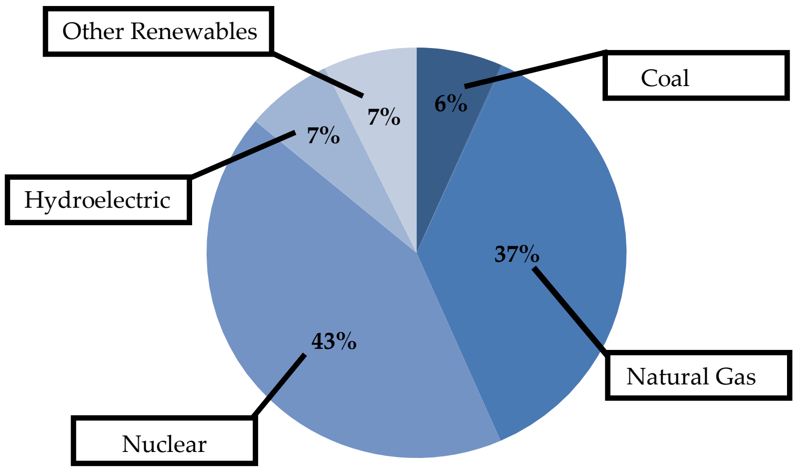

Figure 2 – Electrical generation in NH by source for 2012. Data source: U.S. Energy Information Administration. Graph Source: NH 10-Year State Energy Strategy.

Overview of Energy Consumption[4]

In 2012, energy cost New Hampshire citizens, businesses, and industries (including local and state government) nearly $6 billion[5]. Transportation and residential expenditures accounted for over three quarters of that total amount (Figure 3). Studies by the New Hampshire Office of Energy and Planning (OEP) have shown that the majority of dollars spent on energy (approximately 65%) immediately leave the state to pay for imported fuels[6]. This outflow represents a substantial portion of our state's gross domestic product.

Table 1 - Percent of household income spent on home energy relative to poverty level. Source: Home Energy Affordability Gap (2014).	
Poverty Level	Home Energy Burden
Below 50%	59%
50-100%	31%
100-125%	21%
125-150%	17%
150-185%	14%
185-200%	12%

Residents of NH use a variety of fuels for heating their homes, but they rely heavily on fossil fuels and natural gas. Wood biomass is used as a primary heat source in more rural areas and as a secondary heat source throughout the state. Currently, energy accounts for one of the primary household income expenditures for many New Hampshire residents. In particular, home energy costs are a massive burden for low income residents.

A model used throughout the country calculates that for New Hampshire households at or below the poverty line, energy costs can be between 30% and 60% of total income (Table 1)[7]. While this phenomenon is a result of multiple factors, it is primarily driven by household income, geography, and fuel prices. Low-income households generally reside within less expensive housing, which in New Hampshire, tends to be older or of lower quality, thus contributing to reduced energy efficiency and higher energy costs for its occupants. In general, housing in New Hampshire tends to be more expensive toward developed urban centers, concentrating low income residents in outlying rural areas.

Table 2 - Fuel use by household type. Source: Home Energy Affordability Gap (2014)		
Primary Heating Fuel	Penetration by Tenure	
	Owner	Renter
Electricity	3%	20%
Natural Gas	15%	31%
Fuel Oil	56%	35%
Propane	15%	10%
All Other	11%	4%
Total	100%	100%

Additionally, housing accommodations in developed areas are more likely to include access to less expensive thermal energy sources, such as natural gas. Such a pattern makes fuels such as wood or fuel oil the primary options for residents in our predominantly rural state, where the majority of households rely on fuel oil for thermal heat (Table 2). Fuel oil is also one of the most expensive fuels for thermal energy, with only moderate energy content per gallon (Table 3)[8]. Factors such as these have major cost savings implications for residents and revenue implications for municipalities and the state (See *Ways to Move Forward* section for possible approaches to deal with the above issues).

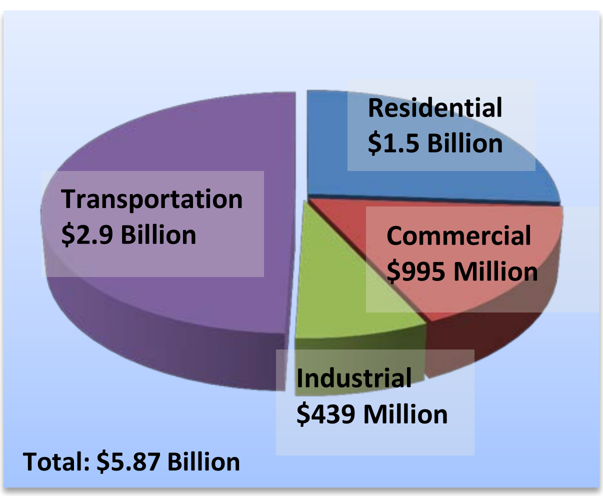

Figure 3 - Proportions of total energy spending in NH for 2012. Data Source: Energy Information Administration.

Table 3 - Price and heat content per unit by fuel source (2014). Source: NH Office of Energy and Planning./		
Fuel Type	Price per unit 2014	Heat Content per unit (BTU)
Fuel Oil	$3.63/gallon	138,690
Propane	$3.32/gallon	91,333
Kerosene	$4.260/gallon	135,000
Natural Gas 1st tier	$0.84/gallon	100,000
Wood Pellets	$234/ton	16,500,000
Wood (cord)	$250/cord	20,000,000
Electricity	$0.15/kwh	3,412

Transportation

Dollars spent on transportation fuel accounted for almost half of all energy spending in 2012 (Figure 3)[9]. Single-occupancy vehicles still dominate NH roads and vehicle miles traveled (total and per-capita) have increased since the 1980s (Table 4 and Figure 4)[10].

Table 4- Approximate vehicle miles driven per-capita in NH. Data Source: US DOT, 2012.

Date	*Miles*
1980	6,982
1990	8,876
2000	9,729
2010	9,926

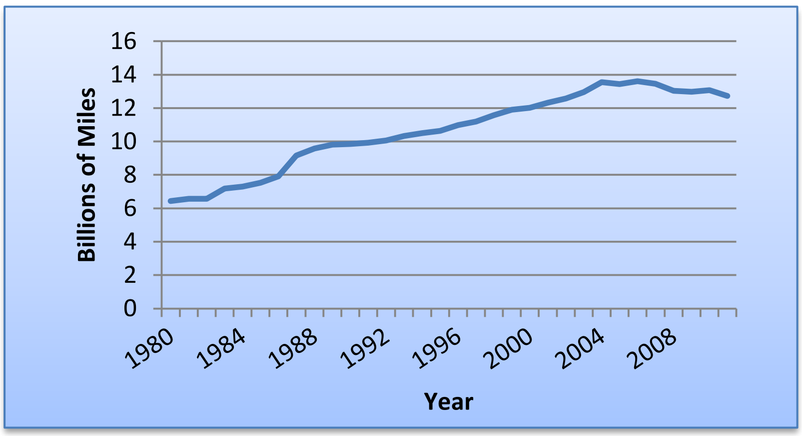

Figure 4 - Total vehicle miles driven in NH. Data Source: US DOT, 2012.

Personal vehicles are a necessity in an area with long distances between urban areas, and in an economy that has forced people to look farther from home for jobs and other opportunities. Although the average fuel efficiency of light-duty vehicles is increasing, fuel prices and vehicle miles traveled are expected to increase into the future, leading to overall increases in per-capita expenditures on transportation fuel[11]. Nationally, transportation accounts for 28% of greenhouse gas emissions[12] and new standards for fuel efficiency are only recently starting to take effect. Increased road congestion, fuel prices, and other factors are influencing travelers to pursue alternative modes of transportation. Over the past 13 years, public transportation has been growing in the Seacoast of New Hampshire. The summer of 2013 set new records for ridership on buses ran by the Cooperative Alliance for Seacoast Transportation (COAST), with 95,000 trips logged[13].

