Energy



Introduction

This chapter is the result of a strong desire in the community to understand better the energy issues in Berlin, and to begin working on them. The purpose of an energy chapter is ultimately to reduce overall energy consumption in the community, to take advantage of the resources the community has in the alternative energy market, and thereby to reduce both overall energy costs and the release of greenhouse gases. Diversification of energy sources and energy conservation are important goals for Berlin and the region, as they will lead to more stability in a time of global uncertainty related to energy sources. Climate change is occurring at a global level, and its effects are now being realized locally. The University of New Hampshire has been a leader in researching the impacts of climate change on our region. They have determined that the weather in New Hampshire has generally become hotter, wetter, and more extreme. This issue presents another critical reason for exploring ways to reduce the amount of energy used locally, and to begin a transition to sources that produce fewer greenhouse gas emissions. The 2009 New Hampshire Climate Action Plan (available through the New Hampshire Department of Environmental Services) is another resource for Berlin to consult as it moves forward.

69% of the net energy use in New Hampshire is related to buildings, and 70% of Berlin's municipal energy use is for buildings.

Key planning and development principles such as mixed use development, re-development and infill in the urban core, the construction and renovation of greener buildings and the use of alternative transportation should be encouraged in Berlin, so as to help reduce energy use and its environmental impacts. Currently, the majority of energy users in Berlin draw electricity from the grid. The origin of that energy is unknown by the consumer. We need to improve our understanding of the fuel mix here in New Hampshire and its contribution to the national supply as citizens, businesses, and government entities make decisions for Berlin's future.

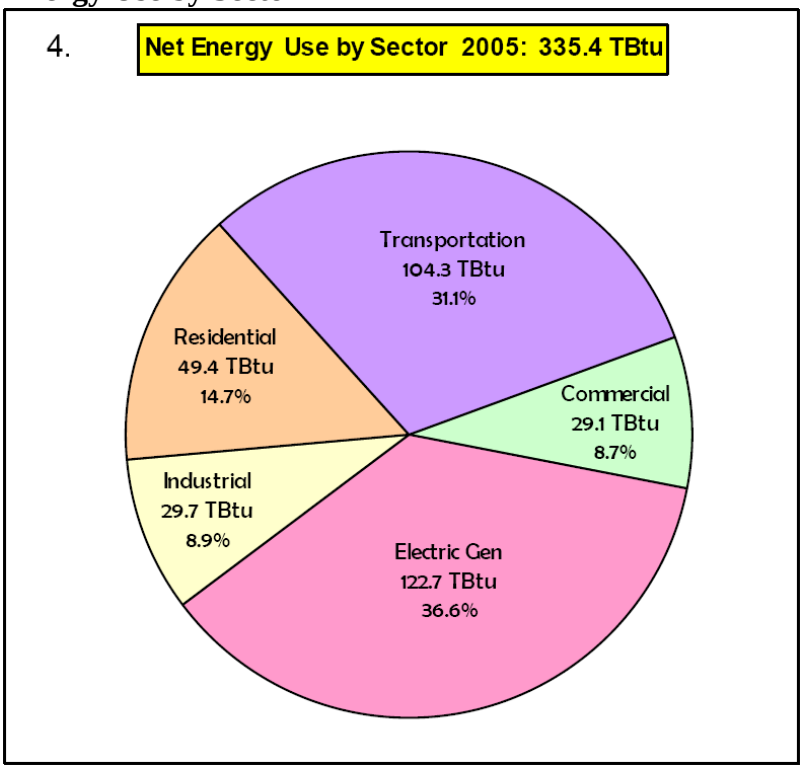
Clean Air Cool Planet, a non-profit organization based in Portsmouth, NH, assisted the City of Berlin with an inventory of municipal energy use (see Appendix), and the key

findings have been included in this chapter. Overall the inventory revealed that Berlin's largest municipal energy use is for buildings (70%), but the largest energy expense for the City is for vehicles ($890,000 annually). The largest portion of the energy used in buildings annually is for the High School (27%) and Junior High School (also 27%). These figures identify the need for additional building specific audits and then building upgrades that will reduce the annual energy use and the cost of operating these buildings.

Climate Change

Now that there is a better understanding of the connection between carbon dioxide emissions and climate change, there is a need to begin addressing this issue at all levels: national, state, and local. This is particularly important for a northern community like Berlin with its high demand for heating energy.

Figure 1 Net Energy Use by Sector



Source: NH Office of Energy and Planning

The Energy Information Administration within the Federal Department of Energy has tracked the carbon dioxide emissions for each of the 50 states. The trend in New Hampshire suggests there has been an +increase in carbon dioxide emissions, rising 33% to 21.8 million metric tons (mmt) since 1990. Historically, the transportation sector in New Hampshire has been the primary source for the release of carbon dioxide. However, between 2002 and 2004, there was a large increase of carbon dioxide emissions from the electric power sector due to the numerous natural gas generating plants that went online in the state. Over this time period the remaining sectors stayed flat or, in some cases,

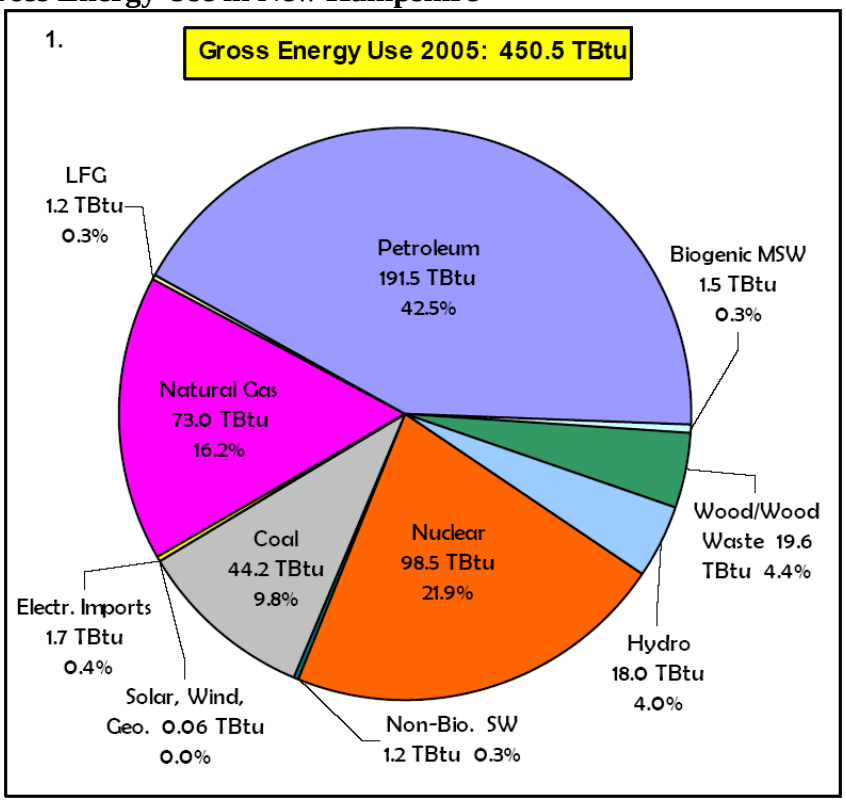
decreased. By 2005, the electric power sector was responsible for 36.6% of the net energy use in New Hampshire, edging past the transportation sector which stood at 31.1%. Following behind were the residential sector (14.7%), the industrial sector (8.9%) and the commercial sector (8.7%). Studies show that most of the electrical generation is related to buildings and the built environment so the Office of Energy and Planning estimates that 69% of the net energy use in New Hampshire is building related.

Energy Supply

Nonrenewable fossil fuel based energy accounts for 69 % of total energy use in New Hampshire.

