FINAL: Chittenden County Energy Consumption and Production Analysis Report

On January 25, 2012 the Steering Committee accepted these Analysis Reports with the understanding that that as a part of the final ECOS product they remain open for amendment until the whole product is finalized.

1/25/2012

An ECOS Analysis Report

An Analysis of Energy Production and Use in Chittenden County and Discussion of Policies and Programs Relevant to Regional Energy Planning.

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ENVIRONMENT | COMMUNITY | OPPORTUNITY | SUSTAINABILITY
A SUSTAINABLE FUTURE FOR CHITTENDEN COUNTY

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ECOS Project Introduction and Goals

The ECOS Project Steering Committee is a broadly-based 60+ member partnership committed to implementing strategies to improve Chittenden County's long-term sustainability: economically, environmentally and socially. The Steering Committee has committed to a five-phase project:

1. Adopt common goal statements;
2. Analyze reports regarding economic development, housing, energy, land use and transportation, natural resources and health/human services/education;
3. Develop indicators tied to the goal statements;
4. Prioritize implementation actions for the next five, ten and twenty years;
5. Invest in high priority implementation actions.

ECOS Energy Advisory Team Composition and Goals

Through the ECOS working group, an open invitation to join the Energy Advisory Team was released. The team was composed of the following entities:

- Burlington Electric Department
- Chittenden County Regional Planning Commission
- Green Mountain Power
- Vermont Electric Cooperative
- Vermont Fuel Dealers Association
- Vermont Gas

The content of this report was developed by VEIC in collaboration with the ECOS steering committees and provides background information on past and current energy use in order to understand current trends and provide context and data for the development of goals and indicators and aims to provide supporting documentation that can be used to pursue the following ideas:

- Reduce energy consumption through energy conservation and efficiency.
- Encourage the generation and use of renewable energy sources
- Support reliable transmission, and distribution infrastructure in Chittenden County.
- Reduce transportation costs and pollution

The objectives set by the ECOS Energy Advisory Team as a guide to its efforts and research toward the accomplishment of the above goals were to compile available information into a format that regional and town planners and administrators can use to consider the energy impact of their planning and decision-making.

Introduction

All Vermonters depend on energy to carry out their work and conduct their lives. As a northern New England state with cold winters, warm summers, and a rural and semi-rural landscape in many locations, the state's residents need space heat in the winter, cooling in the summer, and electricity and transportation fuels year round. As such, a significant proportion of the income of many Vermont households goes to paying energy bills, and energy is a significant expense for businesses, industries, and government as well.

The importance of reliable and affordable energy to the economic well-being of Chittenden County cannot be underestimated. In times of economic downturn, this becomes even more important as low income households and those living on fixed incomes find themselves making difficult choices among food, housing, the electric bill, heating, transportation, and medical care.

Vermont citizens, businesses, and industries spent over $2.5 billion on energy in 2009.[1] Much of this money leaves the state immediately (and in many cases the country). This outflow of energy dollars serves as a drain on the state and Chittenden County's economy.

Total energy consumption in Vermont can be divided among residential, commercial, industrial, and transportation sectors **Figure 1**,[2] Within the residential, commercial and industrial sectors, the energy consumption can be further divided between electricity consumption and predominately thermal needs; this topic is discussed in detail in the section on energy end-use. For this report, in some cases we apply the statewide sector split to Chittenden County due to lack of better available data. As energy consumption is an important issue across sectors and increasingly there are interactive effects among sectors, a sustainability plan needs to address each category.

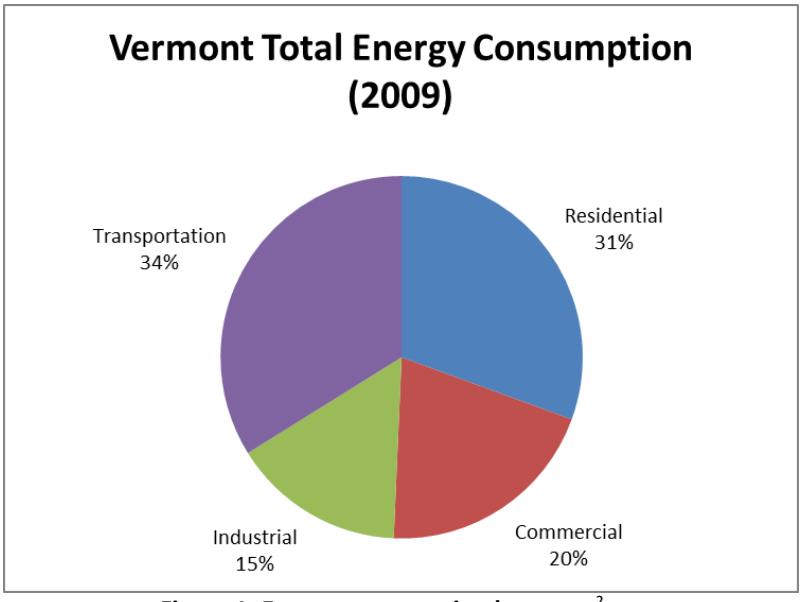

Figure 1: Energy consumption by sector[2]

[1] Energy Information Administration, State Energy Data System, Table ET 1 Total End-Use Energy Price and Expenditure Estimates, 1970-2009, Vermont, http://205.254.135.24/state/seds/sep_prices/total/pdf/pr_VT.pdf

[2] EIA SEDS State Energy Data System, Released: June 30, 2011, http://www.eia.gov/state/seds/seds-states.cfm?q_state_a=VT&q_state=Vermont#undefined

Highlights of Vermont energy consumption, energy efficiency, and transportation include the following snap shots and trends:

- Total energy consumption in Vermont is the lowest of any state in the Nation[3]
- Vermont has a long history of energy efficiency programs dating back to 1990 which have provided significant energy savings and economic benefits to the state.
- In 2011, Vermont was ranked by ACEEE fifth in the nation with respect to policies on energy efficiency, building energy codes, transportation, combined heat and power, appliances and state and government initiatives[4]. It ranks first in electric energy efficiency.
- Trends in energy consumption in Chittenden County show an overall increase in total energy usage in parallel to the population growth the county has been experiencing.
- Trends vary by fuel type and sector (residential, commercial and industrial, and transportation). For example, Chittenden county electricity use has decreased and natural gas use has increased.
- The per household or per employee energy consumption for several fuel types has shown a decline over the last 20 years, consistent with improvement in efficiency and more stringent standards.
- Chittenden County has many renewable energy production sites owned by utilities, private parties and municipalities
- There are several guidebooks and resources available to municipal planners to assist them in developing energy plans for their municipalities and to help them mobilize their communities to form local energy committees

Energy Data and Sources

This report provides a first step to develop an energy baseline for the region by 1) presenting an overview of energy trends over the past two decades, 2) describing Chittenden County current energy consumption, and 3) discussing energy supply and energy mix in the county.

This study did not involve any primary data collection and relied on sources of data that are already available either through publicly accessible data websites or through direct requests to organizations that do not publicly provide the specific data on an ongoing basis. Table 1 summarizes the sources of data used for the analysis section of this report and the type of data available through each organization. For municipal and regional planning purposes, data at the county or local level would be the most useful, but is often unavailable. In those instances the best data available was used to characterize Chittenden County. In some cases Vermont or national trends were adjusted using standard assumptions relating to the proportion of households and employees in the County and in the state as a whole.

[3] http://www.eia.gov/state/state-energy-profiles.cfm?sid=vt
[4] http://www.aceee.org/sector/state-policy/scorecard

Table 1: Overview of Available Data

	Type of data	Census region	State	County	City/ Town
U.S. Energy Information Administration	State Energy data system • Consumption by all fuel sources • End-use consumption by sector • Electric power sector fuel consumption		X		
	Energy consumption by end use for residential (RECS), commercial (CBECS) and manufacturing (MECS)	X			
U.S. Census Bureau	Population data	X	X	X	X
	Housing characteristics	X	X	X	X
	Business characteristics	X	X	X	
Woods and Poole[5]	Employee data			X	
	Population			X	
	Households			X	
Vermont Electric Utilities and Efficiency Vermont	Electric consumption and savings		X	X	X
Vermont Gas Utility	Gas consumption and savings		X	X	X
Vermont Energy Atlas	Renewable energy types, locations, and capacity		X	X	X
Transportation	Vehicle Mile Traveled by sector, Commercial trips by sector, Vehicle Fuel Efficiency	X	X	X	X
Efficiency Vermont	Energy savings data		X	X	X

[5] Data provided to CCRPC by Woods & Poole (http://www.woodsandpoole.com/) in 2010

Energy Trends in Chittenden County

Chittenden County Characterization

Chittenden County is composed of 19 municipalities (including one gore). Towns vary greatly in economic development and other characteristics, ranging from rural (e.g. Bolton), to urban (Burlington). Population density and employment are concentrated around Burlington. This diversity of town characteristics warrants an analysis of energy consumption at the Town level. Trend data are not available at the town level. An analysis of end-use consumption at the Town level was attempted, using relevant assumptions as required (Town level data is provided in an Excel file in Appendix B). Housing type varies greatly regionally as well, with a greater concentration of multifamily housing near Burlington (see ECOS report on housing for details). Business types vary greatly throughout the county, from a family- owned bakery, to the IBM facility in Essex Junction. Due to the wide variety of business types existing in the county, and the confidentiality of energy consumption data at the facility level, the commercial and industrial energy analysis was performed on a per employee basis, rather than a per business basis.

The population and number of jobs in Chittenden County has been steadily increasing since 1969 and could continue growing as predicted by some estimates (Figure 2, red line shows the beginning of forecasting).[6] Development trends vary by region (e.g., town center, suburban, rural, etc.) and the ECOS Historic Development and Future Land Use/Transportation Analysis report delves into this subject; therefore population and job forecasting will not be discussed in depth here.