For more on regional transportation issues and trends, see the *Transportation Trends*, *Executive Summary* in the introductory chapter of the Regional Master Plan, as well as the most recent *Metropolitan Transportation Plan*.

Statewide and Regional Energy Production

Energy generated in New Hampshire comes from several sources. Petroleum and coal (both major sources of carbon pollution) have been in decline over several decades while cleaner sources such as nuclear and natural gas, have come to take their place. Hydroelectric dams have been producing power for generations, and renewables such as wind, solar, and biomass are growing every year. Utility companies throughout New England own power plants that feed a regional pool of available electricity, which is distributed by ISO-NE, and sold by utility companies to consumers. Four primary utility companies provide power for consumers throughout New Hampshire: Public Service of New Hampshire (PSNH), Granite State Electric Company (GSEC), Unitil Energy Systems, Inc. (UES), and the New Hampshire Electric Cooperative, Inc. (NHEC). These utilities generate electricity through a variety of sources (Figure 5). PSNH is by far the largest, serving 70% of retail customers in the state[14], and these companies dominate the energy market.

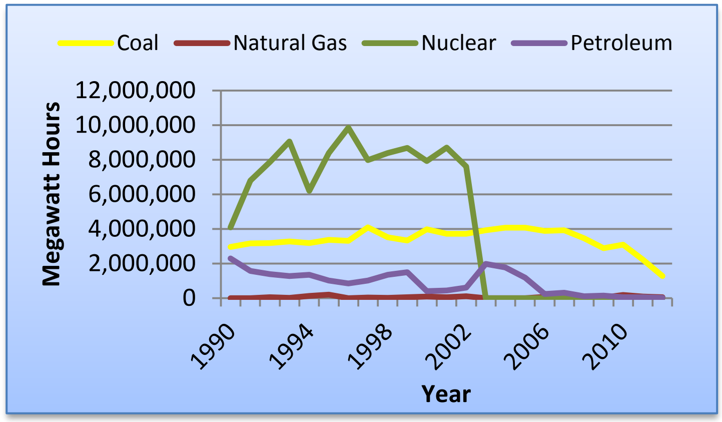

Figure 5 - Utility company energy production from fossil/non-renewable sources. Data Source: Energy Information Administration.

Independent power producers (IPPs) also own plants throughout the region that generate electricity, which is sold to utilities before entering the grid (Figure 6). The Seabrook nuclear station – the largest single power generating facility in the state – is owned by the independent company Nextera Energy Resources [note the change in nuclear powered generation in Figure 5 and Figure 6 when Seabrook station switched from utility to independent ownership]. In 1996, New Hampshire became the first state to begin restructuring utility markets to increase consumer choice, build competition among utility companies, and reduce consumer energy rates[15]. Utilities and IPPs also generate a small amount of electricity from a range of renewable sources (Figure 7 & Figure 8). While the total portion of statewide power generation from renewable sources is small compared to conventional fuels, small-scale renewables like biomass and solar have potential for businesses, residents, and municipalities.

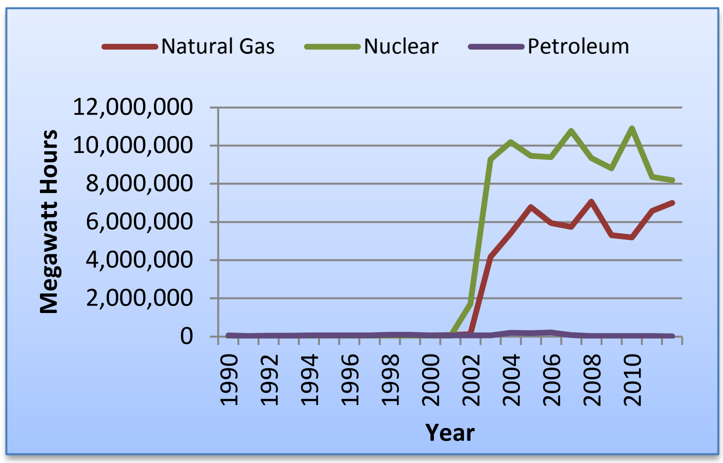

Figure 6 - Independent Power Producer (IPP) energy production from fossil/non-renewable sources. Data Source: Energy Information Administration.

Cogeneration

Cogeneration (also known as combined heat and power) is the name for any integrated process that generates multiple forms of useable energy from one fuel source. The most common example is a plant that burns fuel (such as natural gas or wood pellets) to both generate electricity and recover thermal energy to heat buildings. Cogeneration is not a single technology or a one-size-fits-all solution; it's a pragmatic approach to increasing energy efficiency and reducing costs. There are 19 cogeneration facilities in New Hampshire that burn natural gas, petroleum, or biomass; two of them are in the Strafford region.

LaValley – Middleton Building Supply, Inc. is a New Hampshire company that has been providing hardware and building materials, milling lumber, and manufacturing building components since 1962. With New Hampshire locations in Claremont, West Lebanon, North Walpole, Dover, and Middleton, the company has expanded into Vermont with stores in Rutland and Ludlow. They own and operate the Diprizio Pine Sales saw mill in Middleton, which manufactures 15 million board feet of Eastern White Pine annually[16] (1 board foot = a board 1 foot long by 1 foot wide by 1 inch deep), and provides a perfect example of how to turn "waste" into profits. Timber processing requires electricity to light facilities and run machinery, but it also requires a lot of energy for drying finished lumber. The Diprizio mill also produces over 40 tons of "waste" in the form of bark, woodchips, and sawdust each year. In one year, the mill burned over 300,000 gallons of oil and required nearly 4.5 million kilowatt hours of electricity, for a total cost of over $1.2 million[17].

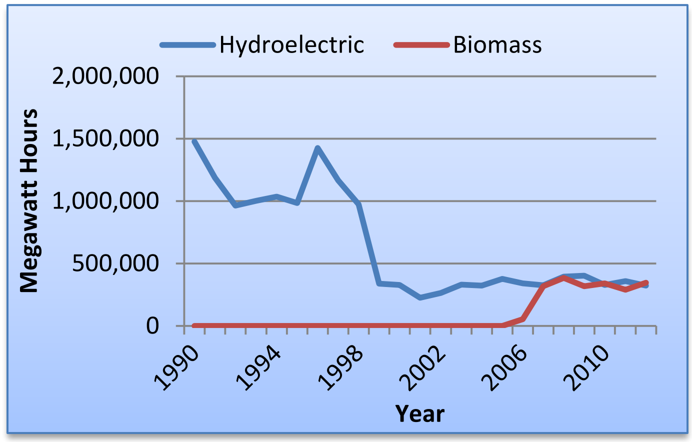

Figure 7 - Alternative/renewable power generated by utility companies. Data Source: Energy Information Administration.

To increase cost efficiency and sustainability, in 2007, LaValley – Middleton Building Supply, Inc. decided to take advantage of incentives and funding assistance to develop a 'green' and more cost-effective approach. Through an agreement with PSNH, a federal grant from the US Department of Agriculture (USDA), and a community development block grant (sponsored by the town of Middleton and administered through the Southeast Economic Development Corporation), the company installed a wood-fired, steam-turbine generator that turns waste wood into electricity and heat. The boiler is fired by wood bi-products of the milling process and provides 60% of the mill's electricity needs, including the heating of several buildings. The new approach has reduced the mill's demand for fuel oil by 390,500 gallons each year and reduced emissions of sulfur dioxide (a major air pollutant and one of the causes of acid rain) by 18%. LaValley–Middleton, the largest independently owned building materials supplier in New Hampshire and Vermont, is using and benefiting from green business practices to continue growing and serving its communities.