Nonrenewable fossil fuel based energy accounts for 69 % of total energy use in New Hampshire. Figure 2 illustrates the gross energy use in New Hampshire by the source of energy generation. The gross energy use includes all of the energy imported into the State, plus all of the energy produced with resources from within the state. The calculation of gross energy use is important to consider because the production of energy, regardless of where it is ultimately used, has economic and environmental ramifications.

Figure 2 Gross Energy Use in New Hampshire



Source: NH Office of Energy and Planning

Energy Consumption

The energy consumption information available is mostly limited to state, national and international levels. From a broad perspective, it is important to look at the sectors of the state's economy to compare energy consumption and its fuel sources to identify opportunities for change. Figure 3 shows a snapshot of the energy consumption in New Hampshire for the years 1990 and 2004.

Figure 3 Energy Consumption in New Hampshire by Sector, 1990 & 2004

Category	1990		2004		% change
	#	% of category	#	% of category	
New Hampshire Total					
Energy Consumption (trillion BTU)	264.6	n/a	340.6	n/a	28.7%
Population	1,109,117	n/a	1,299,169	n/a	17.1%
By Sector (trillion BTU)					
Residential	78.8	29.8%	99.6	29.2%	26.4%
Commercial	43.5	16.4%	75.6	22.2%	73.8%
Industrial	69.3	26.2%	56.2	16.5%	-18.9%
Transportation	73	27.6%	109.2	32.1%	49.6%
Total	264.6	100.0%	340.6	100.0%	28.7%
Fuel Source (trillion BTU)					
Coal	31.5	11.9%	43.4	12.7%	37.8%
Natural Gas	14.5	5.5%	64.5	18.9%	344.8%
Petroleum	159.1	60.2%	205.4	60.3%	29.1%
LPG	7.7	2.9%	10.4	3.1%	35.1%
Gasoline	61.9	23.4%	89	26.1%	43.8%
Nuclear Electric Power	43.2	16.3%	106.1	31.2%	145.6%
Hydroelectric Power	19.6	7.4%	13.2	3.9%	-32.7%
Biomass	27.2	10.3%	23	6.8%	-15.4%
Other	0.2	0.1%	1.5	0.4%	650.0%
Net Interstate Flow Loss	-30.7	-11.6%	-116.5	-34.2%	279.5%
Total	264.5	100.0%	340.6	100.0%	28.8%
Fuel Source (Electricity Production- million Mwh)					
Natural Gas	0.0	0.0%	5.4	22.6%	n/a
Petroleum	2.3	18.9%	2.0	8.2%	-16.5%
Coal	3.0	23.9%	4.1	17.1%	37.7%
Nuclear	4.1	32.9%	10.2	42.6%	149.4%
Hydroelectric	1.9	15.2%	1.3	5.5%	-30.1%
Renewables	1.1	9.2%	0.9	4.0%	-16.8%
Total	12.4	100.0%	23.9	100.0%	92.5%

Source: Energy Data- EIA, 2007(b), Population Data- NH OEP, 2007

In 1990, total energy consumption in New Hampshire was 264.6 trillion British Thermal Units (BTU) and the state population was 1,109,117. On a per capita basis, each resident

consumed 239 million BTUs. By 2004, the energy consumption grew by 28.7% to 340.6 trillion while population grew only by 17.1%. The energy consumption per capita in New

Hampshire rose to 262 million BTUs. Thus, the average resident in New Hampshire consumed 9% more energy in 2004 than they did in 1990.

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There is a heavy reliance on petroleum products in New Hampshire, the region and the nation. In Figure 3 we saw this for New Hampshire, and Table 1 below shows the same trend exists in Berlin according to the US Census. The percentage of natural gas contribution toward total energy consumption varies minimally between the state, region and nation. However, both New England and New Hampshire are more reliant than the United States on natural gas as a fuel source for electricity. Regarding coal, there is also a difference across these three geographic regions. Across the United States, coal produces close to 50% of the country's electricity. However in New England, it drops to a mere 15.1% and only slightly higher numbers in New Hampshire at17.1%. Nuclear in New Hampshire is substantially larger than the U.S. because of the Seabrook nuclear power plant. This is less revealing, because the electricity from that plant enters the New England power grid and the electricity from Seabrook is not necessarily confined to being used in New Hampshire. As a matter of fact New Hampshire exports 34.2% of the energy generated in the state.

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In Berlin we know that the transportation sector relies on fossil fuels to generate the required energy for vehicles. Based on the home heating data from the US Census we can see in Table _ that the majority of homes in Berlin (95%) also use fossil fuels as their primary fuel source.

Table 1 Primary Home Heating Fuels for Residential Units in Berlin

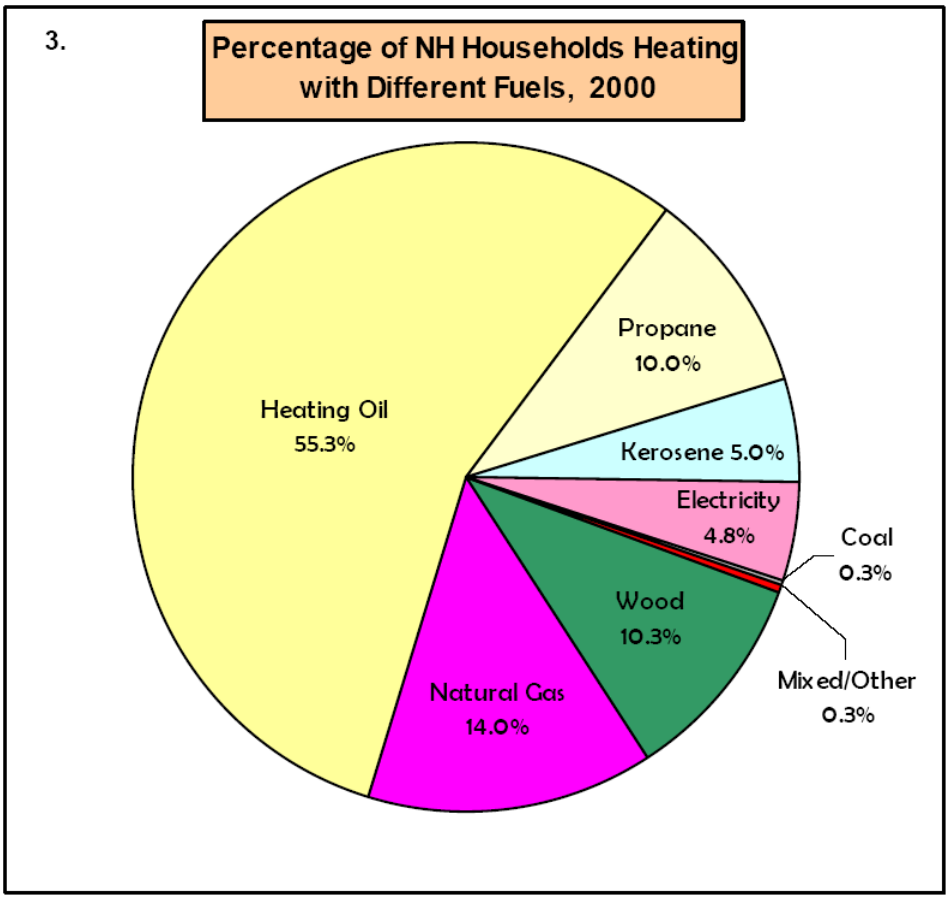
	Occupied Units	**Owner Occupied**	**Renter Occupied**
Total Units:	4,555	2,788	1,767
Utility Gas	0	0	0
Bottled, Tank, LP Gas	45	20	25
Electricity	104	28	76
Fuel Oil, Kerosene, etc.	4,315	2,680	1,635
Coal or Coke	6	6	0
Wood	54	49	5
Solar Energy	0	0	0
Other Fuel	22	5	17
No Fuel Used	9	0	9

Source: US Census, 2000

The New Hampshire Office of Energy and Planning estimates that, on average, at least 85% of our heating energy in New Hampshire comes from imported sources.