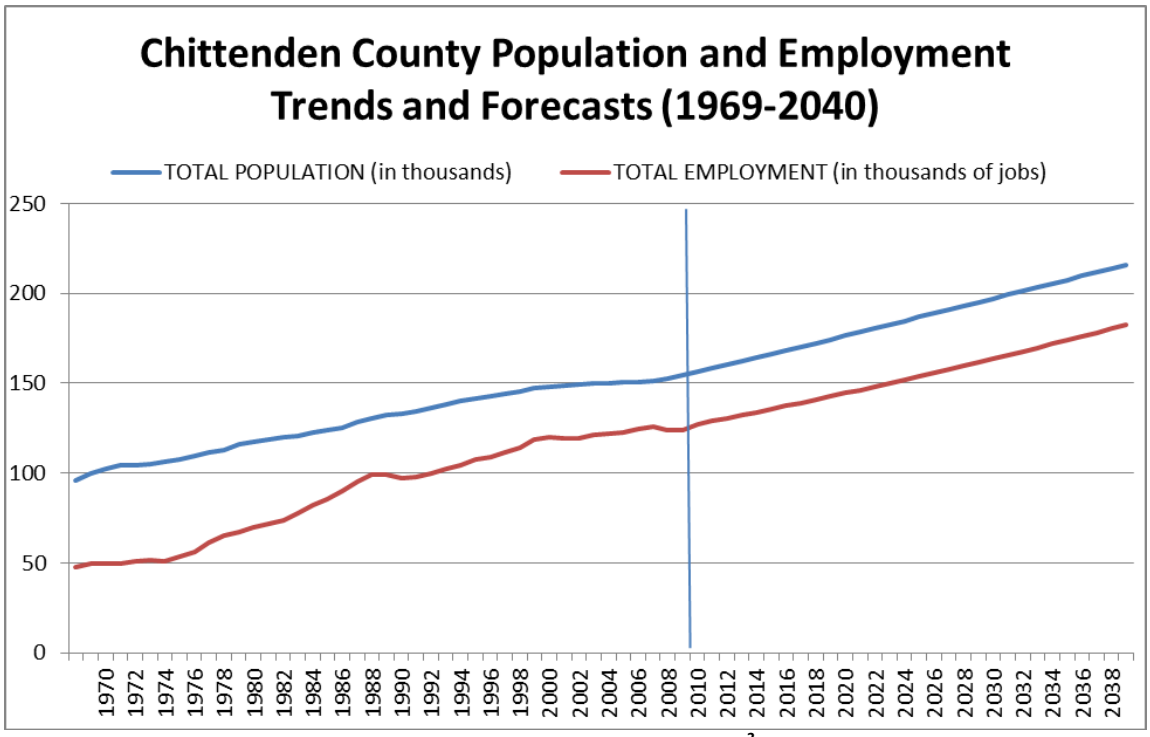

Figure 2: Chittenden County Population Trend[3]

[6] Data provided to CCRPC by Woods & Poole (http://www.woodsandpoole.com/) in 2010

This section focuses primarily on energy trends and uses population and jobs numbers when evaluating the per-household or per-employee energy consumption trends.

Trends data limitations and discussion: we were not able to identify a source of unregulated fuels data at the County and Town level as consumption trends by fuel type were not readily available for Chittenden County. We are presenting Vermont trends that have been scaled down by a ratio (25%, or the proportion of Chittenden County households of the total Vermont households). This ratio is not always ideal, as Chittenden County's proportion of natural gas availability for example is closer to 50%, and the number of accounts has increased over the years. Because Chittenden County households use more natural gas than elsewhere in the state, the ratio for other fuels appears greater than it should be. Therefore trends presented here should be considered at a high level rather than considering the exact values. Similarly, the trends for the C&I sector are scaled using the proportion of employees (33%) in Chittenden County compared to the rest of the State. Trends at the state level were obtained from EIA state profile 1990-2009.

Short term trends for electricity are specific to Chittenden County, but longer trends were extrapolated from the state level as described above. Vermont Gas trends data for Chittenden County by Town was not available at the time of this writing, so again statewide data was used.

Residential Trends

Natural Gas

Population growth in Chittenden County has resulted in an overall increase in residential (non-transportation) consumption of many fuels, including natural gas (Figure 3). Natural gas efficiency programs have mitigated some of this increase. Nevertheless, the per-household natural gas consumption has slightly increased since 1990 (Figure 4), some of this increase is likely to result from the use of statewide data extrapolated to Chittenden County assuming the number of natural gas customers increased at the same rate as population trends, and this is likely not to be the case (see Trends data limitations and). Natural gas may be used for heating or for appliances such as gas stoves, water heating, and gas dryers. Per-household consumption was calculated using state-level consumption data, adjusted to Chittenden County. A possible explanation of increased per-household consumption could be fuel-switching and increased popularity of hot water and cooking appliances fueled by natural gas as opposed to an increase per capita or decrease in efficiency. Natural gas can also be used to fuel vehicles, although this is not currently wide spread.

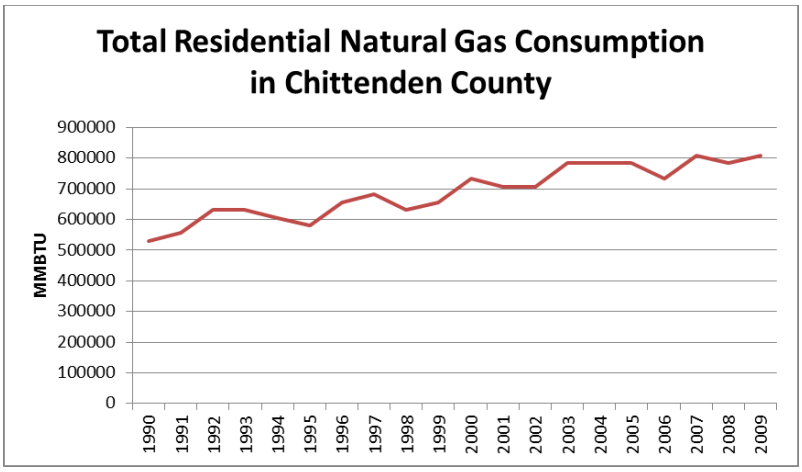

Figure 3: Residential Total Natural Gas Consumption in Chittenden County [7]

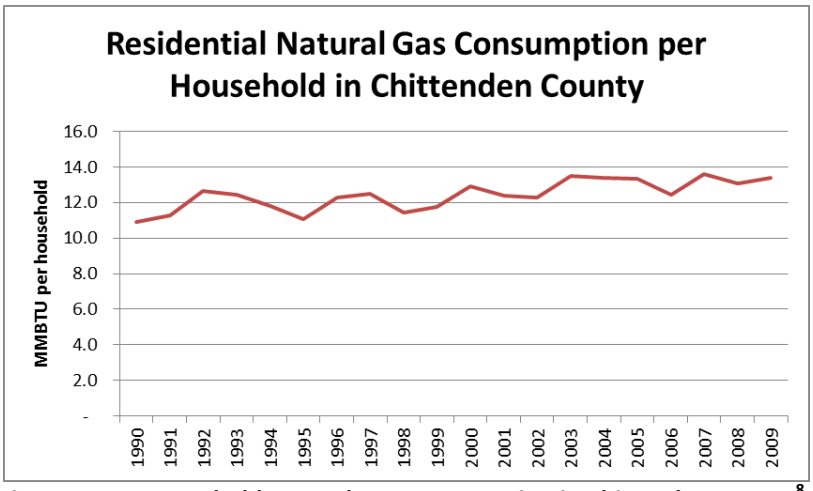

Figure 4: Per Household Natural Gas Consumption in Chittenden County[8]

Petroleum Fuels

The residential (non-transportation) consumption of petroleum fuels in Chittenden County has remained stable over the last two decades (Figure 5), which means, considering the County has experienced population growth, the per household consumption of non-transportation petroleum fuels has declined (Figure 6). Trends vary by petroleum fuel type, with distillate fuel oil showing the greatest decline, propane (or liquefied petroleum gas, LPG) showing a very slight increase in per household consumption and kerosene showing no clear trend. Kerosene is a minor component of the petroleum fuel use in Chittenden County and will not be discussed in great depth in this report. Oil is used essentially for home and water heating, whereas LPG may also be used for other appliances such as gas stoves and gas dryers. Declining trends could be a result of increased efficiency and fuel switching.

[7] http://www.eia.gov/state/seds/seds-states.cfm?q_state_a=VT&q_state=Vermont
[8] http://www.eia.gov/state/seds/seds-states.cfm?q_state_a=VT&q_state=Vermont

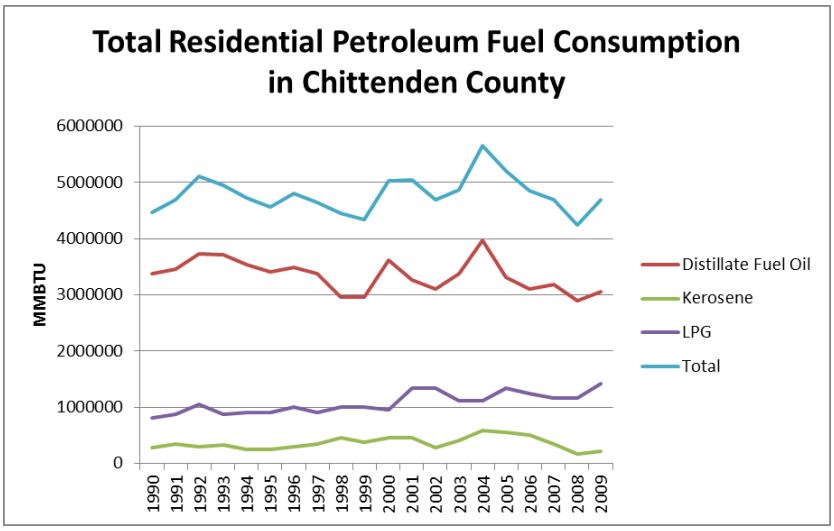

Figure 5: Residential Non-transportation Petroleum Fuels Consumption in Chittenden County[9]

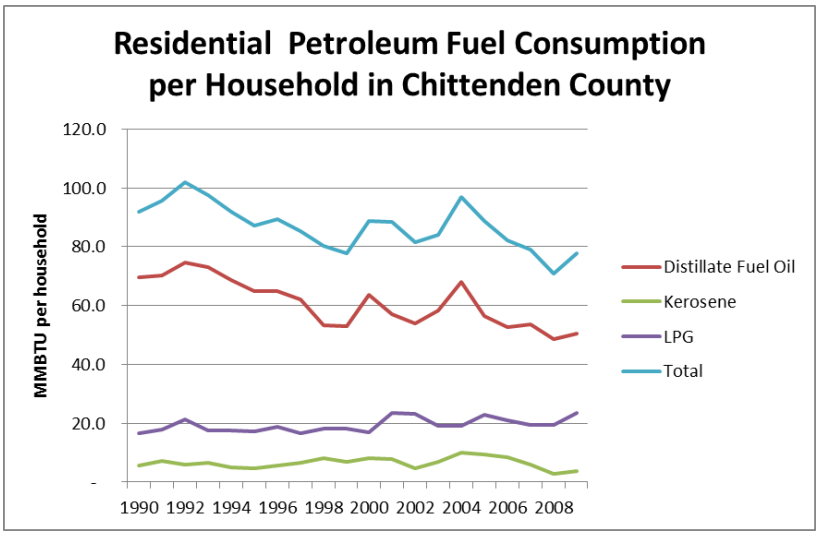

Figure 6: Per Household Non-transportation Petroleum Fuels Consumption in Chittenden County[10]

Wood

Residential consumption of wood for heating shows an overall increase of both total county level consumption and per household consumption (Figure 7 and Figure 8). The trends vary sharply from decade to decade, with a lower consumption in 1997-2004. The high variability in wood consumption may be explained by the prevalence of wood stoves as secondary heat sources. Because households can chose to use more or less wood depending on their primary fuel price, on weather, and on the availability and price of cord wood and other fuels, trends are less consistent than for other fuels (such as oil for example). In recent years, the increased popularity of cord wood stoves, pellet stoves, and

[9] Ibid.
[10] Ibid.

boilers, as well as higher petroleum fuel prices may all explain the overall upward trend in residential wood consumption.