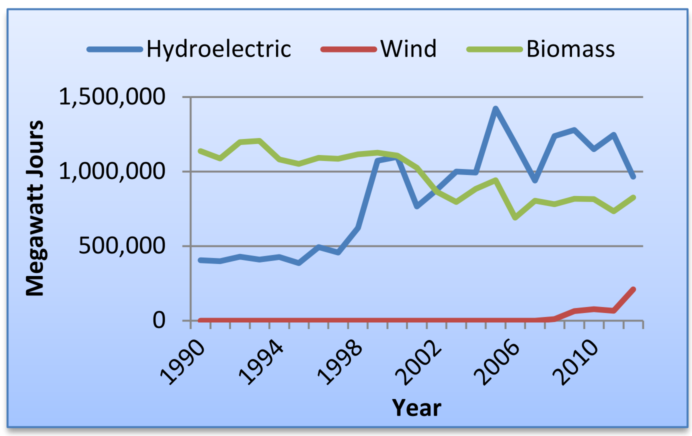

Figure 8 - Alternative/renewable power generation from independent power producers (IPPs). Data Source: Energy Information Administration.

The University of New Hampshire (UNH) campus at Durham, NH requires a vast amount of electricity and heat for its approximately 90 buildings. The university has taken innovative steps toward reducing its costs, repurposing waste, reducing its carbon footprint, and creating a more sustainable campus. The UNH power plant burns natural gas and oil to generate electricity and beginning in 2006, a cogeneration system from the COGEN plant has been recovering the heat from this process to be used in facilities. Switching to cogeneration reduced the university's carbon emissions by 21% during the first year of its operation[18], and is expected to pay back by 2026. UNH enhanced its commitment to energy efficiency and reducing its impact in 2009 when it became the first university in the U.S. to use methane (natural gas) from a landfill as its primary fuel source. Organic matter contained in landfills breaks down over time to create methane gas, which is usually vented to avoid gas buildup and the risk of explosions. But UNH worked with Waste Management of New Hampshire, Inc., as well as a host of engineers and scientists, to implement its EcoLine project which collects methane gas from the Turnkey landfill in Rochester, NH purifies it, and pumps it to the COGEN plant for power generation. Gas from the landfill fills up to 85% of campus energy requirements and the project will likely pay back in 10 years. Investing in green energy has enabled UNH to recover project cost over time by selling renewable energy credits (REC's). Any excess electricity the plant generates is directed back into the regional grid to offset electricity generation from non-renewable fuel sources. Cogenerating electricity and heat, and turning trash into energy are major steps in the university's commitment to reducing its overall carbon footprint and greenhouse gas emissions. Under their draft Climate Action Plan (WildCAP) UNH aims to cut its greenhouse gas emissions by 50% by 2020, and by 80% by 2050, with the ultimate goal of carbon neutrality by 2100[19].

Photovoltaic Installations

Photovoltaic (PV) panels, which are used to generate power from solar energy, are still a developing technology, but more and more private residents, businesses, and towns, both in NH and the Strafford region (Figure 9), are taking advantage of the significant energy savings they can provide. The Open PV Project[20], which manages a database of information on the photovoltaic market throughout the U.S., provides comprehensive data on installations in New Hampshire. As of June 2014, the Open PV Project had logged 593 PV installations throughout New Hampshire, 72 of which are in the Strafford region. These range in capacity from 1-7 kilowatt residential panels, to the 29 kilowatts generated for municipal buildings in the town of Durham, to the 140 kilowatts capacity panels at businesses such as Favorite Foods in Somersworth. Overall, PV panels in the Strafford region can provide approximately 541 kilowatts of electricity directly to our homes, businesses, and public buildings.

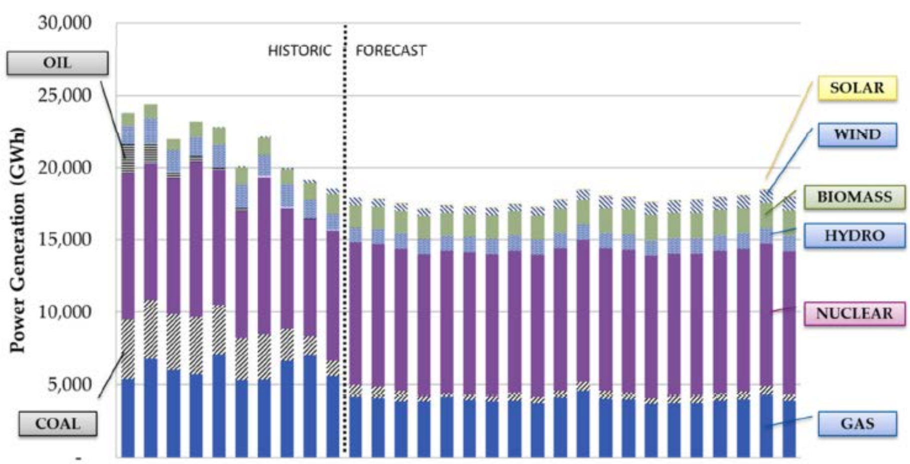

Figure 9 – Forecast in-state power generation by source through 2032 (New Hampshire Energy Strategy 2014)

Greenhouse gas emissions from the fossil fuels humans burn for energy and transportation are a primary driver of climate change. Improving the energy efficiency of our buildings and vehicles – thereby reducing their consumption of fossil fuels – and increasing our use of sustainable and alternative energy sources not only reduces greenhouse gas emissions, it leads to healthier and happier people, economic growth, and prospering communities.

What the Future Holds

In June of 2013 the State Energy Council was formed by law[21] to develop a 10-Year State Energy Strategy for New Hampshire. Research, analysis, and technical support from Navigant Consulting have provided projections for energy demand, consumption, and expenses for the next 18 years[22]; the data and projections are an integral part of State Energy Strategy. The strategy is based on strong research about critical energy challenges in New Hampshire's future. The New Hampshire 10-Year State Energy Strategy was informed in-part by the 2014 Annual Energy Outlook published by the U.S. Energy Information Administration[23]. The 2014 Energy Outlook describes complex national level trends and predictions in the energy sector, including energy sources and federal policy.

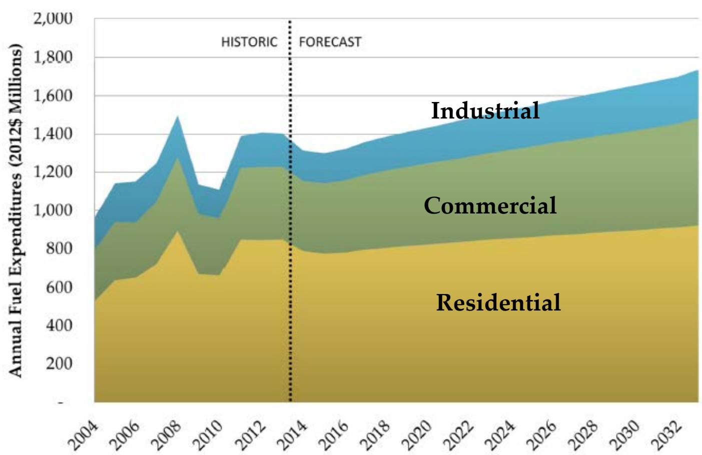

Figure 10 - Thermal fuel expenditures by sector

General trends discussed in these documents provide a foundation for discussion of future energy concerns for the Strafford region. Nationally, less energy is being generated through the burning of coal. The phenomenon is in response to multiple factors, including the increasing availability of natural gas and federal regulation on carbon pollution; New Hampshire however, is well ahead of this trend. The state has been reducing an already low dependence on coal for electricity generation over the past 10 years, and petroleum accounts for a small amount of in-state generation (Figure 9). Natural gas and nuclear are the dominant fuels energy production, but analysis in the Energy Strategy predicts that 20% of in state power will come from renewable sources by 2025. All sectors have seen increases in energy efficiency in recent history, but the price of fossil fuels will continue to rise. These two factors are projected to result in a flat trend for total energy generation over the next few decades.

Without major investments in energy efficiency and alternative energy sources, the cost of thermal energy consumption (primarily the burning of oil and gas) will increase consistently into the future, thus presenting a significant problem for homeowners and businesses (Figure 10).