This suggests a heavy reliance on an imported fuel source. The rising cost of this fuel and its environmental impacts suggest that the community needs a more diverse mix of fuels, and that alternative sources (such as solar hot water and wood) could play an important role. The New Hampshire Office of Energy and Planning estimates that, on average, at least 85% of our heating energy in New Hampshire comes from imported sources. Residences may offer one of the best opportunities to increase the use of renewable and local energy sources. These renewable energy options could also be implemented for larger uses and structures over time.

Figure 4 Home Heating Fuels in New Hampshire, 2000



Source: NH Office of Energy and Planning

The cost of energy is an important consideration for all users in Berlin and the surrounding region. A closer look at the fossil fuel sources of energy (no. 2 fuel oil, natural gas, propane, gasoline) shows that the costs were relatively level between 1990 and 2002. After 2002, each fuel source rose significantly. No. 2 heating oil and gasoline

prices in New Hampshire and New England have followed the national trends closely. However, the price of propane and natural gas is significantly higher than the national average.

Regarding electricity, rates in New England are substantially higher than the national average, which is largely due to the limited availability of coal to the New England region. Coal is an affordable fuel source for many areas with rich deposits of the mineral, but New Hampshire is not one of these regions. It is also important to note that this lower cost does not take into consideration the significant damage to human health and the environment that are frequently linked to coal. The result in New Hampshire is a heavier reliance on natural gas and nuclear for power generation.

It should be noted that the energy cost data available as of the writing of this Master Plan covers through 2007. However, in the first half of 2008, fossil fuel based energy prices have risen dramatically. For example, gasoline prices have exceeded $3.50 and No. 2 fuel oil has exceeded $4.50/gallon. It is impossible to say whether these prices are early spikes or will be sustained. If they are sustained, the economic viability of alternative fuels and energy sources will become significantly stronger.

Berlin Municipal Energy Inventory

Clean Air Cool Planet assisted the City of Berlin with an inventory of municipal energy use. The data was provided by the City and Public Service of New Hampshire for 2007/2008. Overall the inventory revealed that Berlin's largest municipal energy use is for buildings (70%). The largest portion of energy used, and the largest cost, for buildings annually is for the High School (27%) and Junior High School (27%).

Figure 5 Municipal Energy Use in Berlin Annually

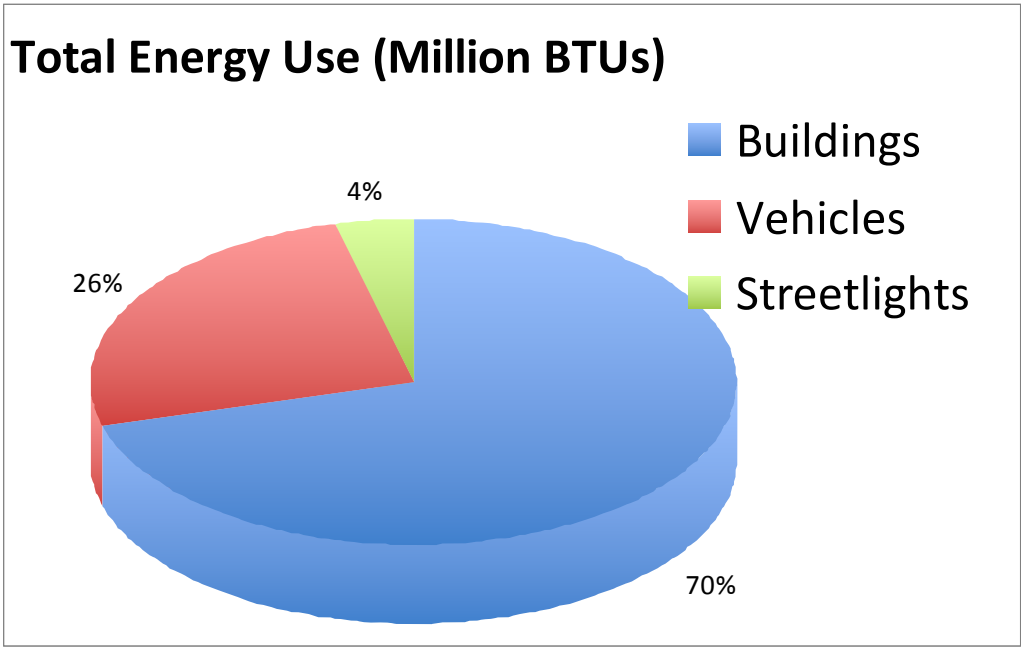
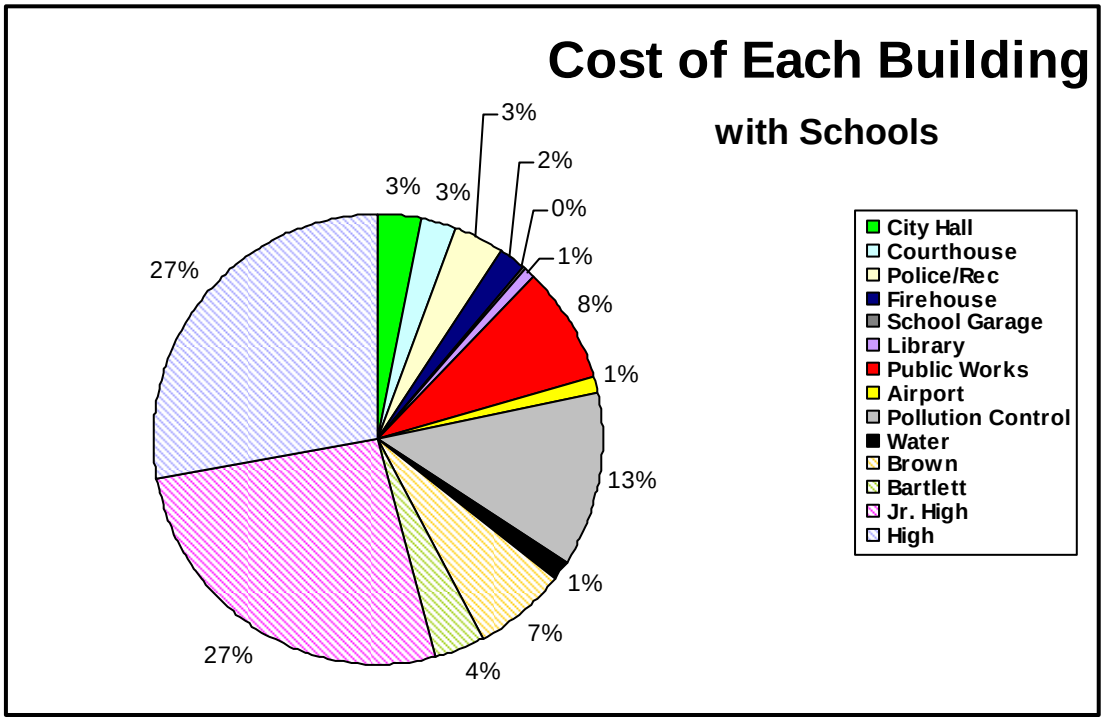
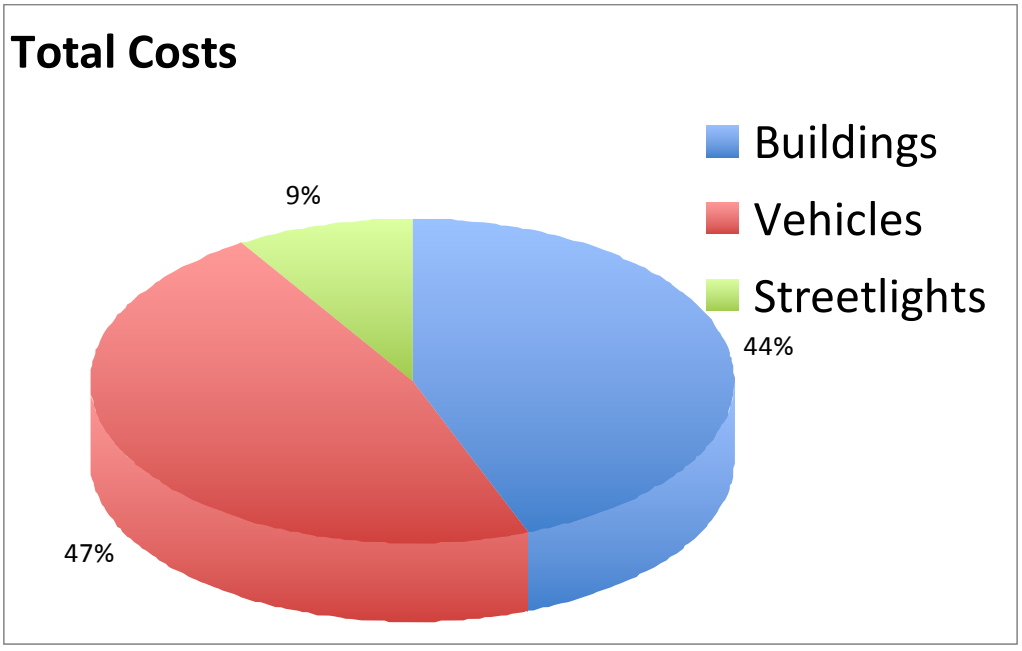