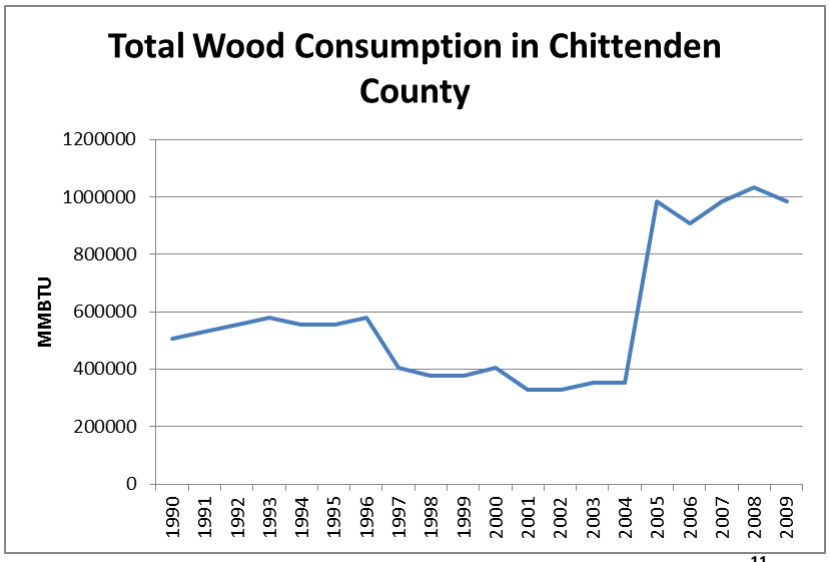

Figure 7: Residential Wood Consumption in Chittenden County[11]

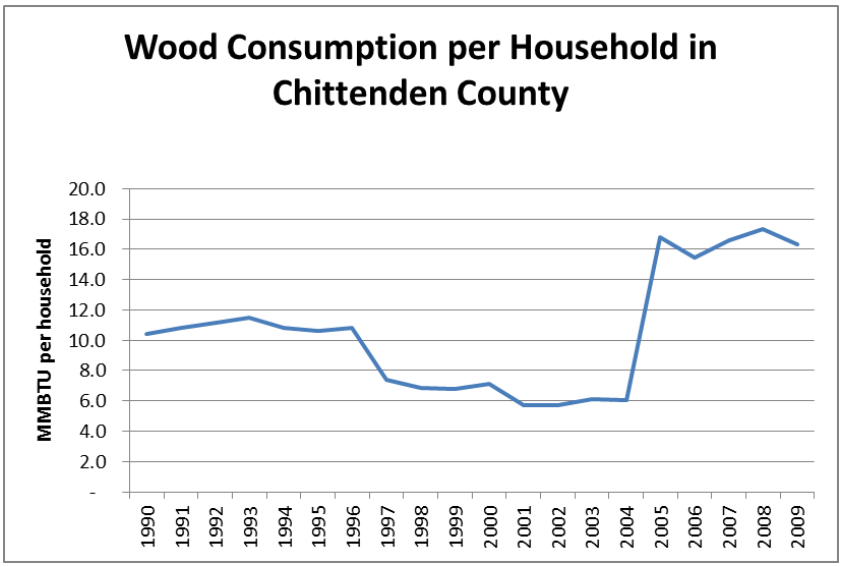

Figure 8: Per Household Wood Consumption in Chittenden County[12]

Electricity

Residential electricity use in Chittenden County increases (Figure 9) along with the increase in population growth, however per household consumption is decreasing (Figure 10), due to successful efficiency improvements (federal standards and energy efficiency programs) and increased awareness of

[11] Ibid.
[12] Ibid.

the economic and environmental costs associated with energy consumption. As discussed further in a following section (Consumption by End-Use), the use of electricity for heat is very low. Electricity is used in Chittenden County homes primarily for lighting, appliances (kitchen and laundry), water heating, and for an increasingly large plug-load (electronics, home computers, televisions, portable devices charging devices, etc.). Pool and spa pumps and pool heaters also require a lot of electricity, and forecasts of pool ownership as well as electronics and appliances would be helpful in predicting energy use for the future. Electricity also can be used to power vehicles either "plug-in hybrids" or electric vehicles but is not yet wide spread in Chittenden County (further discussed below).

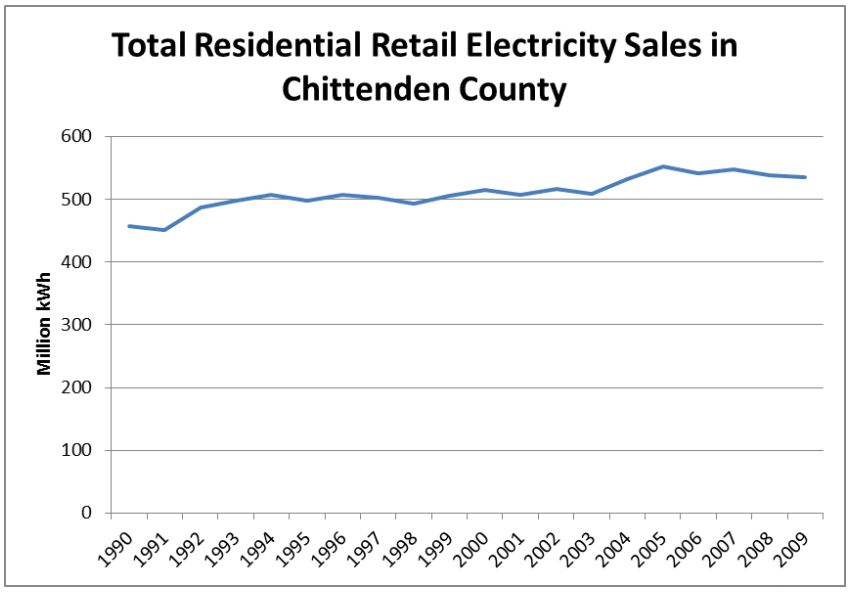

Figure 9: Total Residential Electricity Sales in Chittenden County[13]

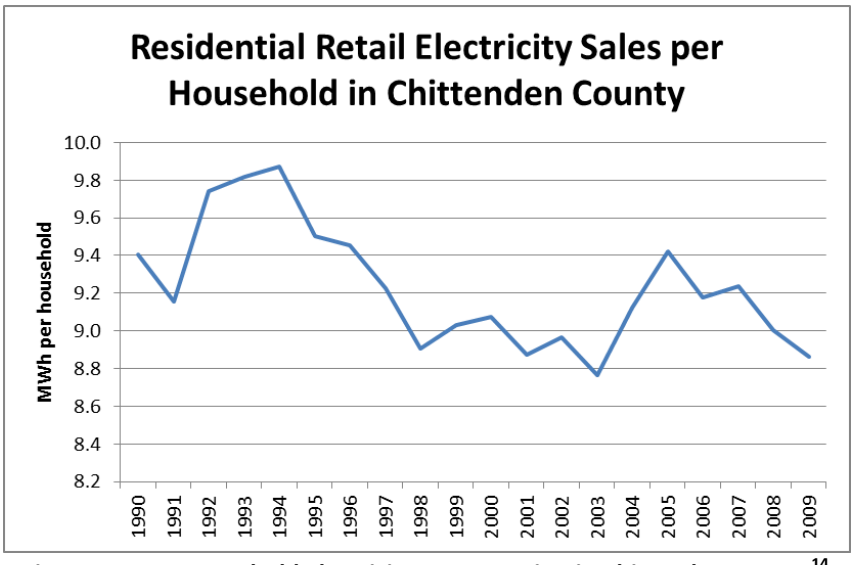

Figure 10: Per Household Electricity Consumption in Chittenden County[14]

[13] Ibid.

Commercial and Industrial Trends

Natural Gas

The number of employees in Chittenden County has increased over the last two decades, along with growth in population and businesses. Similar to residential natural gas consumption, commercial and industrial gas consumption is increasing, but per employee consumption remains relatively stable. The per-employee trend could reflect the fact that businesses are very aware of the cost of energy and are taking measures to limit their consumption. Natural gas is used for heating, hot water, cooking and industrial processes in commercial and industrial facilities. It is also used for transportation; for example UVM buses and Casella Waste Management trash haulers run on compressed natural gas.

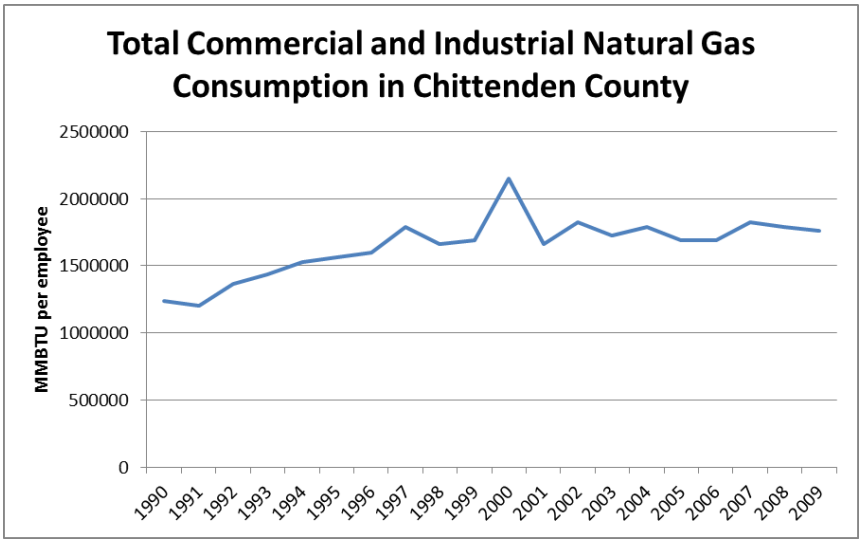

Figure 11: Commercial and Industrial Natural Gas Consumption in Chittenden County[15]

[14] Ibid.
[15] Ibid.