Energy and Climate Change in New Hampshire

> **By 2070–2099, southern New Hampshire on average can expect twenty-three days per year with daytime maximum temperatures above 90˚F under the lower emissions scenario, and over fifty-four days per year under the higher emissions scenario, about eight times the historical average. (Wake et al. 2014)**

While, the NH Energy Strategy (state level) and the 2014 Annual Energy Outlook (national level) both provide an avenue for discussion on energy issues, climate change has been omitted from both of them as a significant issue of concern. The NH Energy Strategy contains no reference to climate change in its analysis, and the 2014 Energy Outlook only mentions climate change as a driver of federal policy on carbon emissions.

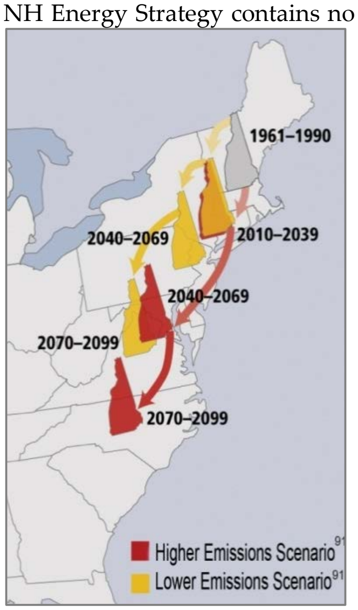

Figure 11 - Projection of how summer temperatures will feel under high and low emissions scenarios in New Hampshire. Source: Frumhoff et al., 2007.

The availability and price of energy sources is a central issue for regional and local energy planning, however climate change is a complex variable that needs to be integrated into planning practices. While it will take time to observe the comprehensive impacts of climate change on our region, some trends are becoming noticeable as more robust scientific evidence emerges. Regional climate studies predict that by the end of this century, New Hampshire's climate, particularly in the summer, will be more similar to Virginia or North Carolina[24] (Figure 11) and people will spend more time at above 95˚F temperatures during the summer months.

The projected shift in regional climate and temperature poses an increase to electricity demand for air conditioning purposes, which will increase costs for the region's homeowners and businesses (Figure 12),. In particular, the trend will increase vulnerability of populations such as young children, senior citizens, and low-income residents. While the impacts of climate change will increase indirect costs for the region's communities, rising temperatures in particular pose a strain on regional and local electrical infrastructure through future increased electricity load and demands. As the projected rise in summer temperatures match those of Virginia or North Carolina, residential electricity prices are also projected to increase (Figure 12). With rising summer temperatures, Southern New Hampshire will also see an overall decrease in the number of days below 32˚F – as well as a decrease in the number of winter days with extreme temperatures (below 0˚F) . While this may seem like good news for winter fuel expenditures, fuel prices are likely to rise faster than winter temperatures, resulting in overall rising costs for home owners and businesses.

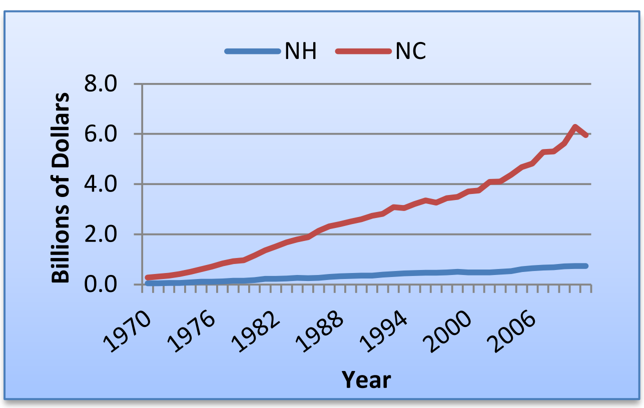

Figure 12 - Residential electricity expenditures in New Hampshire (NH) and North Carolina (NC). Data Source: Energy Information Administration.

> Climate change will amplify the effects of rising energy prices in a fossil fuel-based economy, and the effects will have a wide reach. As the price of transportation fuels continues to rise we will not only feel the effects at the pump, but also in the cost of food that travels hundreds or thousands of miles to local grocery stores. Changes to the world of energy have significant cost of living implications for residents in the Strafford region, unless communities prioritize energy efficiency and invest in alternative energy sources.

Ways to Move Forward

> "New Hampshire has little ability to influence fuel prices, but should help contain these rising costs by investing in efficiency and small-scale distributed resources. This will provide residents and businesses in New Hampshire with greater flexibility in meeting their home and business thermal needs and protection from future fuel price volatility."(NH Energy Strategy, pg. A-8)

New Hampshire towns and cities retain strong independence but it is important to remember how interconnected municipalities are with one another and the rest of the world. Each community relies on interstate, national, and global production and distribution of critical services. Residents of the Strafford region rely on food grown in other states and countries that arrives on a network of local, state, and national highways and roads. The fuels for our cars come from other states and nations. The Strafford region relies on critical daily communications through interstate cables and global wireless networks. Energy is a particular regional concern. The Independent System Operators of New England (ISO-NE) coordinate the generation and distribution of electricity in Connecticut, Rhode Island, Massachusetts, New Hampshire, Vermont, and Maine. Energy for our homes and businesses is produced throughout New England and is distributed through a regional power grid. We can predict the specific impacts climate change will have on our region, but how climate change affects our neighboring states (and counties) has consequences for us in the Strafford region. Impacts from climate change on energy generation in all New England states will likely affect the residents of the Strafford region. Energy challenges at the local level come with far-reaching interactions of elaborate complexity. However, the energy sector presents a unique opportunity for communities of the Strafford region to build resilience against vulnerabilities related to climate change and energy costs, and make significant strides toward appropriate regional and local independence.

Energy Efficiency

Communities in the Strafford region have an incredible opportunity to benefit economically and socially from proactive investment in energy efficiency. As stated previously, of the nearly $6 billion spent statewide on energy, most of it went outside New Hampshire to pay for fuels. Some of it went outside the United States. According to a recent independent study completed for the NH Office of Energy and Planning (OEP), achieving the maximum, cost-effective energy efficiency improvement to buildings statewide would result in a 210% return on investment and wide ranging benefits to residents, businesses, and utilities[25]. Reaching this goal would require investments over the next 3-4 years totaling $941 million. Such an investment would save business owners $195 million per year, and total savings from reduced energy use would $2.9 billion[26]. Most importantly, investing in energy efficiency retains dollars that would otherwise be spent outside New Hampshire. The independent study found that investing in all cost-effective energy efficiency improvements would create 2,300 in-state jobs, and add $160 million per year to state GDP[27].

A survey of residents in the Strafford region and statewide confirms public support for improving energy efficiency and increased municipal involvement in energy planning[28]. In particular, a majority of Strafford region residents support raising energy standards for new buildings (Figure 15), and expanding incentives for residential energy efficiency (Figure 13). Most residents also feel that communities should play a greater role in setting standards for renewable energy facilities such as wind power sites and geothermal installations (Figure 14).

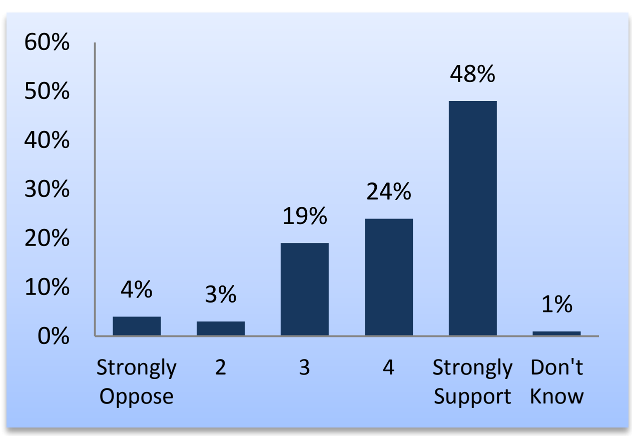

Figure 13 – Support for expanding incentives for home energy efficiency improvements. Data Source: UNH Survey Center.