Figure 6 Building Energy Costs in Berlin



The largest energy expense for the City annually is for vehicles ($889,328). The annual cost of energy for buildings ($837,096) and streetlights ($166,915) is also significant, and all three areas are prime for conservation efforts that will reduce emissions and save tax dollars.



This inventory will serve as a baseline for further study of energy use in Berlin. Further fuel cost analysis is recommended, and new data should be gathered in 2009/2010 for comparison to this inventory. The school buildings provide the best opportunity for energy savings. Building specific audits should be completed on any of these structures prior to building upgrades. The vehicle fleet will need further examination. Some of the changes related to the vehicle fleet will include behavior change (ex. anti-idling policies, and route analysis) while others may be new guidelines for purchasing (ex. higher gas mileage requirements) or a change in fuel type.

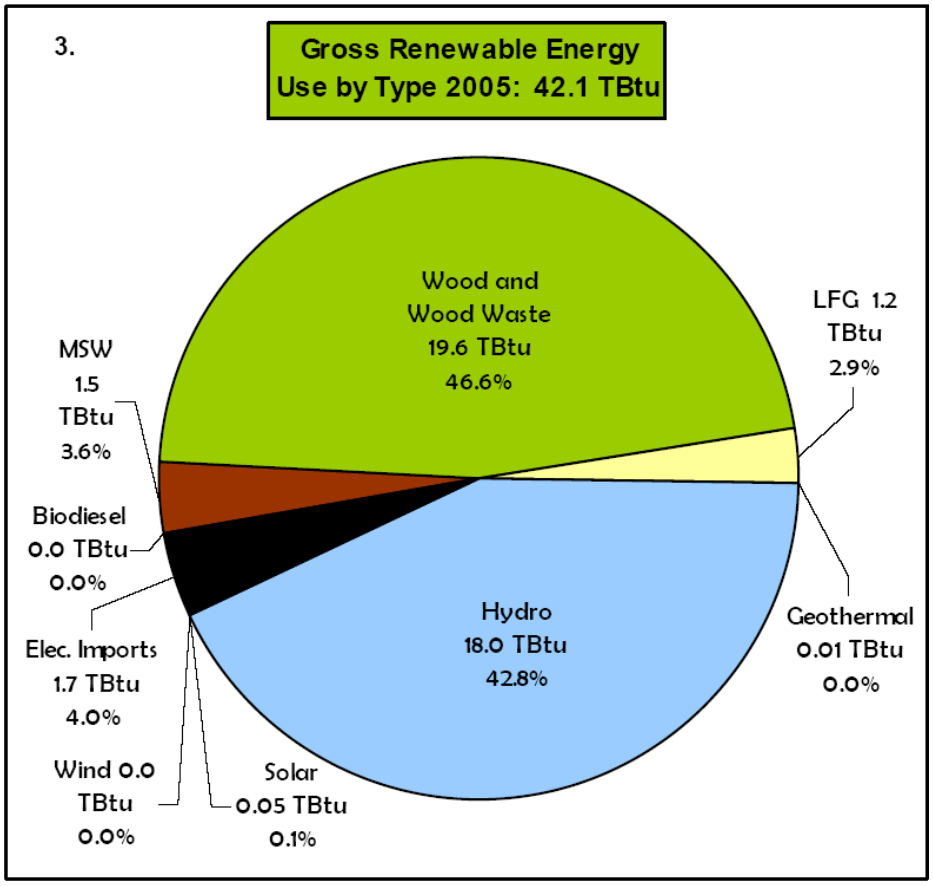
Tackling the issue of street lighting will require cooperation with Public Service of New Hampshire (PSNH) to inventory and analyze the existing locations and types of street lights in Berlin. Once this has been completed there are many options available to the City through PSNH that could result in a reduction in energy use and cost annually. These include a change in technology to a fixture that uses less energy, the use of "midnight sensors" to turn lights off when they are no longer needed in the middle of the night, or the removal of unnecessary lights.

Renewable Energy

Renewable energy sources are inexhaustible, although sometimes limited in the amount of energy available per unit of time. A stream may generate lots of energy in the spring, but less in the middle of July or August. Renewable energy contributes to energy assurance, by adding diversity and additional energy resources to meet the community's needs. It also provides energy security, by using indigenous energy sources, which are less subject to geopolitical influences. These sources provide environmental protection by reducing pollution and other negative impacts on air, water, and land while meeting energy demand in ways that can be maintained indefinitely. There are also opportunities to create economic stability and growth by using renewable energy technology to retain dollars in-state, create new jobs, and stimulate the local and regional economies.

In New Hampshire there are abundant renewable energy possibilities, especially wood, geothermal, wind, solar and hydroelectric. Currently, some of these renewable energy resources (especially wind, solar and geothermal) are greatly underutilized. In New Hampshire, only 9.3% of the gross energy use is from renewable sources. The largest renewable sources in New Hampshire currently are wood and hydro as Figure _ illustrates. In 2007 and 2008 several renewable energy incentives became available from the state and from some utilities. These programs are anticipated to be expanded over time, and could greatly reduce the up front cost for small scale installations.