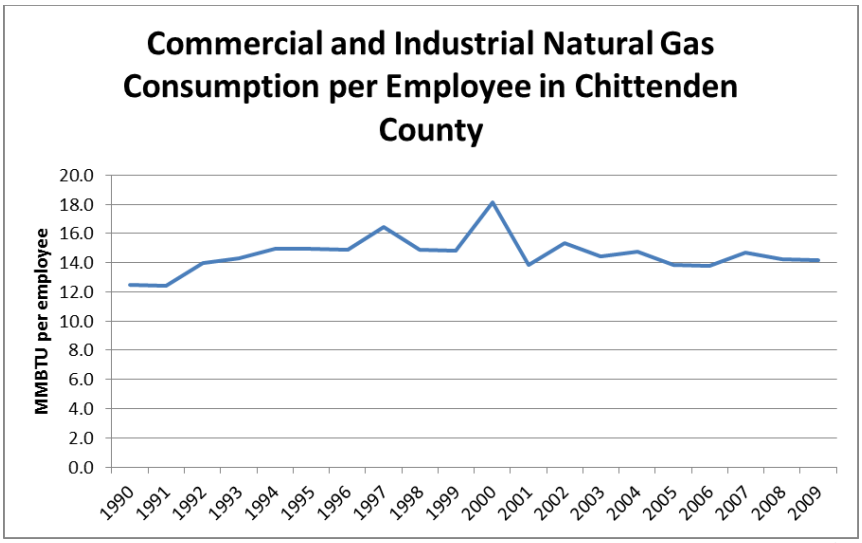

Figure 12: Per Employee Natural Gas Consumption in Chittenden County[16]

Petroleum Fuels

Commercial and Industrial non-transportation petroleum fuel consumption has increased and decreased irregularly until 2005 and appears to be showing a leveling or declining trend since 2005, although the future will tell if this is a short-term trend due to the recession or a longer-term trend. Liquefied Petroleum Gas shows a slight increasing consumption trend and residual fuel oil a decreasing trend. Per employee consumption decreases for petroleum fuels in general, and for distillate fuel oil; trends for other fuels are unclear. Petroleum fuels are used for heating, hot water, cooking and industrial processes.

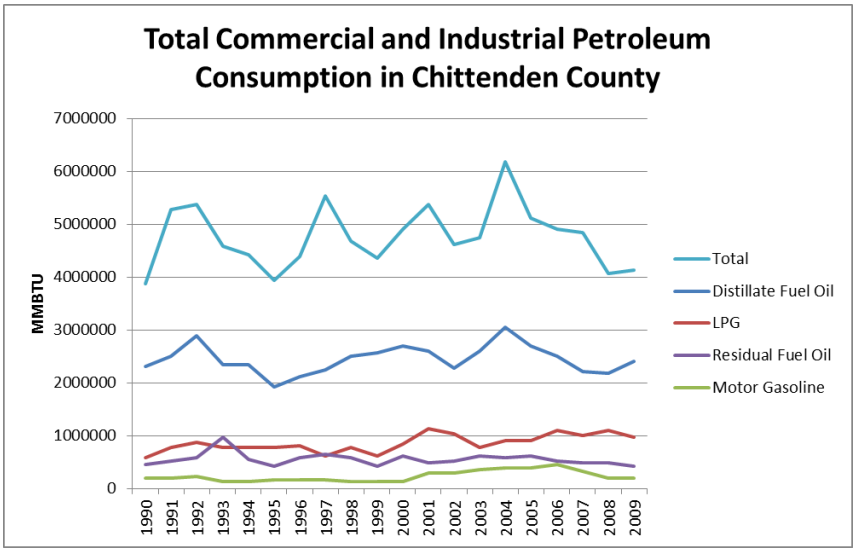

Figure 13: Commercial and Industrial petroleum Fuels Consumption in Chittenden County[17]

[16] Ibid.
[17] Ibid.

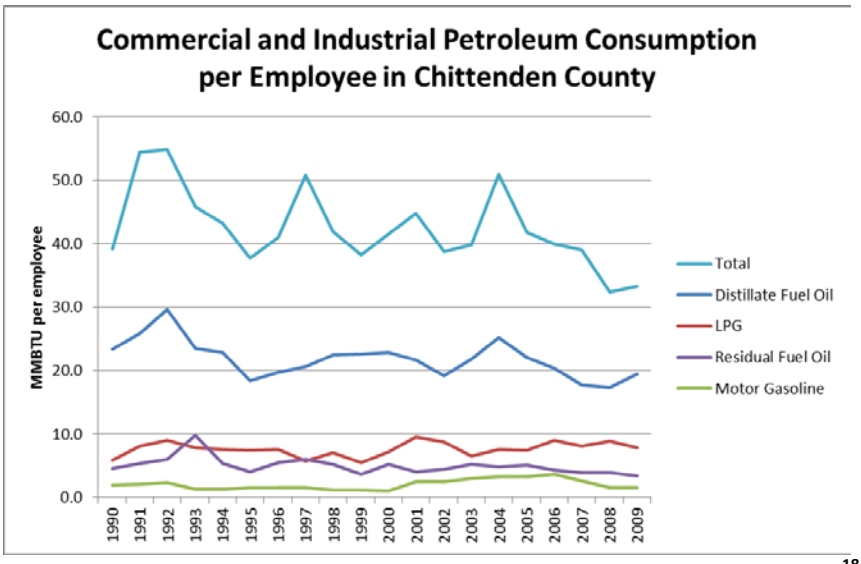

Figure 14: Per Employee Petroleum Fuels Consumption in Chittenden County[18]

Wood and Wood Waste

Trends in commercial and industrial wood waste consumption seem to indicate an overall decline in consumption, especially per employee consumption. The data includes wood, wood-derived fuels, and biomass waste and prior to 2001, also includes non-biomass waste. Analyzing the trend is difficult because different fuel types (non-biomass waste) included in the data in different years may bias the trend. Nevertheless as for the residential sector, the price of fuels and the price of wood products (other than energy, such as lumber, pulp and paper, etc.) for wood will affect a business's choice to use wood as a fuel.

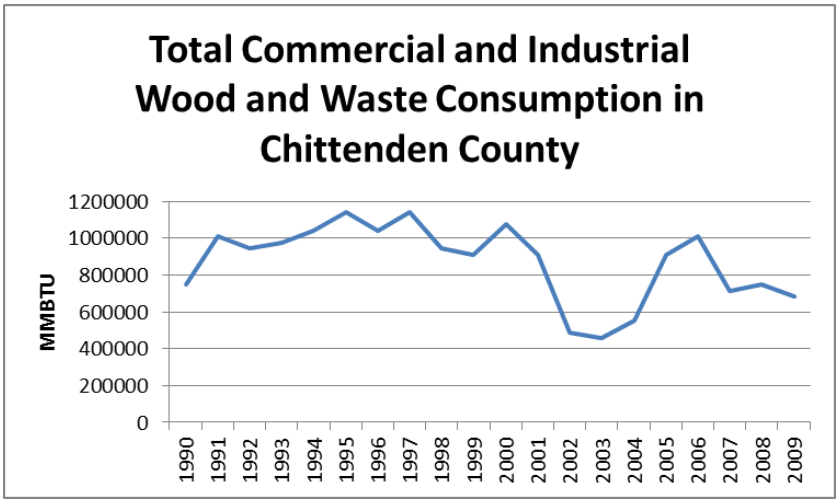

Figure 15: Commercial and Industrial wood and waste consumption in Chittenden County[19]

[18] Ibid.
[19] Ibid.

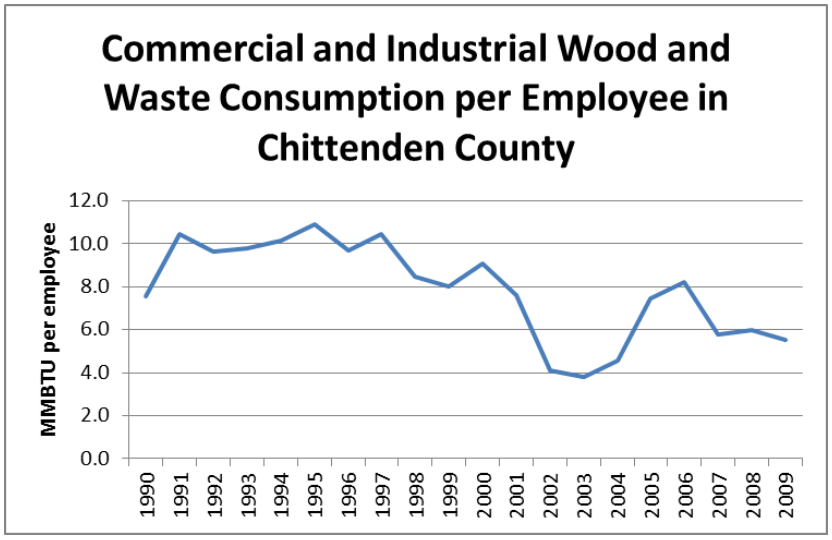

Figure 16: Per employee wood and waste consumption in Chittenden County[20]
(read Trends data limitations and before referencing this data)

Electricity

Commercial and Industrial electricity consumption in Chittenden county overall increased until about 2005, when the consumption leveled and even declined over the last 5 years. The per employee consumption trend is variable but overall shows an increase until the late 90s when the per-employee consumption appeared to level off. Electricity is used for lighting, cooling, heating, domestic hot water and cooking. It can also be used by vehicles for transportation.

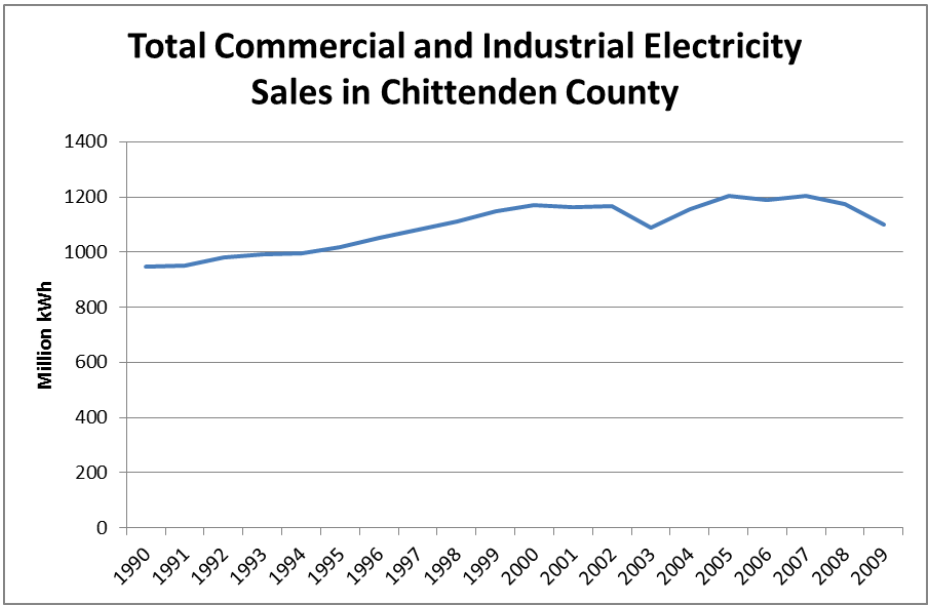

Figure 17: Commercial and Industrial Electricity Sales in Chittenden County[21]

[20] Ibid.
[21] Ibid.