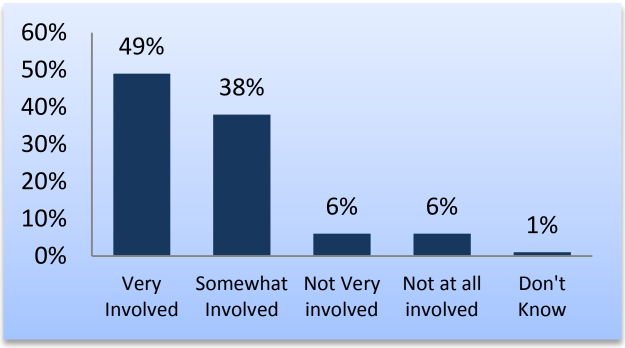

Figure 14 - How involved do you feel local communities should be in developing guidelines and standards for renewable energy facilities? Data Source: UNH Survey Center.

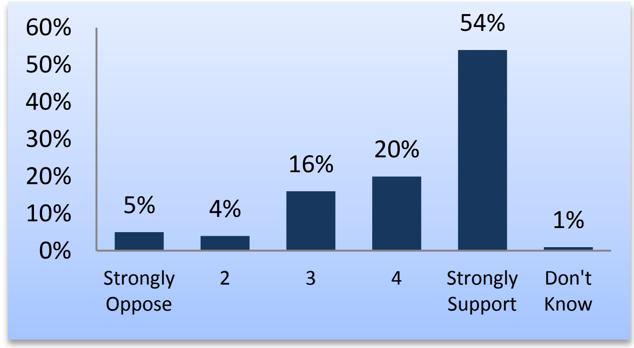

Figure 15 - Support for higher energy standards for new buildings. Data Source: UNH Survey Center.

Green Building: Return on Investment

Designing buildings to be energy efficient is beneficial for environmental and public health, with benefits yielding in clean air, clean water, and overall wellbeing. However, energy efficient building design is not just an eco-friendly trend in architecture. Energy efficiency relates directly to the bottom line of municipalities, businesses, and home owners. There are a number of examples of investments in energy efficiency throughout the Strafford region and the state. New buildings can be built to take full advantage of new technologies and materials, but older buildings can also be retrofitted to reduce their energy costs significantly. Increasing energy efficiency can be a major boost to economic development, and the State Office of Energy and Planning (OEP) has granted funds directly to municipalities and counties to encourage energy planning, building retrofits, new developments, and energy projects. OEP has distributed several million dollars to cities and towns throughout New Hampshire for a wide range of projects to reduce energy use and waste: town building retrofits, energy efficient street lights and traffic signals, fuel efficient police cruisers and other town vehicles, and local energy production (wood pellet boilers, photovoltaic panels, and wind turbines). Several projects have been implemented here in the Strafford region[29]. Newmarket and Durham received funding to replace street lights with more energy efficient models, Dover and Farmington upgraded lighting in town buildings, and Lee used grant funds to conduct studies and develop a town energy plan.

Thin profit margins are a reality for all businesses, and more of them are investing in energy saving methods and technology that lower energy bills. Favorite Foods[30] has been a regional food distributer for many restaurants and businesses in the seacoast of New Hampshire and Maine – as well as schools in Concord, NH – for over 25 years. As the business has grown, its owners have taken advantage of multiple ways to reduce energy consumption[31].

- Biodiesel powers the generator and all delivery vehicles are increasing their fuel efficiency, saving around $11,000 annually since 2007.
- Incentives from Public Service of New Hampshire in 2011 funded the installment of high-efficiency lighting controlled by motion sensors that save 74% annually over the previous fixtures and will begin paying back this year. In 2012, PSNH also supported the installation of an air conditioning system that draws outside air to chill a receiving dock and cooler, with an anticipated short payback period.
- By baling and recycling all plastics and cardboard, the company went from paying for five dumpster loads per month to one dumpster load per month, for an annual savings of $3,800.
- A 20 year power agreement with Revolution Energy[32] and $125,000 grant from the New Hampshire Public Utilities Commission helped fund the installation of a 140 kW solar panel array, which is the largest roof-mounted array in the state. Energy generated from the sun will save Favorite Foods approximately $14,000 annually.

Businesses that have invested in energy efficiency have not only seen cost reductions, but increased profits as well. The internet and social media have increased the transparency of businesses, and consumers in many sectors are choosing to support businesses that have a sustainability based philosophy. As a result, energy efficiency is quickly becoming an important aspect of the modern business model. The Smuttynose Brewing Company is an example of a thriving business that has made sustainability one of its core principals. Originally based out of Portsmouth New Hampshire, Smuttynose has been brewing craft beer, since 1994 and their beer is distributed in every east coast state, California, and Sweden. The company recently opened a new headquarters brewery on the historic Towle Farm in Hampton, New Hampshire. The new headquarters expand a flourishing business while reducing its impact on the environment and enhancing local historic culture. The new Smuttynose facility has minimal environmental impact on the 17 acre site and has installed rain gardens to treat all stormwater on-site rather than sending it to the sewer. The property and its unique attributes, such as the farmhouse, are being well-preserved, and have been alleviated from its prior proposed use for commercial and industrial development, which would likely lead to site paving . The company went the extra mile and spent the extra dollars to incorporate numerous energy efficient designs and components into the main brewing facility, and – not surprisingly – some of the greatest 'green' investments are helping get more beer out of the brewing process. From start to finish, the investments are getting 20% more beer out the brewing process.

- High efficiency brewing equipment helps get more from raw materials (e.g. malted barley) while requiring less energy.
- Previously, a significant portion of beer had to be discarded along with spent yeast and other sediment from the fermentation process, but a centrifuge can separate beer from sediments and helps get several extra barrels of finished product out of every batch.
- Cooling finished beer from nearly 80˚C to nearly 0˚C requires a vast amount of energy. Carbon dioxide is used as a chilling agent and is stored as a liquid in a large tank, which at most breweries is separate from where beer is chilled – resulting in significant loss of potential cooling power. But the new brewery is designed with the tank inside the chilling room, taking advantage of an already cold tank to chill beer.
- In the bottling stage of beer-making it is critical to keep as little oxygen as possible out of individual bottles, and new equipment can inject beer into bottles with virtually 0% oxygen. The brewery is also considering collaboration with other smaller local breweries that cannot afford such equipment.

Energy Efficiency at Wastewater Treatment Plants

For the larger communities in the Strafford region, wastewater treatment facilities represent a significant percentage of local energy costs and consumption. Treatment plants that operate 24 hours a day have significant energy requirements; however they can also serve as sources of energy. Eight communities in the region have central wastewater treatment facilities (WWTFs) and five of them have recently conducted energy audits to find ways to reduce energy consumption or obtain some of their used energy back. What are the sources for all of the bullets below?

- The Dover WWTF uses its effluent flow to turn a turbine and generate off-grid electricity that will replace propane used to fuel an immersion heater. The town has taken many steps to increase energy efficiency at the treatment facility (and other municipal buildings), including high efficiency lighting, motion sensors to control lighting, staff training, and envelope weatherization (insulation and weather stripping).
- The town of Durham wastewater facility has been investing in energy efficiency for a number of years, with their most recent investment involving the replacement of the WWTF's heating system with high-efficiency electric heat pumps. Installation of efficient lighting and a solar wall on the dewatering building for supplemental heat is also on their to-do list.
- The Farmington WWTF has installed a system that will recover heat energy from the sewage treatment process. During the upgrade, they also made energy efficiency improvements including high efficiency lighting with motion sensors, building weatherization, and staff training. The Farmington WWFT received $50k in rebates during upgrade.