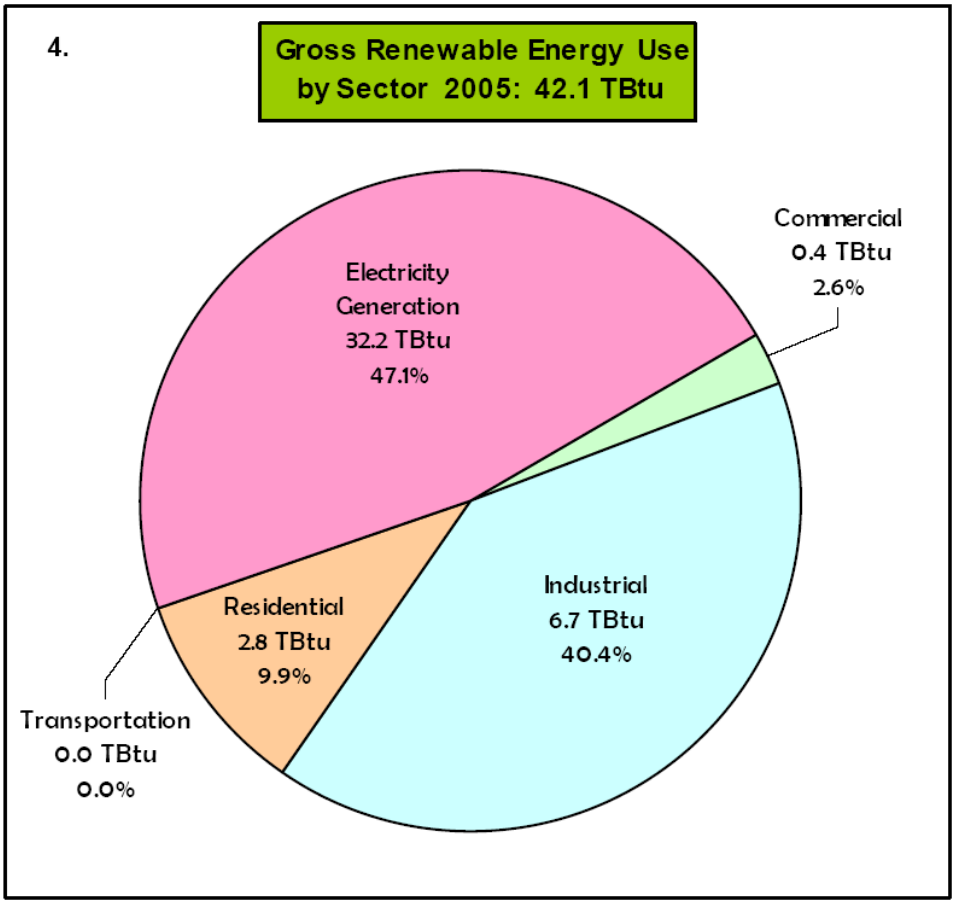
Figure 7 Renewable Energy Use by Type in New Hampshire



Source: NH Office of Energy and Planning

The two largest sectors using renewable energy in New Hampshire are Electricity Generation (47%) and Industry (40%).

Figure 8 Renewable Energy Use by Sector in New Hampshire



Source: NH Office of Energy and Planning

Renewable energy sources are increasingly being discussed as an economical and environmentally friendly way to meet future energy demands and to diversify energy sources. While there are a host of benefits to renewable energy projects, including reduced emissions and decreased transmission losses via the use of a decentralized energy grid, there are always potential negative impacts. These include environmental impacts to wildlife habitat, visual changes to the landscape, and economic constraints. Both the positive and negative impacts need to be weighed so an informed and educated decision can be made about their expanded role in providing energy in Berlin and beyond.

For the purposes of this section on renewable energy sources, the information will be categorized by its use. Those uses are electricity generation, thermal generation and transportation. Within each of these categories, there are opportunities for renewable energy.

New Hampshire's 25 x '25 Renewable Energy Initiative

In August of 2006 Governor John Lynch announced the 25 x '25 Renewable Energy Initiative. The goal of 25 x '25 is for New Hampshire to obtain 25% of its energy from clean, renewable sources by the year 2025. This initiative is part of a national effort aimed at producing 25 percent of the energy consumed in the United States from clean, renewable power by the year 2025.

Achieving 25% renewable energy for New Hampshire will be more easily accomplished as an overall goal rather than working toward 25% renewable energy in each of the end use categories and economic sectors. It will also be easier to meet the overall goal for renewable energy if demand for energy is reduced by means of energy efficiency and conservation.

Currently a plan is being developed jointly by the Office of Energy and Planning and the Department of Environmental Services, in coordination with a New Hampshire-based consulting firm to clearly articulate how New Hampshire will achieve this goal. This effort is significant to the state and the nation, and Berlin should monitor it as the plan is developed to identify opportunities for the community to be part of the solution.

Electric Generation

When people discuss renewable energy, they are often referring to how renewable energy can be used to create electricity. Renewable sources of energy that are used for electricity production include wind, solar (photovoltaic), solar (thermal), geothermal, and biomass. These renewable energy sources are defined below:

Biomass- Renewable organic materials, such as wood, agricultural crops or wastes, used as a source of fuel or energy. Biomass can be burned directly to heat water and produce steam which is then used to turn a turbine to produce electricity, or processed into biofuels such as ethanol and methane.

Geothermal- Energy generated by heat stored beneath the Earth's surface. This heat is used to heat a liquid (typically water) to produce steam which is then used to turn a turbine to produce electricity.

Hydro- The force or energy of moving water used to turn a turbine to produce electricity.

Solar (photovoltaic)- Electricity produced by the sun shining on panels made of interconnected silicon "cells".

Solar (thermal)- Reflective mirrors are used to concentrate the heat from the sun onto a central focal point. The concentrated light from the sun heats up water or oil and produces steam which is then used to turn a turbine to produce electricity.

Wind- As wind blows through turbine blades affixed to a tower, the blades turn a central shaft which is attached to a generator to produce electricity.

Figure _ compares the costs and shows the cost trends of some of these renewable energies for the production of electricity. The costs used are levelized to dollar values in 2000. The costs listed are also indicative of projects located in areas with optimal resource availability. Most recently the greatest progress in renewable energy technology has occurred within the wind industry. In the early years of wind technology, electricity production cost was around 30 cents/kwh. By 2002, cost of electricity production from wind resources dropped dramatically to 3-5 cents/kwh. A commercial wind facility has been discussed for Berlin, but the status of the project is unclear and several approvals would be needed prior to the facility being constructed.

Geothermal technologies traditionally have not had such a dramatic advancement; however they are among the cheapest renewable energy sources to produce electricity at 2-4 cents/kwh if an ideal site is available. Biomass is of particular importance to New Hampshire with its large stands of forests, and Berlin has experienced a great deal of interest from several companies that would like to create biomass facilities to create electricity. It is estimated that electricity produced from biomass sources costs 6-8 cents/kwh. Berlin currently has four hydroelectric facilities in operation with a total production of 29.6 Mega Watts of hydro power.

Table 2 Hydro Facilities

Facility Name	**Power Generation**
Riverside Hydro	7.9MW
Sawmill Hydro	3.2MW
Cross-Power	3.5MW
Smith Hydro	16MW

Source: City of Berlin

The highest price for electricity from a renewable energy source is from photovoltaic panels which average between 22-26 cents/kwh. This is changing in New Hampshire as incentives are being made available for the installation of photovoltaic sytems that are tied into the electrical grid. For comparison, electricity produced from traditional fuel sources cost approximately 3-5 cents/kwh for coal, 10-12 cents/kwh for oil, 6-8 cents/kwh natural gas, and 10-14 cents/kwh for nuclear. Therefore, it can now be said that many properly sited renewable energy projects are price competitive with traditional fuel sources.

Therefore, It can now be said that many properly sited renewable energy projects yield power that is priced competitively with traditional fuel sources.

Appropriate siting of these technologies is critical. The single greatest factor that affects the price of producing electricity is the availability of the renewable resource. Berlin does have a number of renewable energy options available to produce electricity. Wind power, one of the most economically feasible renewable energies, located along Berlin's higher elevations make utility scaled applications feasible. However, wind speeds within Berlin are highly variable and very dependent on location. Data on wind resources is important for any potential renewable energy facilities. Wind resource maps for Berlin indicate that the locations with the highest mean wind speeds (15 miles per hour and higher) are on the high ridges and peaks, but also depend on the height of the turbine above the ground. All proposed locations will require the collection of wind data for at least one calendar year to gather site specific information.