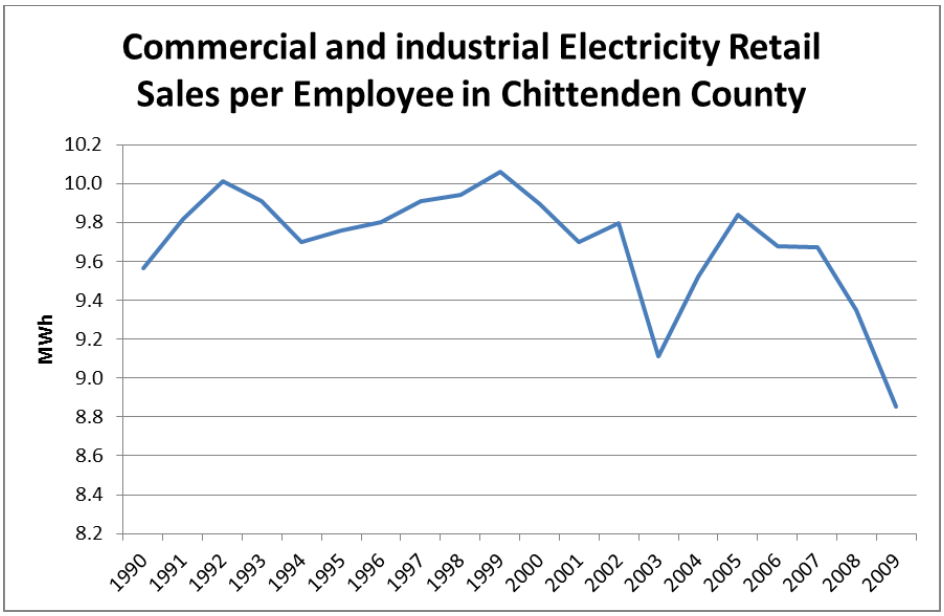

Figure 18: Per Employee Electricity Sales in Chittenden County[22]

Transportation Trends

Along with population growth, gasoline consumption in Chittenden County has increased (Figure 19), as more residents drive to and from work, run errands, and consume more goods, resulting in an increase in merchandise transport. Consumption of fuel ethanol seemed to have picked up in 2005 and has been growing exponentially since (note: starting in 1993, motor gasoline includes ethanol blended in the product). Societal factors affect transportation trends such as land use patterns (e.g. suburban sprawl requires more driving than well-designed and pedestrian-friendly urban centers with all required amenities located within a short distance). Demographics trends also impacts transportation needs (e.g. populations of different ages have different needs due to limited mobility, school-age children, etc.). The energy sector and land-use planning are closely connected on the transportation side.

[22] Ibid.

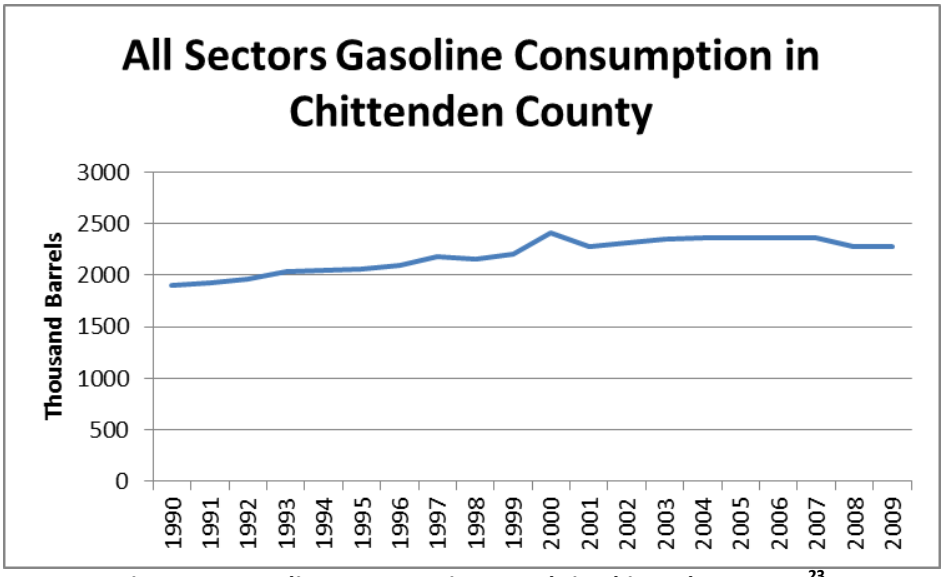

Figure 19: Gasoline Consumption Trends in Chittenden County[23]

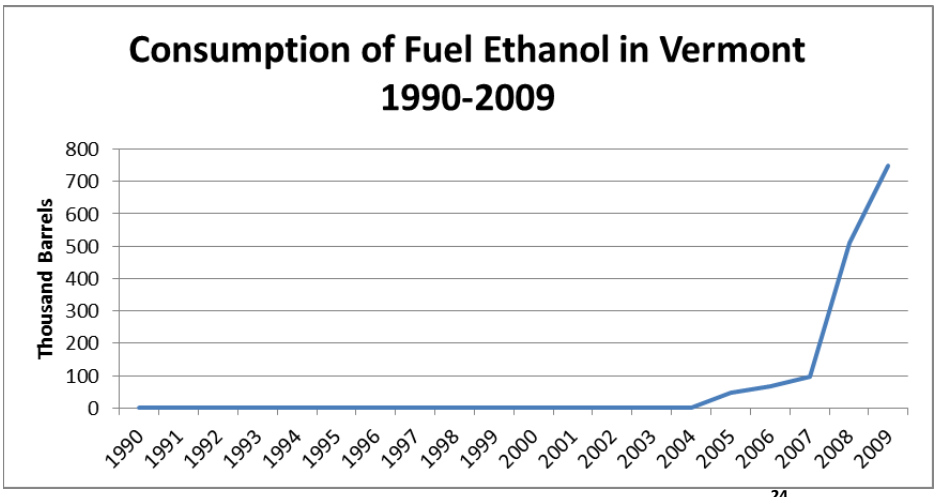

Figure 20: Fuel Ethanol Consumption Trends in Vermont[24]

Trends and Forecasting Conclusion

As illustrated by the trends presented above, forecasting of energy consumption in Chittenden County is extremely complex. Population trends only represent one of the factors affecting trends and forecasts. Others affecting energy consumption include: progress in efficiency and standards, price of fuels, land use, housing type, changes in the mix of business types, weather, health of the economy, popularity of certain products (e.g., wood stoves, consumer electronics), etc. While complex, these forecasts are necessary for the development of a sustainability plan that can establish realistic goals and be evaluated according to indicators grounded in reality. Due to the extrapolation of statewide data to Chittenden

[23] based on EIA statewide trends and assuming that Chittenden County's share of gasoline consumption is proportional to its share of households and employees
[24] Ibid.

County, precise conclusions and comments on the magnitude of the trends is unfortunately not likely to be accurate. Collection of county level data would be necessary going forward to precisely record progress towards any goals established through the ECOS project.

Consumption by End-Use

Understanding how Chittenden County uses energy is a complex undertaking but is important for planning purposes to be able to target efforts to reduce consumption appropriately. Energy consumption can be disaggregated first into sector like transportation (residential and commercial and industrial) and buildings (residential and commercial and industrial). Then with in each sector, the energy use can be assigned to categories like lighting, heating, hot water, appliances, consumer electronics and industrial process for buildings. For transportation, example end-use categories are residential trips from home to various destinations, trips in and out of the county, commercial light, medium and heavy trucking.

In the follow in sections residential, commercial and transportation energy end-use distributions are examined.

Residential

Residential energy consumption can be broken down by fuel type and by end-use. End-use data is usually obtained through customer surveys and Vermont has conducted several surveys particular to the state but they are not extensive enough to produce data at the county or town level. Regional data available through EIA *Residential Energy Consumption Survey (RECS)* and national trends often apply to our region as well and can be used to get a general idea of end-use energy consumption. For example, the following national trend in energy use would apply to some degree to Chittenden County:[25]

> *Over the past three decades, the share of residential electricity used by appliances and electronics in U.S. homes has nearly doubled from 17 percent to 31 percent, growing from 1.77 quadrillion Btu (quads) to 3.25 quads. This rise has occurred while Federal energy efficiency standards were enacted on every major appliance; overall household energy consumption actually decreased from 10.58 quads to 10.55 quads, and energy use per household fell 31 percent. Federal energy efficiency standards have greatly reduced consumption for home heating. Total energy use in all U.S. homes occupied as primary residences decreased slightly from 10.58 quads in 1978 to 10.55 quads in 2005 as reported by the most recent consumption and expenditures data from the Residential Energy Consumption Survey (RECS). A dramatic reduction in the energy needed to heat homes, along with other efficiency improvements, led to a 31 percent reduction in energy use per household. As a result, total residential energy consumption remained virtually the same.*

[25] http://www.eia.gov/consumption/residential/reports/electronics.cfm

The above text is shown another way in these graphs:

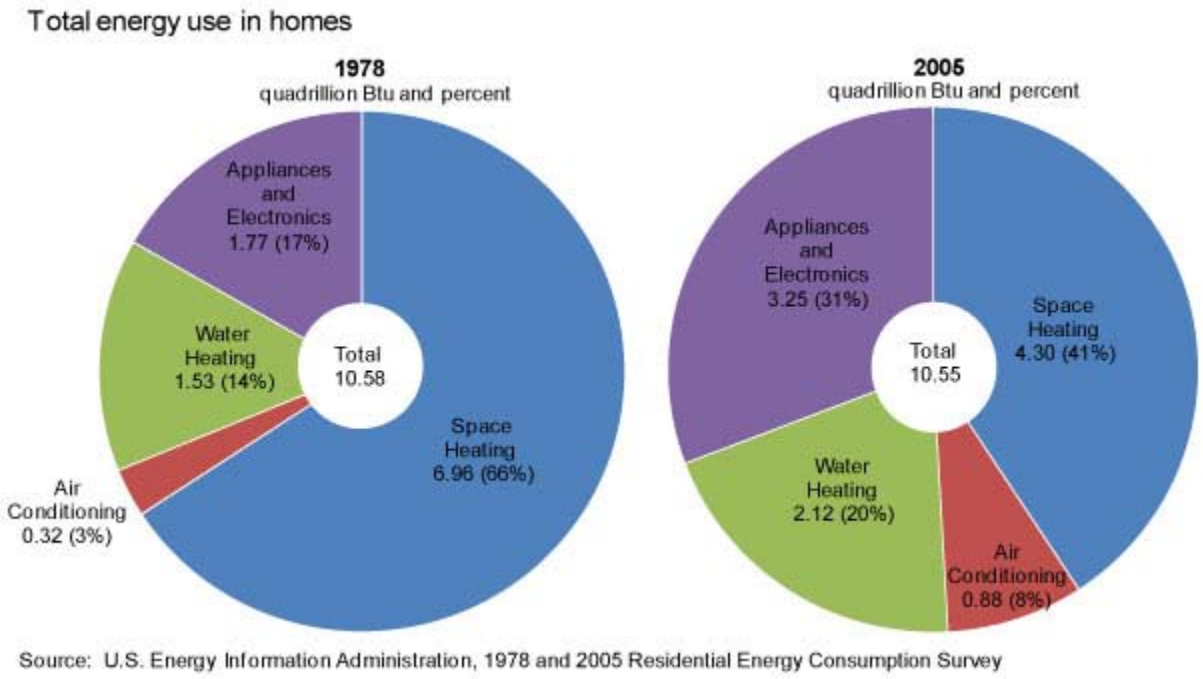

Figure 21: Federal level data on changes in total energy use in homes

Chittenden County Electricity Consumption by End-Use

In a typical Vermont and Chittenden County home, the categories responsible for the largest share of electricity consumption are lighting, appliances, and consumer electronics, which are present in virtually every home. Other end-uses (e.g. pool pumps, electric heat) are not necessarily present in every home but when they are present they can represent a significant load; **Error! Reference source not found.** and Table 2 provide an average for all homes.

In general, consumer electronics are responsible for a larger and larger share of the total plug load. This is due in part to the rise in the number of devices requiring chargers, an increased penetration of personal computers in homes, and changes in technologies used for television. Electricity consumption by electronic devices can be mitigated by unplugging chargers, ensuring that devices are off rather than on standby (addressing what is often referred to as *phantom load*), and selecting energy efficient devices in the first place (e.g. ENERGY STAR labeled). Phantom load can be greatly reduced by using *Smart Strips*, power strips that shut down all devices (e.g. game consoles) connected to a master (e.g. a television) when the master is turned off. The electricity consumed by appliances and lighting can be greatly reduced by selecting energy efficient products (e.g. ENERGY STAR labeled). The energy required to heat or cool a home can be reduced by insulation and air sealing improvements. Energy efficiency programs offered in Chittenden County provide assistance and incentives to take these efficiency steps. It is expected that in the future, electricity consumption by end use will continue to shift as federal standards (e.g. Energy Independence and Security Act of 2007- EISA) are implemented, federal energy

standards continue to improve (e.g. limits on consumer electronics standby consumption to <1 kWh), new technologies emerge, and consumer preferences evolve. As such the end-use analysis provided in this report is a snapshot in time. Currently, electric vehicles represent a very small proportion of the electric load because of low market penetration. If electric vehicles were to become more prevalent in Chittenden County, those vehicles would have to be included in the end-use analysis. The impact of electric vehicles on the electric grid will in part be dependent on when vehicles are re-charged. A large number of electric vehicles plugged in during peak hours would increase the peak demand of electricity and might require the upgrade of the grid to handle the additional peak demand. If cars are charged mostly off-peak, during the night for example, peak demand would not be affected to the same degree, but there would still be in increase in electricity consumption from this new category. The increase in electricity consumption would be mirrored by a reduction in gasoline and diesel consumption. Electric vehicles are also discussed in the Transportation section.

This split among end-uses varies regionally. Penetration rates appropriate for Chittenden County (county, state, or regional data, as available) were used to estimate the electricity consumption by end-use for Chittenden County (summary presented in Table 2). The estimated split of electricity consumption in Chittenden County is overall very similar to what occurs elsewhere in the nation and is dominated by appliances, consumer electronics, and lighting.

Table 2: Electricity consumption by end-use in Chittenden County[26]

Estimated Consumption per End Use in 2009[26]	Total kWh	Percent of Total	Annual kWh per household
Electric Heat/Furnace Fans/Humidifier	43,549,000	10%	688
Cooling/ Dehumidifier	24,216,717	5%	383
Hot Water	31,447,446	7%	497
Lighting	77,777,675	18%	1,229
Kitchen Appliances	84,419,504	19%	1,350
Laundry Appliances	46,344,173	10%	732
Consumer Electronics (TV, Computers, and Accessories incl. rechargeable portable devices)	83,179,062	19%	1,315
Spa/Pool	11,067,114	2%	175
Other	40,022,703	9%	633
Total electricity	443,019,394	100%	7,001

[26] Efficiency Vermont Town Level Data http://www.efficiencyvermont.com/about_us/energy_initiatives/vt_town_energy.aspx End-use assumptions are available in the Excel file in Appendix and in Appendix A.

Chittenden County Thermal Fuel Consumption by End-use

Different fuel mix assumptions need to be used in Towns that have access to natural gas, and Towns that do not. Natural gas is one of the more cost-effective options for hot water and heat and, when available, it is often a fuel of choice for these end uses. Fuel mix assumptions used in the end-use analysis and results of the analysis on consumption by fuel type and end-use are presented in

Table 3,

Table 4, and in the Excel file in Appendix B.

Table 3: Thermal fuel disaggregation (non-transportation) at the County level[27]

	Fuel	Category	Total (MMBTU)
Fossil Fuels (MMBTU)	Natural gas	Number of households	35,230
		Space Heating	1,803,286
		Water Heating	337,151
		Kitchen	226,285
		Laundry	204,977
		Other*	107,219
		Total consumption (MMBTU)	2,688,773
	Oil	Number of households	25,836
		Space Heating	1,117,657
		Water Heating	124,184
		Kitchen	-
		Laundry	-
		Other*	-
		Total consumption	1,241,841
	Propane	Number of households	6,546
		Space Heating	103,387
		Water Heating	24,755
		Kitchen	17,474
		Laundry	-
		Other*	-
		Total consumption	145,615
	Wood	Number of households	5,673
		Space Heating	87,888
		Water Heating	-
		Kitchen	-
		Laundry	-
		Other*	-
		Total consumption	87,889

[27] Efficiency Vermont Town Level Data http://www.efficiencyvermont.com/about_us/energy_initiatives/vt_town_energy.aspx End-use assumptions are available in the Excel file in Appendix B and in Appendix A.

*Other = gas cooktop and gas oven, gas laundry dryer, pool heater

Table 4: Electricity used for thermal needs (MMBTU) -2009

Electric primary heat only, annual consumption MMBTU	148,589
Hot water, annual consumption MMBTU	107,299

Residential Town Level Data

A lot of assumptions on penetration rates, units of electricity consumption, and number of households using each type of fuel go into calculations of energy consumption by Town and by end use. Those assumptions and calculations are provided in Appendix B and should be reviewed prior to referencing this data. Overall calculations of fuel consumption by Town (**Error! Reference source not found.**) show that the main difference among Towns is whether they have access to natural gas or not. Overall Town energy consumption varied between 68-101 MMBTU per year, however the precision of the data is not such that valid detailed comparisons can be supported.

Electricity and natural gas data is the most accurate, as it was provided at the town and sector level by the utilities. Unregulated fuel data (oil, propane, wood) is state level data extrapolated to the Town level using several assumptions. Burlington and Winooski have lower electricity consumption, possibly due to the greater proportion of multi-family housing buildings, with different consumption patterns than single-family homes dominating other Towns. Buel's Gore has very few homes, and any outlier in this Town will have a much greater impact on the average, which would explain the much lower electricity consumption. Charlotte and Shelburne have higher electricity consumption than the average. This could be due to differences in the housing stock (e.g. larger homes). Natural gas consumption by household by Town varies as natural gas service has reached a different proportion of the housing stock in different Towns.

Table 5: Estimated Per Household Aggregated, Residential (non-transportation), Energy Consumption by Fuel Type and by Town in Chittenden County (total Town MMBTU consumption/ total number of household in the Town, regardless of the number of households using each fuel as primary fuel)

Town	Per household MMBTU consumption					
	Electricity	Oil	Natural Gas	Wood	Propane	Total
BOLTON	24	48	0	3	6	82
BUELS GORE	10	48	0	3	6	68
BURLINGTON	18	9	57	1	1	86
CHARLOTTE	30	48	0	3	6	88
COLCHESTER	24	20	36	1	2	84
ESSEX	26	13	59	1	2	101
ESSEX	23	16	53	1	2	95

JUNCTION						
HINESBURG	25	37	7	3	4	76
HUNTINGTON	24	48	0	3	6	81
JERICHO	27	30	24	2	4	88
MILTON	26	26	27	2	3	84
RICHMOND	26	48	0	3	6	84
SHELBURNE	30	21	46	2	2	101
SOUTH BURLINGTON	22	13	58	1	2	96
ST. GEORGE	26	48	0	3	6	83
UNDERHILL	27	40	6	3	5	80
WESTFORD	28	48	0	3	6	85
WILLISTON	25	19	43	1	2	91
WINOOSKI	19	11	54	1	1	86
Average	**23**	**20**	**42**	**1**	**2**	**89**

Chittenden County Commercial and Industrial

Finding Chittenden County specific data on end use distribution in commercial and industrial buildings is much more difficult than for the residential sector. Commercial and industrial buildings vary greatly in size, construction type, purpose and operating hours to a much greater extent than residential structures. The energy use of a hospital with round the clock operation, food services, laundry facilities, laboratories and high demands on HVAC with will be much different than an office building or a grocery store, so to gather effective data, more buildings would need to be included which is a very expensive undertaking and why it happens less frequently and with less specific data than the residential surveys.
The available end-use data is from EIA Commercial Buildings Energy Consumption Survey (CBECS) and Manufacturing Energy Consumption Survey (MECS). The CBECS data was updated in 2007 but the EIA web page reports that there were flaws in the data collection methodology and the results were not high enough quality to be posted. Therefore the data from 2003 was used. The most recent MECS data is from 2006 and is currently going through a 2010 update. For end-use CBECS is aggregated to the census region then by the division of New England. Energy use data categorized by building type is aggregated at the national level.