- The Newmarket WWTF uses methane from digester for generating heat and upgrading to high-efficiency lighting through rebates, and is also upgrading their treatment process motors.
- The Rochester WWTF recently installed solar powered storage pond mixers made by Solar Bee[33] that not only reduce energy consumption, but increase the efficacy of the treatment process. Other high-efficiency equipment was also installed, including lighting, and several parts of the system that were losing energy during the previous audit have been corrected.
- Rollinsford has been improving the weatherization of its wastewater treatment buildings, and is currently conducting an audit of the facilities' energy demands.

Mitigating Emissions for Clean Air

Reducing greenhouse gas (GHG) emissions is important for mitigating global climate change, but can also have an immediate impact in our communities and region. Emissions from fossil fuels in cars and power generation directly affect local and regional air quality, and impact human health. Emissions of carbon dioxide (CO^2) and other GHGs directly affect regional concentrations of ground level ozone – one of the leading drivers of asthma – which is a serious and growing health challenge statewide[34]. Even with national policy and advances in fuel efficiency, transportation and power generation are the greatest sources of GHGs in New Hampshire[35]. Increasing fuel prices and longer, more congested commutes are an incentive for enhancing regional public transportation, which has demonstrated its need with a record 95,000 trips on COAST buses in the summer of 2013. It is also important to note that increases in national fuel standards and environmental regulations on emissions have not negatively affected New Hampshire's economy. Gross domestic product in the state has been increasing steadily for many years, even as CO^2 emissions have decreased sharply [36](Figure 16).

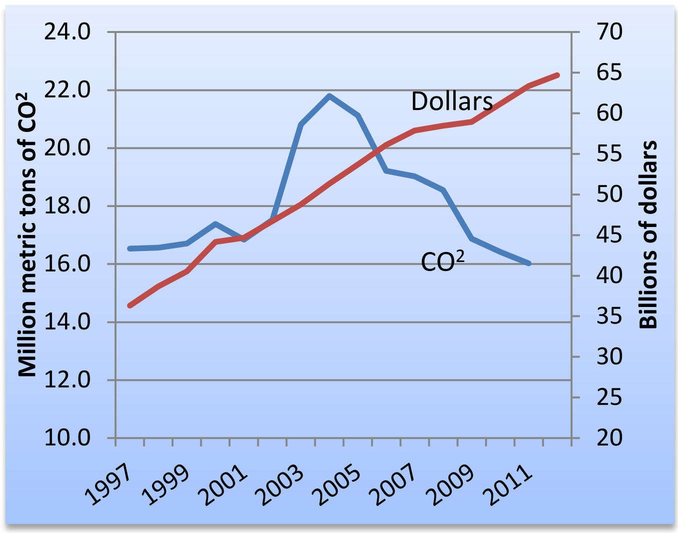

Figure 16 - Carbon emissions (million metric tons of Carbon dioxide) vs. gross state product (billions of dollars) over time. Data Source: U.S. Department of Commerce (GDP);

Local Energy Resilience

Climate change in NH will increase the likelihood of damaging weather events, but also the uncertainty about the scale of local-level threats and impacts. Such uncertainty poses a grave threat to energy production and delivery at national, state, and local levels. The severe weather exacerbated by climate change is a reminder of the vulnerabilities of the region's critical public services and infrastructure. While some electricity is generated by regional and a few local sources, the vast majority of this vital resource is generated and distributed at an interstate scale before arriving at local homes and businesses. Electricity is managed and distributed by several parties before it reaches homes and businesses in the Strafford region (Figure 17). The quintessential culture of New Hampshire emphasizes local decision-making and independence, yet communities are completely dependent on massive national and regional electric grids. Disruptions to the system can cause local outages that are inconvenient at best, and at worst can cause long-term economic damage or even loss of life. Most importantly, communities have no control in maintenance of electrical infrastructure and little participation in the recovery process following disruptions. As climate change increases the frequency and strength of severe weather events that cause long-term damage to vital electrical infrastructure, a vital threat is posed to municipalities.

Despite these challenges, energy generation presents a wide-open opportunity for communities of the Strafford region to increase their independence and resilience against growing energy challenges. Advances in technology and multiple opportunities for funding support have enabled communities to increase the energy efficiency of existing structures, build new and 'green' facilities, explore the possibility of developing local power sources, and protect the wellbeing of their citizens. The current energy framework is built on single, large power plants, and one-way energy distribution through a regional grid. Localized energy production – known as 'distributed generation' (Figure 18) – presents an alternative approach that can reduce costs for taxpayers and increase local and regional resilience. The distributed generation approach essentially combines new technology for local-scale electricity generation with the traditional grid system, and adapts it to the local level. For example, solar arrays and other power sources owned by a community can meet local demand and significantly offset the cost of utility-generated power. Additionally, since local power generation is linked through existing infrastructure, any excess electricity goes back into the grid to help meet regional demand. Incorporating distributed generation offers greater flexibility for responding to changes in local demand, and increases resilience against disturbances to the grid. Currently, disruptions to a major power source or distribution infrastructure would result in widespread, potentially long-term power loss. But a regional network of local power generators can absorb impacts to one or more facilities and continue providing electricity for critical services. Of course, any significant transition from the status quo comes with challenges. This is especially true of the electricity system in the United States, which has remained remarkably unchanged since Thomas Edison and the early development of the national grid[37]. Increased energy efficiency and power generation at the municipal, business, and individual level has significant implications for utility company profits, regional energy markets, and the energy industry at large. Policy and regulatory tools will have to be designed or adapted to meet the changing energy landscape and take advantage of opportunities. One such policy that has been adopted by New Hampshire and other states is known as "net metering", which allows for two-way distribution of electricity from localized sources. For instance, a homeowner with a roof-mounted solar array may generate more electricity than they need during peak daylight hours. This electricity is diverted back into the grid, and often the homeowner is paid or credited by a utility. The homeowner may still need supplemental electricity from the utility if they are not generating power (e.g. when the sun is not out). "Decoupling" is an example a policy mechanism that can reduce the potential financial impact of distributed generation on electric utilities. Put simply, this approach separates a utility's fixed costs from the amount of gas or electricity it sells to consumers. A utility could also be compensated (e.g. by federal or state

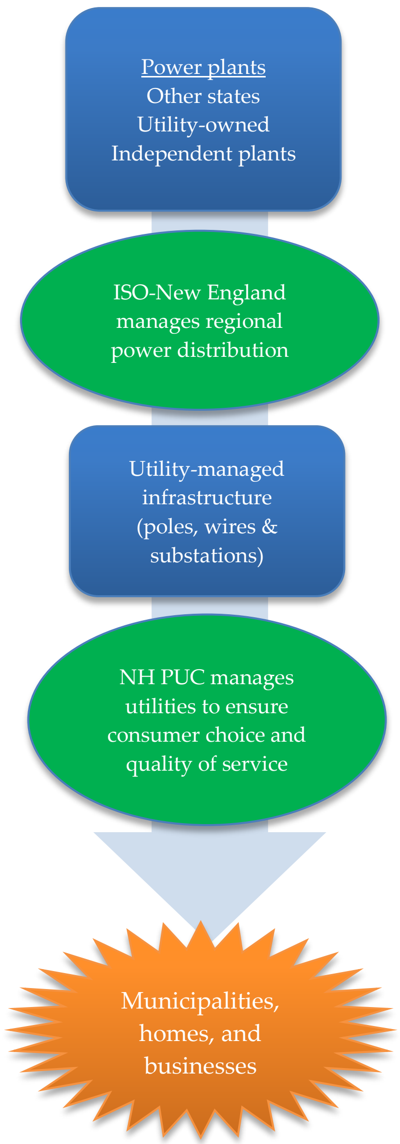

Figure 18 - Primary stakeholders in regional electricity grid.