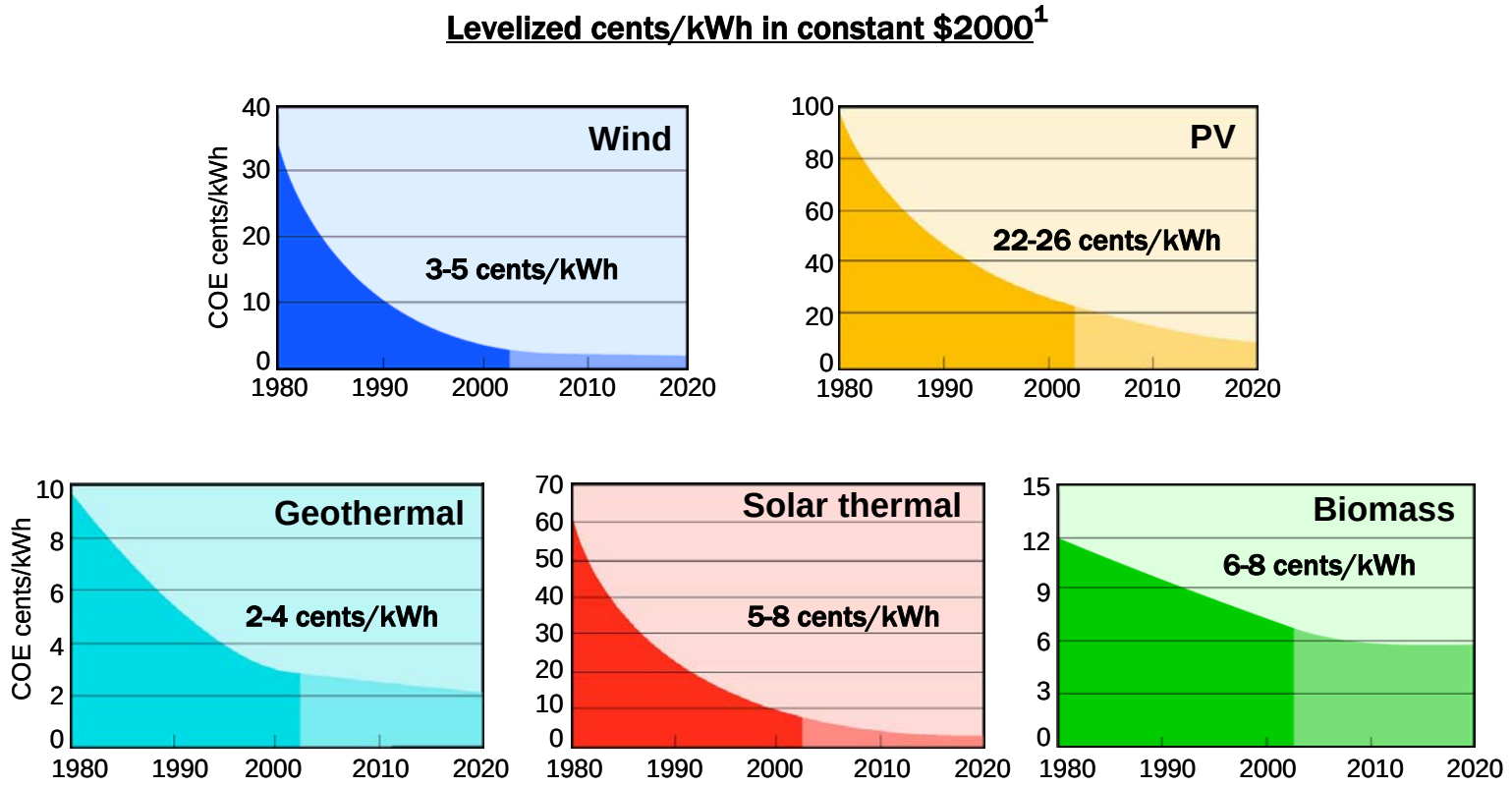
Solar power both from photovoltaic and thermal applications are feasible in Berlin and much of the surrounding region. Biomass is increasingly discussed, thanks to New Hampshire's large quantity of wooded forests and an established logging industry.

Finally, the capturing of methane gas from capped landfills and wastewater treatment facilities, while not considered a renewable energy, should also be encouraged within the city as an environmentally friendly energy source for electrical generation and waste heat. Methane, one of the most harmful greenhouse gases, is produced when waste is broken down. Typically this gas is vented and released into the atmosphere. Innovative advancements have occurred which permit this gas to be captured, and then burned to power turbines to produce electricity. Such a facility has been considered for a location adjacent to the Wastewater Treatment Facility in Berlin.

The Androscoggin Valley Regional Refuse Disposal District (AVRRDD) installed a landfill gas collection system in 2007, and is currently flaring off the methane while they consider their options for energy production from this fuel source. AVRRDD is working with the US Environmental Protection Agency and others to evaluate the amount of energy that could be produced, and the cost for the development of the remaining system infrastructure.

Figure 9

Renewable Energy Cost Trends



Source: NREL Energy Analysis Office (www.nrel.gov/analysis/docs/cost_curves_2002.ppt)
[1]These graphs are reflections of historical cost trends NOT precise annual historical data.
Updated: October 2002

Thermal Generation

Thermal generation is using energy to create heat. In New Hampshire, heat is predominantly used for space heating in residential and commercial applications, but a small portion of this heat is also used for industrial manufacturing. Approximately half of the energy used by New Hampshire homes is for heating. Heating demand represents both a large expense and a significant opportunity for savings.
There are four renewable energy sources for thermal generation.

Biomass - Renewable organic materials, such as wood, agricultural crops or wastes, used as a source of fuel or energy. Biomass can be burned directly to heat water which is used to heat buildings, or can create electricity and the waste heat from that process can then be used for space heating..

Geothermal - Energy generated by heat stored beneath the Earth's surface. This heat is used to heat a liquid (typically water) and extracted by a heat exchanger into a useable form of energy to heat buildings.

Solar (thermal) - Focus the sun’s rays onto glass tubes or a flat panel filled with a liquid which is then used to heat a building or for hot water applications.

Solar (Passive) - Collection of the sun’s heat obtained through non-mechanical means by orienting a building to maximize southern window exposure.

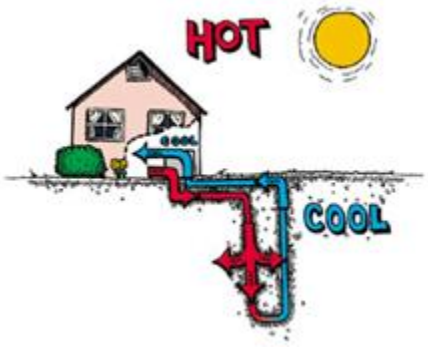
Within thermal generation, district heating and cogeneration are two areas that are experiencing a resurgence in community planning. This is an ideal application for biomass fueled facilities. The concept of district heating hinges on a central boiler supplying heat to multiple buildings within a region rather than each building having their own boiler. Instead each building is outfitted with a heat exchanger to draw heat from the hot water running through the closed loop utility pipes that run underground. Fuel sources used to produce the heat could be any of the renewable methods explained above as well as traditional fossil fuel sources.

The sizing of these projects can vary greatly. Small applications such as the neighborhoods of 15-20 houses are feasible as are larger downtown areas such as Concord, NH, which is served by Concord Steam. The benefits of district heating are a greater efficiency in the mechanical systems which reduce fuel costs and emissions, and a spur in economic development potential in commercial areas, among others.