Given all of these issues, we would like to emphasize that information available by end-use for commercial and industrial for Chittenden County is much less rigorous than the residential sector, but because it's the best data available, we can use it to gain some insight into the way energy is used in Chittenden County. Commercial buildings in the Northeast use most of their energy for space heating (55%), followed by lighting (16%). The rest of the energy is distributed across electronics (office

equipment, and computers) water heating, ventilation, cooling and miscellaneous as shown in Figure 22[28].

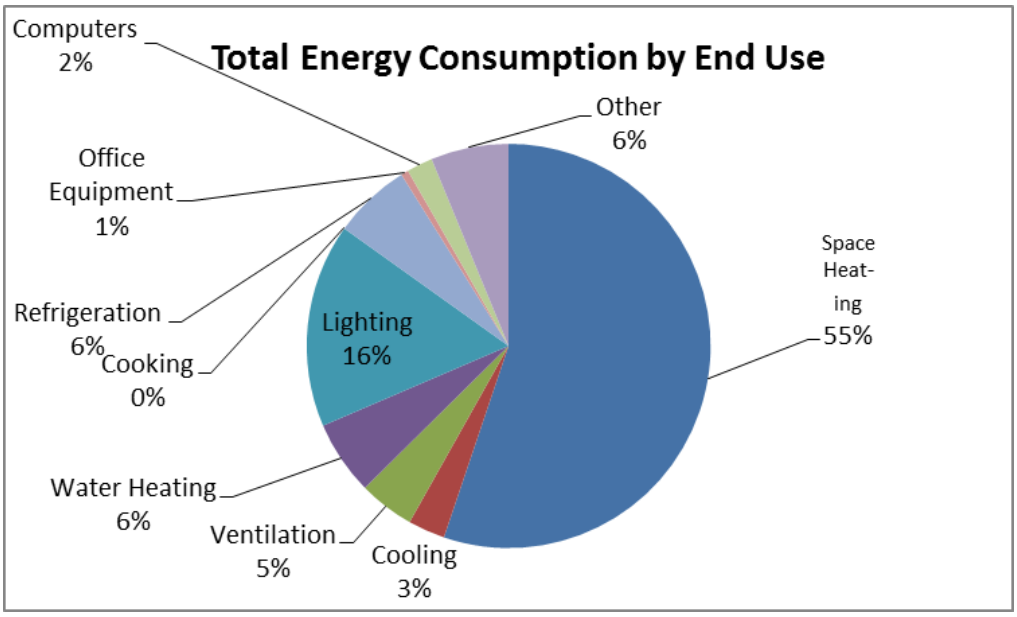

Figure 22: Commercial Energy Consumption by end use (non-transportation) for New England[29]

Commercial and Industrial Electric Consumption by End-use

Commercial and industrial buildings use electricity for lighting, HVAC, refrigeration office equipment and for processes. The highest use of electricity is for indoor and outdoor (which includes street lighting). This percent should shift downward as the federal lighting standard EISA phase in requiring higher efficiency lighting in typical commercial fixtures and lamps. Figure 23 and Table 6[29] show the estimated end-use disaggregation for electricity and electric use per employee.

[28] http://www.eia.gov/emeu/cbecs/

29 Data source http://www.eia.gov/emeu/cbecs/ and VEIC internal planning documents

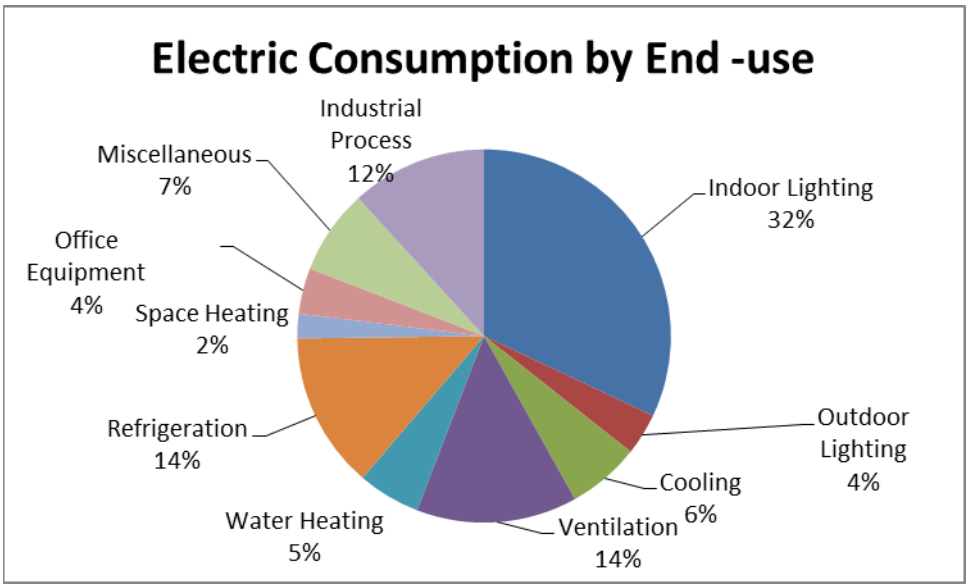

Figure 23: C&I Electric Consumption by End-use

12

Table 6: C&I Electric End-use disaggregation

Electric (kWh) 2009	All Building Types	Percent	Per Employee
Indoor Lighting	248,545,499	32%	2,003
Outdoor Lighting	27,997,869	4%	226
Cooling	48,767,127	6%	393
Ventilation	108,050,725	14%	871
Water Heating	42,049,939	5%	339
Refrigeration	104,915,881	14%	845
Space Heating	16,509,564	2%	133
Office Equipment	30,853,869	4%	249
Miscellaneous	57,037,236	7%	460
Industrial Process	91,241,826	12%	735
Total	**775,969,536**		

Commercial and Industrial Thermal Disaggregation

The highest use of energy for fuel types falls into the category of space heating. Natural gas and propane can be used for cooking, water heating, space heating and industrial processes. Oil and kerosene are used for space heating, water heating and process. Figure 24: C&I Natural Gas Consumption by End-use and Table 7 show natural gas end-use and per employee use. Figure 25 and Table 8 show oil and kerosene and Figure 26 and Table 9 show propane[30].

[30] Natural gas data is 2010 from Vermont gas. Oil and propane are 2009 from EIA

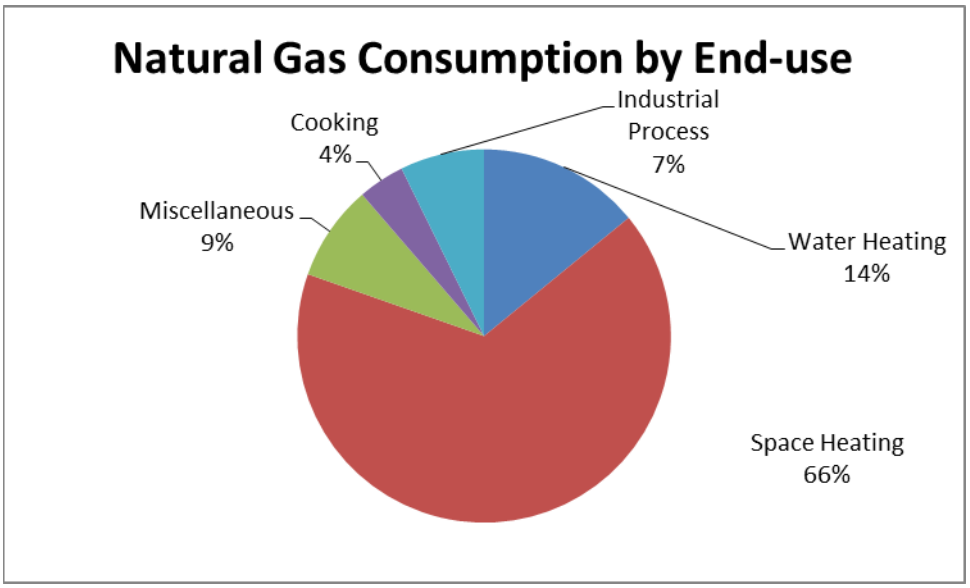

Figure 24: C&I Natural Gas Consumption by End-use[30]

Table 7: C&I Natural Gas Consumption[31]

Natural Gas (therms) 2010	All Building Types	Percent	Per Employee
Water Heating	5,174,936	14%	42
Space Heating	24,361,240	66%	196
Miscellaneous	3,051,182	8%	25
Cooking	1,480,994	4%	12
Industrial Process	2,677,504	7%	22
Total	**36,745,856**		

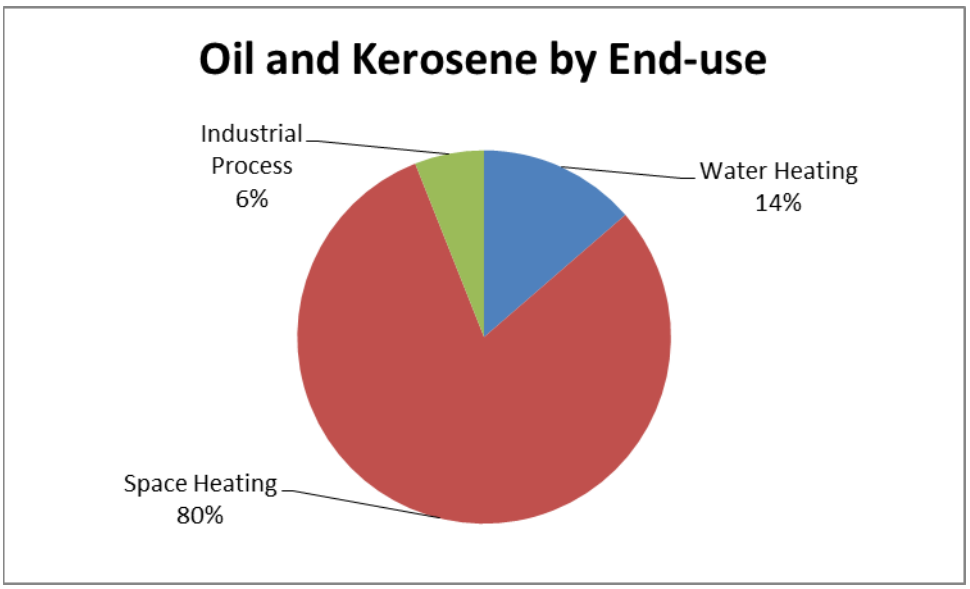

Figure 25: C&I Oil and Kerosene by End-use[32]

[31] Ibid..