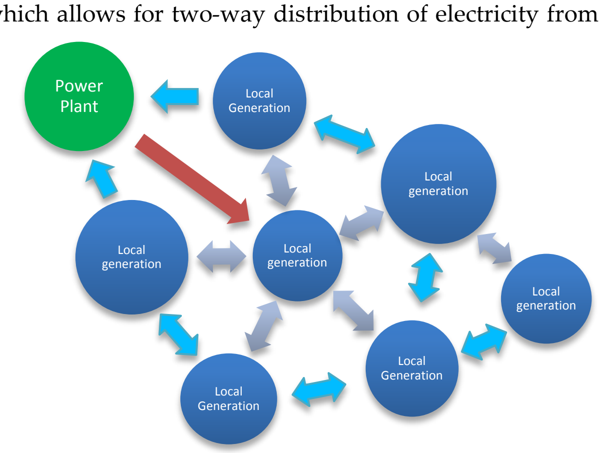

Figure 17 - Basic model of distributed generation.

subsidies) on a per-customer basis, rather than per-kilowatt basis.

The NH Public Utilities Commission and U.S. Department of Energy both have expanded information on decoupling. For more information on distributed generation, see the following report from the American Public Power Association: http://www.publicpower.org/files/PDFs/Distributed%20Generation-Nov2013.pdf

Case Study: Federal Support for Local Energy Efficiency

Between 2010 and 2013 the BetterBuildings NH program distributed just over five million dollars to fund deep energy retrofits for homes and businesses in New Hampshire. Primary program funding came from the American Recovery and Reinvestment Act (ARRA), but loans from local and regional banks and credit unions were also critical for individual projects. The program was managed by the New Hampshire Community Development Finance Authority (CDFA) and focused on the communities of Nashua, Plymouth, and Berlin (but assistance was offered statewide) and involved city representatives, advisory boards, and other local decision-makers as stakeholders. The program helped recipients obtain energy audits and select private-sector energy contractors to complete upgrades that fit their specific needs. All told, BetterBuildings funded energy upgrades for 829 homes and 69 commercial buildings (1,276,816 sq feet). Total annual savings for funding recipients will include 1,155,492 dollars, 2,447,158 kilowatts of electricity, 221,119 cubic feet of natural gas, and 178,459 gallons of petroleum heating oils.

The project helped home owners insulate attics and basements, as well as seal windows, doors, and other openings. In one example, the insulation and sealing of an 80 year-old home in Plymouth will reduce its energy consumption by 29% and save the owner 144 gallons of heating oil every year. A resident in Berlin will save over 600 gallons of heating oil and over 300 kilowatts of electricity every year thanks to insulation and a new wood pellet boiler (for a total of 40% energy savings). Many small businesses who participated in the program have seen an immediate boost to their bottom line. Insulation, high-efficiency lighting, and a new furnace will save the Nashua Farmer's Exchange 47% on its energy bill. Fagin's Pub, a local favorite in Berlin is revitalizing thanks to solar panels and other upgrades that have reduced the electric bill by 50% even after adding air conditioning for thirsty summer customers.

For more information, see the NH Community Development Finance Authority:
http://www.nhcdfa.org/resources/publications-and-forms/docs/35

Energy Efficiency at the Municipal Level

Municipalities across the state are decreasing costs by increasing the energy efficiency of local government buildings. The first step in improving energy efficiency often consists of an assessment of a building's energy use and its weak spots (where it loses or wastes energy), such as venting heat through poorly insulated doors, windows, and roofs. Many communities in the Strafford region completed building assessments with funding from the Energy Technical Assistance and Planning for New Hampshire Communities (ETAP) program[38]. Energy audits are important for determining the most cost-effective way to improve energy efficiency, and many similar programs exist to help municipalities achieve the benefits of energy efficiency. The New Hampshire Sustainable Energy Association provides a useful field guide for beginning this process.[39] Looking for ways to improve energy efficiency is always a good cost-saving measure, but there are two occasions that offer the greatest cost-effectiveness: 1) when replacing or making changes to heating and cooling systems (environmental controls), or 2) when making changes to a building or landscaping. Such a concept is known as integrating energy planning with conventional capital improvement planning (CIP).

Improving the energy efficiency of municipal buildings is only the first step. The cost-saving benefits of energy efficiency should be expanded to local residents – especially those who are particularly burdened by energy costs. As mentioned in earlier sections of this appendix, thermal energy costs can represent an overwhelming burden for low-income households throughout New Hampshire. For households at or just below the federal poverty level (approximately 2,491 households in Strafford County), home energy can account for nearly one quarter of total income. For households well below the poverty line (approximately 2,766 households in Strafford County) home energy costs can be 45% of total income[40]. Ensuring that homes have proper insulation against the extreme temperatures in New Hampshire is the most effective way to reduce home energy costs, increase residents' quality of life, and boost local economies. By working with NH OEP's weatherization assistance program[41], municipalities could help low-income residents significantly reduce their energy costs.

Public Service of New Hampshire (PSNH) – the largest electric utility in the state – operates the Smart Start program to assist municipalities in implementing energy saving measures by subsidizing all up-front costs. Similar to PACE financing, PSNH pays for costs associated with a range of measures that improve the energy efficiency of municipal facilities. That cost is repaid through additions to the municipal electricity bill that are lower than the savings achieved through improved energy efficiency[42].

Championing Energy Efficiency for Local Economic Development

Energy can be a significant cost for small and large businesses alike. Municipalities benefit from the prosperity and growth of local businesses, and helping businesses reduce their energy costs is an effective way for municipalities to help businesses and the local economy grow. Energy efficiency is an opportunity to increase collaborative relationships between municipal officials and local business communities. Efforts to improve energy efficiency will be most effective if they have a community-wide focus. Local businesses – especially small businesses – may struggle for time, money, and expertise required for making the investment in energy efficiency improvements. Community leaders and decision-makers can act as champions for energy efficiency – engaging the business community and facilitating action. A champion is committed to action, engages business community stakeholders, makes the case for improving energy efficiency, helps stakeholders find critical resources, and works to build community-wide success. Reducing energy costs is a straightforward way for businesses and their communities to see immediate results and continue to grow. Such an approach should also extend to residential areas. Reducing energy costs for community residents frees up income that can stimulate local economies. Municipalities should encourage smart and energy efficient design when working with housing developers. As energy prices rise, without investment in energy efficiency, more and more dollars will leave communities and the state to pay for energy. However, if residents – and the community overall – have to spend less on heat and electricity, more money will stay in the region to help community growth. *Getting to 'Yes' for Energy Efficiency* from the Maryland Energy Administration is a helpful guide for municipal decision-makers and community leaders who will champion energy efficiency at the local level[43].

Quality of life depends heavily on a healthy indoor environment; this means a clean living space that is well-insulated from extreme seasonal temperatures and keeps thermal energy from escaping and being wasted. Energy efficiency is a straight-forward way to reduce home energy costs and create healthy indoor environments. Such an approach is especially important for low-income housing. Energy efficiency should be considered a core component of new housing design at the local level. Ensuring that energy efficiency is integrated with housing development will be critical as energy prices rise and the climate continues to change.

Actions for our homes and businesses

Technological advances have given home owners and businesses a wide range of options for increasing energy efficiency. However, upfront costs remain a major deterrent for families and small businesses. The Property Assessed Clean Energy (PACE) program is an approach to enabling residents to make efficiency retrofits or install small renewable energy systems by spreading initial costs over many years. State legislation enables PACE, but the town of Durham is the only municipality in New Hampshire to have implemented the program locally. The town makes bonded loans to property owners for the upfront cost of an energy project, who repay the loan through an assessment on their annual property taxes over 10-20 years[44]. If a homeowner wanted to install a typical solar array (~3kilowatts) ,the initial cost could be collectively absorbed by a rebate through the NH Public Utilities Commission[45] ($.75 per watt up to $3,750, or 50% of the total cost), a 30% tax incentive from the federal government[46], and a local PACE bond. A standard 3kW array produces enough power that the homeowner could expect to make annual payments and still save money based on the energy generated. Many Strafford region communities already offer tax-based incentives for residential energy production (Table 5)[47].

Table 5- Strafford region communities with renewable energy tax exemptions. Data Source: Office of Energy & Planning, 2014.