Cogeneration, also referred to as combined heat and power (CHP), is the production of heat and electricity from the same mechanical system. The purpose of cogeneration is to improve the overall efficiency of the system by using residual heat to either heat a building or produce electricity. It takes 165 units of energy to produce 35 units of electricity and 50 units of heat. Due to the large losses of energy in the production of electricity, these systems operate at an average efficiency of 53%. Through a

cogeneration unit, 100 units of fuel can produce the same amount of electricity and heat, representing an average efficiency of 85%.

Geothermal systems are electrically powered systems that tap the stored energy of the earth below the structure. These systems use the earth's relatively constant temperature to provide heating, cooling, and hot water for homes and commercial buildings. While many parts of the country experience seasonal temperature extremes - from scorching heat in the summer to sub-zero cold in the winter - a few feet below the earth's surface the ground remains at a relatively constant temperature. Like a cave, this ground temperature is warmer than the air above it during the winter and cooler than the air in the summer. A geothermal heat pump takes advantage of this by exchanging heat with the earth through a ground heat exchanger.



Source: Dragin Geothermal

One of the most cost-effective ways to include renewable technologies into a building is by incorporating solar hot water. A typical residential solar water-heating system reduces the need for conventional water heating by about two-thirds. It minimizes the expense of electricity or fossil fuels to heat the water and reduces the associated environmental impacts. Solar water heaters use the sun to heat either water or a heat-transfer fluid in the collector. Heated water is then held in the storage tank ready for use, with a conventional system providing additional heating as necessary.

Passive solar building design uses a structure's windows, walls, and floors to collect, store, and distribute the sun's heat in the winter and reject solar heat in the summer. It can also maximize the use of sunlight for interior illumination. Unlike active solar heating systems, it doesn't involve the use of mechanical and electrical devices — such as pumps, fans, or electrical controls — to circulate the solar heat. Buildings designed for passive solar incorporate large south-facing windows and construction materials that absorb and slowly release the sun's heat. The longest walls run from east to west. In most climates, passive solar designs also must block intense summer solar heat. They typically incorporate natural ventilation and roof overhangs to block the sun's strongest rays during that season. Due to its topography, Berlin has many residential and commercial buildings that are ideally situated to capture passive solar energy.

Transportation

The transportation industry is working to develop renewable energy solutions for itself, but its advancement is being debated. The two fuel sources that some are considering renewable include ethanol and biodiesel, otherwise known as biofuels. Biofuels are produced by cultivation of agricultural crops, which are then processed into a useable fuel that can be combusted. The benefits of these fuel sources are the absorption of carbon dioxide, a harmful greenhouse gas, as the plant grows and the ability to cultivate the fuel

source. The other side of the debate contends that the amount of fossil fuel needed to grow and process the crops and transport the fuel to the consumer exceeds the amount of fuel that can actually be produced by the crops. Therefore there is a net gain in atmospheric carbon dioxide.

There is also a concern over the price for fuel crops versus food crops. Farmers are paid more for fuel crops, resulting in more farmers growing fuel crops. This increase in fuel crops has caused a reduction in supply for food crops, which has in turn increased the price of the commodity. This is especially important in Berlin where the food supply is generally imported from outside the region and very susceptible to cost increases.

There is still merit to this early technology in renewable biofuels. Work at the University of New Hampshire, among others, is looking into growing crops which can produce a higher quantity of biofuel per acre farmed. These crops include strains of sunflowers and switch grasses. Additionally, the cultivation of prolific algae, using exhaust from power plants and industrial uses, is being explored as a biofuel. Waste oil is also cleaned and converted to biodiesel to create another alternative fuel source.

Increased use of electric vehicles and hybrid technology is also an increasingly important both for single occupant vehicles and for public transportation. In a city like Berlin, where the development is fairly concentrated but there is steep terrain, there may be more interest in electric vehicles which do not have long ranges and do not need to travel at high speeds. Another transportation alternative within the city, at least seasonally, is the use of electric assist bicycles and scooters. Although most of the city is fairly accessible by bicycle, some of the hills may intimidate riders, and the additional assistance would make this form of transportation possible for a greater number of people during most of the year.

Efficiency and Conservation

Energy Conservation is the wise use or management of energy. Energy Efficiency refers to achieving the same desired goal, such as powering a building, while reducing the energy inputs. The goal of energy conservation is a reduction in the amount of total energy consumed. Energy savings are often achieved by substituting technologically more advanced equipment to produce the same level of end-use services. Energy efficiency measures are one means to this end. Another may simply be to use less through behavioral changes, for example, by walking instead of driving. Overall energy efficiency may be achieved by a combination of conservation and efficiency improvements.

Creating local requirements that exceed the State Energy Code is one approach worth considering in Berlin. This would require setting the standard for new structures in Berlin higher than that required by the code, and as a result getting units that are cheaper for the users to operate annually for no additional construction cost.

Energy and Planning

State statutes outline the purpose of planning and land use regulations. Pertinent sections which relate to environment and energy include the following sections:

> *RSA 672:1 III*
> "Proper regulations enhance the public health, safety and general welfare and encourage the appropriate and wise use of land;"
>
> *RSA 672:1 III-a*
> "Proper regulations encourage energy efficient patterns of development, the use of solar energy, including adequate access to direct sunlight for solar energy uses, and the use of other renewables forms of energy, and energy conservation. Therefore, zoning ordinances should not unreasonably limit installation of solar, wind, or other renewable energy systems or the building of structures that facilitate the collection of renewable energy, except where necessary to protect the public health, safety, and welfare."

Reducing energy consumption is not a new concept in the planning world. Smart growth has become a buzzword and has many components which address energy conservation measures. Ideas such as mixed use development and compact village centers helps to reduce energy by reducing transportation between shopping areas and the distance between these shopping areas and where residents live. Similarly, alternative transportation reduces vehicular traffic and subsequently carbon dioxide emissions. What is newer to community planning is the regulation of resources used to construct buildings and upgrading municipal systems to more efficient models.

Providing a framework for decision making at the municipal level is extremely important to ensure that the City works toward more sustainable solutions. One strategy being used to accomplish this is to establish four guiding objectives commonly referred to as the "Natural Steps" Process.

1) Reduce dependence upon fossil fuels, extracted underground metals and minerals.
2) Reduce dependence on chemicals and other manufactured substances that can accumulate in Nature.
3) Reduce dependence on activities that harm life-sustaining ecosystems.
4) Meet present and future human needs fairly and efficiently.

These four objectives tackle the reduction of environmental pollutants, the desire for alternative means of transportation, and develop areas of the community using smart growth principles. If these objectives are incorporated into a municipality's daily operations, along with a commitment to training from staff and board members annually, it would reduce energy consumption for the community. Zoning ordinances and planning

regulations are then tools that the City can use to implement actions by the community to develop in a less energy intensive manner.

Transmission Issues

In 2007 the State of New Hampshire determined that existing transmission infrastructure, particularly in the northern part of the state, will need to be upgraded, or replaced, or new transmission facilities will need to be built. The passage of House Bill 873 in 2007, establishing minimum renewable portfolio standards for electric generation, will create additional interest in the development of new generation facilities utilizing renewables. New Hampshire's transmission system is an integrated part of the interconnected New England transmission network, and this highly complex electrical equivalent of our "interstate highway system" allows for the efficient and reliable transport of electric energy from the generation sources to the millions of customer locations in the region.

The load carrying ability of the Coos County loop varies based on system conditions, but is generally about equal to the load in the area. PSNH has stated that the existing transmission system in the area is adequate to support the existing load and expected load growth for many years. According to PSNH, the Coos County loop could support approximately 100 MW of new generation in the area without significant transmission upgrades, but the reality is that this may not be enough. There are several proposed generation facilities in the North Country in the queue for permission to connect to the transmission grid, and several of them are 100 MW or greater in size.

According to the New Hampshire Public Utilities Commission, attempting to determine the cost of new or upgraded transmission without performing a complete, detailed engineering analysis, is not only difficult but provides results which are rough estimates at best. When the amount of new generation precipitating the need for the new or upgraded transmission is unknown, as is the case in northern New Hampshire, the process is even more involved and less accurate. To interconnect substantial additional renewable generation resources into this transmission system or to interconnect these resources to remote higher capacity transmission substations will require upgrades to existing facilities, or the construction of new transmission lines. Once specific generation projects are proposed with detailed resource information, system impact studies will need to be performed in accordance with planning procedures established by ISO-NE (the regional electric transmission management entity)..

The Coos County loop is currently loaded to near its limit to allow the reliable transfer of electric power. To transfer additional power over these lines, equipment must be replaced or upgraded, although it is possible that up to 60 MW of generation could be accommodated under existing conditions. The least expensive upgrades would cost approximately $10 million dollars and would allow 100 MWs (or an additional 40 MWs) to be interconnected to the transmission loop. Interconnecting new generation in excess of 100 MWs to the loop, will require more costly upgrades to the transmission system. These costs could change significantly based on the exact location and characteristics of

the new generation resources. The timing and escalation in material prices, siting requirements, and additional costs of electrical equipment required to maintain system stability and voltage.

To accommodate 400 – 500 MW of additional generation resources interconnected any where into the loop would require rebuilding approximately 73 miles of transmission lines (plus substation upgrades) between Whitefield, Lost Nation (Groveton), Berlin and back to Whitefield. The estimated cost of these upgrades is approximately $210 Million.

New Hampshire took the first step in the process of informed decision making when it identified the need to upgrade the electric transmission system in northern New Hampshire in order to accommodate the construction of the sizable wind and biomass generating facilities. These facilities will be critical to achieving the benefits of the establishing minimum renewable standards for energy portfolios, and accomplishing the Governor's "25 x 25" goal for renewable generation. More work needs to be done to develop specific alternatives and to produce some consensus around an approach that accommodates sometimes competing concerns.

Berlin Action Plan

Berlin is uniquely positioned to be a model for how a municipality can move toward energy independence and attract economic growth. A combination of reducing demand through conservation and development of site and municipal-scale energy production facilities could put the city on the map. There are currently significant opportunities to leverage public and private financing. All we need is a clear vision that is embraced by elected officials and community residents and the ability to coordinate.

- $20M HUD funds to address NH home forclosures, including energy modifications prior to re-sale.
- Private sector energy entrepreneurs corrently seeking permits for community scale/cogen system also interested in district heating.
- WMCC in early stages of developing green tehnology program to train workers in green building science and renewable energy technology
- Biomass Energy Resource Center has done a preliminary assessment of municipal and building scale biomass systems, indicating significant opportunity in Berlin.

There is no simple answer towards stabilizing energy issues and their environmental impacts. The answer for Berlin is implementing a combination of available solutions. Through these the community can play a direct role in reducing its energy use and the impacts on the environment. Chiefly, Berlin can encourage different scales of renewable energy generation, improving energy efficiency in the built environment, and continue to promote smart growth principles that concentrate development in the downtown. These efforts will improve the efficiency of the community and minimize the potential impacts on the environment.

Specific initiatives for the City to pursue include:

- Establish an "energy manager" position to:
    - Assess opportunities for reducing demand – public and private sector. (Audit)
    - Identify and capture private and sector funding for energy efficiency measures (housing ,private and public buildings)
    - Work with energy entrepreneurs to develop and build *appropriate scale* energy production facilities (wind, biomass)
    - Work with other city agencies to assess, plan and implement district heading system.
    - Assess the potential for *community owned* systems
- Forming a Local Energy Committee and adopting an energy action plan to reduce energy consumption in Berlin.
- Leading by example and requiring new municipal buildings be built to green building standards, such as US Green Building Council Leadership in Energy and Environmental Design (LEED).
- Adopting ordinances that improve energy efficient private development including green building design and small wind energy systems.
- Adopting property tax exemptions for all three residential renewable energy systems, permitted under RSA 72:61-72. Berlin currently allows exemptions for solar, but not for wind or wood fueled systems.

Efforts should also be made to promote efficiency and conservation as priorities. These measures are much more economical than the cost of creating new generating capacity, and will ensure that future fuel sources will go much further to heat and power the city. Specific efficiency and conservation initiatives for Berlin to pursue include:

- Residents, businesses and the City should adopt energy conservation and efficiency measures. This could include creating local energy requirements that exceed the State Energy Code.
- Promoting voluntary efforts to insulate units and reduce the demand for heat and electricity.

Many opportunities exist in Berlin to create distributed forms of renewable energy, and to create jobs locally as this is accomplished. This will take cooperation from all sectors, but will lead to a much more sustainable situation for the future. To accomplish this the City should reduce barriers to, and promote the development of, appropriate thermal and electric renewable energy sources. Because of Berlin's dense Downtown and redevelopment opportunities the City should also encourage district heating opportunities where feasible.

Berlin does not need to tackle all of this alone. As a large community in a very rural region it is important that the City find ways to encourage the surrounding communities to also be engaged. In order to do that Berlin should explore the possibility of aggregating municipalities in the area together into a single energy performance contract with an Energy Service Company. This may provide some economy of scale for all involved, result in the identification of facilities that could be shared, and lead to operation and maintenance savings.

Accomplishing all of this will require outreach to property owners, leading by example with municipal structures and decision making, and establishing a range of renewable energy facilities. All of this combined could put Berlin on the map as a City committed to energy conservation and the production of renewable energy, and could mobilize the entire region.

Land Use Implications and Potential Actions

Below are the critical items related to energy in Berlin, and an array of possible actions the City may want to consider pursuing. This section will be used to identify the specific actions for Berlin to take upon completion of the master plan.

Land Use Implications	Potential Actions
Municipal Efforts Berlin must lead by example to show residents and businesses how they can conserve energy, reduce their impact on climate change, and reduce their dependence on fossil fuel energy. It is also important for Berlin to ensure that municipal projects reflect the life cycle costs of the building, and not just the initial capital costs of construction.	• **Form a Local Energy Committee and adopt an energy action plan** to reduce energy consumption in Berlin. • **Conduct a greenhouse gas inventory** to develop some baseline data specific to Berlin. • **Research and develop property tax exemptions for all three residential renewable energy systems**, permitted under RSA 72:61-72. Berlin currently allows exemptions for solar, but not for wind or wood fueled systems. • **Identify ways to reduce emissions within Berlin**, and to reduce the City's contribution to global warming and the related climate change.
Efficiency and Conservation Efforts must be made to promote efficiency and conservation as priorities over the creation of new fuel sources. These measures are much more economical, and will ensure that future fuel sources will go much further to heat and power the city.	• **Promote voluntary efforts** to insulate units and reduce the demand for heat and electricity.

Renewable and Local Sources

Many opportunities exist in Berlin to create distributed forms of renewable energy, and to create jobs locally as this is accomplished. This will take cooperation from all sectors, but will lead to a much more sustainable situation for the future.

Regional Efforts

Berlin does not need to tackle all of this alone. As a large community in a very rural region it is important that the City find ways to encourage the surrounding communities to be engaged.

• Because of Berlin's dense Downtown and redevelopment opportunities the City should **encourage district heating and/or commercial opportunities where feasible.**

• **Support the creation of a regional farmers' market** in the Downtown.