Municipality	Solar	Wind	Biomass
Barrington	■	■	
Durham	■		
Farmington	■	■	■
New Durham	■		
Newmarket	■	■	■
Northwood	■	■	■
Rochester	■		
Wakefield	■	■	■

Numerous options exist for Strafford region businesses looking to improve their energy efficiency and reduce costs. First, the New Hampshire Public Utilities Commission provides funding assistance through its commercial and industrial incentive program[48]. The program offers rebates for solar electric and thermal systems that are 100 kW (or equivalent) or smaller. The incentive levels for solar electric systems are $0.80 per Watt, up to $50,000, and for solar thermal systems the incentive level is $0.07 per thousand-Btu per year ($0.12 per thousand-Btu/year for systems of fifteen collectors or fewer in size), up to $50,000. The program is open to non-profits, businesses, public entities, and other non-residential entities.

Implementation

Local Solutions is a vision and resource for the eighteen communities within the Strafford region. The findings of this plan reflect the 'advisory only' role of Regional Planning Commissions under RSA 36:45, which outlines the Purpose of Commissions and specifically the preparation of a "coordinated plan for the development of the region, taking into account the present and future needs with a view towards encouraging the most appropriate use of land". The RSA further defines the role of the comprehensive plan as that which promotes the "health, safety, morals, and general welfare of the region and its inhabitants" Regional Planning Commissions are also asked to "render assistance on local planning problems" and "make recommendations on the basis of…plans and studies to any planning board." This Plan represents not only a consultative resource for local-decision making, but also a foundation for the future work-planning of Strafford Regional Planning Commission and Strafford Metropolitan Planning Organization. Findings within each appendix shall shape the priorities and goals of this organization. The first step in this process is the identification of specific strategies, extracted from each appendix that fit within the goals created by the Strafford Regional Planning Commission, the Strafford Metropolitan Planning Organization, and Executive Director.

Strafford Regional Planning Commission staff, with the support of the Regional Master Plan Advisory Team, have compiled an comprehensive list of high, medium, and low priority implementation strategies within the following implementation table. These strategies are designed to carry forward the findings and conclusions of this Master Plan and its appendices, as well as provide support functions and build capacity of our regional communities and stakeholders. Each strategy identified in the table below was extracted from a larger list of strategies within each appendix. Thus, these represent the most important (but not always those with the highest priority rating) implementation strategies from each plan appendix. It is important to note that for each strategy identified, Strafford Regional Planning Commission or Metropolitan Planning Organization is the acting or responsible body.

On the following page, please find the implementation table key. This key is intended to provide important information about each field within the table. Such information includes a list of possible values for the field, additional formatting elements, and a description of the field's contents.

Implementation Table Key

Priority Rating

Field Values: *High, Medium, Low*

Field Description: *Represents a qualitative ranking by SRPC staff based on the following weighted factors (weighted as ordered below):*

1. **Need**

   How great is the need for the strategy

1. **Impact**

   How large of an impact with the strategy have on stakeholders

1. **Feasibility**

   How feasible is the strategy from a budgetary and staffing perspective

1. **Term**

   How long will the strategy take to complete and is the strategy a long, mid, or short term effort

Strategy

Field Values: *(Open Response)*

Field Description: *Includes narrative of the action to be taken by SRPC/SMPO.*

Stakeholder Level

Field Values: *Local, Regional, State*

Field Formatting: **Bold** or *Italic*

Field Description: *Who will a strategy impact.. Primary stakeholder level shall be in bold font, while secondary level(s) shall be italicized.*

Functional Areas

Field Values: *Land Use, Housing, Transportation, Economic, Water Infrastructure, Environment, Climate, Energy, Engagement*

Field Formatting:

● *Primary Functional Area Affected*

○ *Secondary Functional Area(s) Affected*

Field Description: *Strategies may bridge multiple planning areas. The Functional Areas field is an opportunity to identify those connections on both a primary and secondary level. Each strategy shall have only one primary functional area, but may have secondary functionality in multiple appendices.*

Potential Partners

Field Values: *(Open Response) Listed by acronyms, please see Partner Acronym List on following page.*

Field Description: *Identifies a list of potential partners.*

Organizational Capacity

Field Values: *Support the Development of Statewide and Regional Data Systems, Align Data Collection, Performance Measures, and Outcomes with Policy Making, Incorporate Consistency into Plans and Processes, Modernize Planning and Development Tools, Improve Capacity to Use Decision Making and Planning Tools*

Field Description: *SRPC Organizational Goals were drafted by the Strafford Regional Planning Commission Executive Director with guidance from the Strafford Regional Planning Commission Executive Committee. These values represent long term organizational goals.*

Table 6 - Partner Acronym List

Partner Acronym	Full Partner Name
CAW	Climate Adaptation Workgroup
CEDS Committee	Comprehensive Economic Development Strategy Committee
CSNE	Carbon Solutions New England
DRED	New Hampshire Department of Resources Economic Development
EDA	Economic Development Administration
EMD	Emergency Management Director
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
ICNET	Infrastructure and Climate Network
GBNERR	Great Bay National Estuarine Research Reserve
GRANIT	Geographically Referenced Analysis and Information Transfer System
HEAL	Healthy Eating Active Living
NHDA	New Hampshire Department of Agriculture
NHDES	New Hampshire Department of Environmental Services
NHDOT	New Hampshire Department of Transportation
NHDPS	New Hampshire Department of Safety
NHEDA	New Hampshire Economic Development Association
NHFG	New Hampshire Fish and Game
NHHFA	New Hampshire Housing Finance Authority
NHHSEM	New Hampshire Homeland Security and Emergency Management
NHOEP	New Hampshire Office of Energy and Planning
NOAA	Nation Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Services
PREP	Piscataqua Region Estuaries Partnership
RPC	Regional Planning Commission
SAU	School Administrative Unit
SPNHF	Society for the Protection of New Hampshire's Forests
SWA	Southeast Watershed Alliance
TNC	The Nature Conservancy
UNH	University of New Hampshire
UNH T2	University of New Hampshire Technology Transfer Center
UNHCE	University of New Hampshire Cooperative Extension
UNHSC	University of New Hampshire Stormwater Center
USACE	United States Army Corps of Engineers
VHB	Vanasse Hangen Brustlin
WHCGS	Workforce Housing Coalition of the Greater Seacoast

Planning Function	Appendix	Priority Ranking	Strategy	Stakeholder Level	Functional Areas*									Potential Partners
					Land Use*	Housing	Transportation	Economic	Water Infrastructure	Environment	Climate	Energy	Engagement	
Technical Assistance	**EE**	**High**	Support communities in performing energy audits of municipal buildings (completing ETAP building assessments for all communities.	**Local**								•		Municipalities, Energy efficiency experts
Technical Assistance	**EE**	**High**	Provide technical support to municipalities for increasing local power generation (e.g. build partnerships between municipalities and alternative energy companies).	**Local**							○	•		Municipalities
Partners	**EE**	**Medium**	Engage with local economic interest groups (e.g. chambers of commerce, economic development offices) to develop educational and incentive programs, and explore local energy efficiency policy.	**Local**				•			•	•	•	Municipalities
Data	**EE**	**High**	Identify knowledge gaps in energy efficiency at different sectors (municipal, commercial, residential)	**Local**								•		Municipalities
Partners	**EE**	**High**	Work with state agencies (OEP, CDFA) to develop funding opportunities for local (municipal and commercial)energy efficiency retrofits (similar to CDFA "Better Buildings")	**State**								•		State agencies

Outreach	**EE**	**High**	Improve SRPC web content and presence on energy-related projects and educational materials	**Regional**								•		
Partners	**EE**	**Med**	Increase collaboration with regional energy providers (include representatives on comprehensive economic development strategy committee)	**Regional** *State*								•	•	Regional energy providers

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Contact: Liz Nixon (Elizabeth.Nixon@puc.nh.gov)
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