Table 8: C&I Oil and Kerosene by End –use[33]

Oil & Kerosene (gallons) 2009	All Building Types	Percent	Per Employee
Water Heating	574,065	14%	5
Space Heating	3,378,148	80%	27
Industrial Process	253,078	6%	2
Total	**4,205,292**		

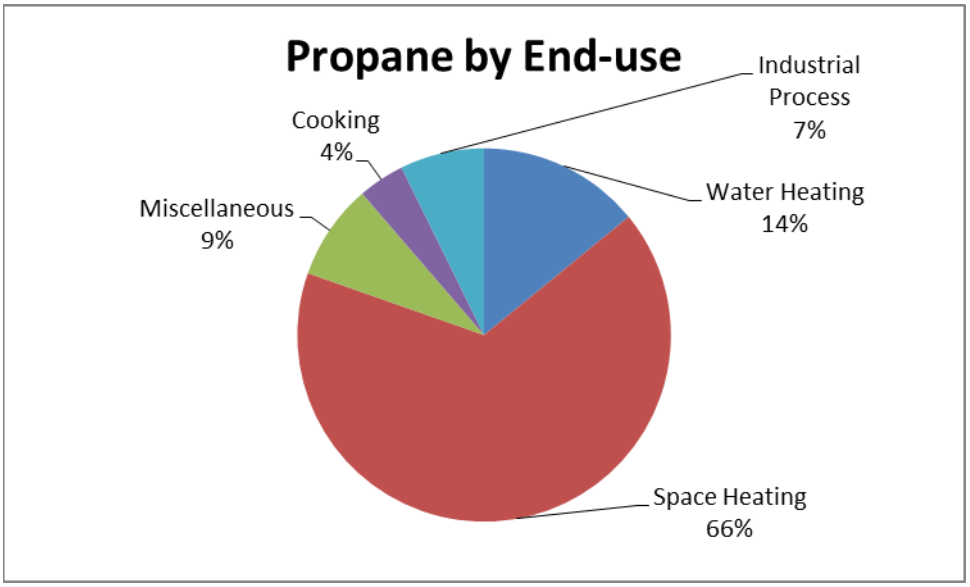

Figure 26: C&I Propane by end-use[34]

Table 9: C&I Propane by End-use[35]

Propane (gallons) 2009	All Building Types	Percent	Per Employee
Water Heating	69,185	14%	0.6
Space Heating	325,693	66%	2.6
Miscellaneous	40,792	8%	0.3
Cooking	19,800	4%	0.2
Industrial Process	35,796	7%	0.3
Total	**491,266**		

Town Level C&I data

This section has C&I data at the town level for electricity and natural gas. This is data that came from Efficiency Vermont and Vermont Gas. Non-transportation petroleum fuels (propane, oil, kerosene) and wood are not included in the tables because of the lack of available data to assign those fuels at the town level. For the residential sector, there are many valid assumptions that can be made about the housing stock to estimate fossil fuel use down to the town level. For commercial and industrial, this is

[32] Ibid..
[33] Ibid.
[34] Ibid..
[35] Ibid.

not the case. As discussed earlier, energy use at commercial and industrial buildings varies widely, preventing valid assumptions to disaggregate the data.

Table 10: Electric Use per Town 2009[36]

Chittenden County Cities and Towns	2009 Commercial & Industrial Electricity (MWh)
BOLTON	2,767,796
BUELS GORE	0
BURLINGTON	261,050,319
CHARLOTTE	3,012,041
COLCHESTER	80,126,375
ESSEX	37,461,060
ESSEX JUNCTION	28,075,265
HINESBURG	7,256,471
HUNTINGTON	594,277
JERICHO	5,702,759
MILTON	32,025,718
RICHMOND	5,385,400
SHELBURNE	25,780,694
SOUTH BURLINGTON	174,124,180
ST. GEORGE	466,903
UNDERHILL	1,234,136
WESTFORD	609,653
WILLISTON	84,945,422
WINOOSKI	25,817,970
Total	**775,969,536**

Table 11: Chittenden County Commercial & Industrial Natural Gas (therms)[37]

Chittenden County Cities and Towns	2010 Commercial & Industrial Natural Gas (therms)
BOLTON	-
BUELS GORE	-
BURLINGTON	13,570,466
CHARLOTTE	-
COLCHESTER	3,529,622
ESSEX & ESSEX JUNCTION	8,514,313
HINESBURG	33,408
HUNTINGTON	-
JERICHO	44,175
MILTON	675,469
RICHMOND	-
SHELBURNE	667,962
SOUTH BURLINGTON	5,618,933

[36] http://www.efficiencyvermont.com/about_us/energy_initiatives/vt_town_energy.aspx
[37] Data from VGS

ST. GEORGE	-
UNDERHILL	1,902
WESTFORD	-
WILLISTON	3,161,143
WINOOSKI	928,463
Total	36,745,856

Transportation

Chittenden County transportation data is publicly available through several sources, among them the Chittenden County Regional Planning Commission/ CCMPO maintains an extensive library of reports and databases relating to transportation in Chittenden County; the Transportation Research Center at the University of Vermont also makes available a number of research reports pertaining to transportation in Chittenden County; the National Household Travel Survey provides national data on travel behavior, allowing for the analysis of daily travel by all modes. A separate ECOS report focusing on transportation provides an analysis of transportation for Chittenden County. This ECOS Energy report only evaluates transportation metrics that relate to energy consumption for the transportation sector and therefore will only focus on energy-related metrics.

Several metrics relating to transportation are important to consider, as they provide useful indicators: total number of trips (all modes), Person miles of travel (equivalent to accounting for Vehicle Miles Traveled (VMT) and vehicle occupancy), and vehicle fuel efficiency. Land use patterns are also very important in determining the distance that residents and commercial vehicles need to travel; land use is discussed in detail in another ECOS report. Other indicators representing the availability of other transportation options should also be taken into account (e.g. miles of sidewalk and bike path in relation to miles of roads, pedestrian and biker safety, public transportation ridership).

Vehicle Miles Traveled (VMT) is the total number of miles driven by all vehicles within a given time period and geographic area. Vehicle Miles Traveled directly affects gas consumption, emissions, and traffic patterns and is a common measure of roadway use. VMT is not a direct estimate of total personal travel since it does not account for vehicle occupancy (a discussion of vehicle occupancy can be found in the 2009 Vermont Transportation Energy Report). VMT is a major factor affecting Vermont's transportation energy use. Reducing VMT would clearly reduce energy use, but alternatives for travel, especially in a rural state, may be limited.[38]

Annual VMT and annual number of trips for Chittenden County (by trip type) are presented in a table below. External trips are much longer than internal trips, so while they are about 11% of the person trips, they generate about 40% of the VMT in the county (not to mention the additional VMT outside

[38] VTER TRC 11-007, Sears & Glitman, page 10.

Chittenden County not included in this calculation). Work commute trips inside the county also tend to be longer (Table 12).[39]

Table 12: Vehicle Miles Traveled in Chittenden County[40]

Trip Type	2005 Annual VMT Estimate (millions)	Percent of Total Chittenden County VMT	Number of Trips	Percent of Total Trips
Home Based Work (HBW)	166	12%	77,800	10%
Home Based Other (HBO)	251	18%	253,600	33%
Non home Based (NHB)	181	13%	232,400	30%
Light Commercial, 4-tires (L_Comm)	172	12%	101,400	13%
Medium Commercial, 6-tires (M_Comm)	23	2%	12,500	2%
Heavy Commercial 6+ tires (H_Comm)	6	0%	3,000	0.4%
Internal to External (IX)	207	15%	33,000	4%
External to Internal (XI)	371	26%	58,700	8%
External to External (XX)	38	3%	1,800	0.2%
Total	**1,415**	**100%**	**774,200**	**100%**

Overall 92% of trucks (including pickups) use gasoline, 8% use diesel, and a small minority use propane and other fuels[41]; a large majority of cars use gasoline. Therefore the majority of fuel consumption in the county is in effect gasoline. In addition to traditional fuels, a few institutions in Chittenden County use compressed natural gas for their fleets, such as the University of Vermont (buses), and Casella Waste Management CNG (waste haulers), for example. Casella recently installed a natural gas fuelling station at their Williston facility.

In the future, electric vehicles (EV) may come to play a more important role in transportation. This additional electric load would need to be factored into any forecast of electricity use. To forecast the rate of adoption of EV, one could use the assumption that hybrid vehicle owners will be the early adopters of EV. Rate of hybrid vehicle adoption (currently 1.5% of registered vehicles in Chittenden County), used as a proxy for identifying early adopters, would allow for an initial forecast of the impacts of EV on electric load growth and decline of gasoline/diesel consumption. In 2010, there were slightly over 6,300 hybrids registered in the whole state (~1,500 were sold in 2009, ~30,000 new vehicles in total were registered in Vermont). In 2010 hybrids vehicles represented about 1.5% of registered vehicles in Chittenden County.[42]

[40] Base year trip Production model: CCRPC (formerly CCMPO).
[41] Census data, 2002 Economic Census, Vehicle Inventory and Use Survey, issued September 2004 http://www.census.gov/prod/ec02/ec02tv-vt.pdf
[42] UVM TRC Report #11-007, Vermont Transportation Energy Report, Sears & Glitman

Vehicle fuel efficiency varies by Town in Vermont, with vehicles in Chittenden County towns having generally better fuel efficiency than many Vermont Towns (Figure 27 and Figure 28). Differences between towns may be related to several factors including the urban or rural nature of each town, the proportion light vehicles vs. heavier trucks (for farming, forestry, landscaping, building trades, etc.), demographic characteristics (e.g. income), etc.

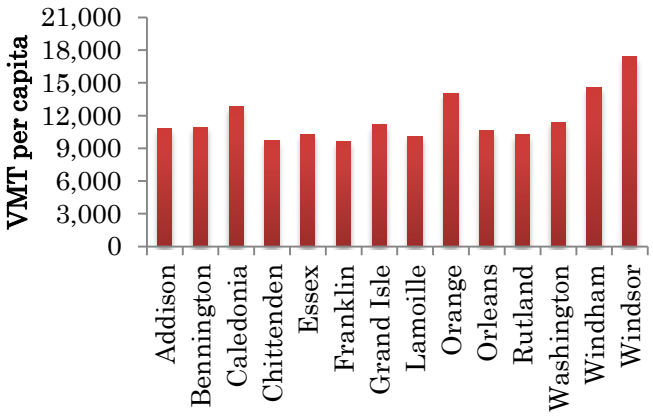

Figure 27: Figure 3-5. VMT by Vermont County, Scaled to Population, 2009[43]

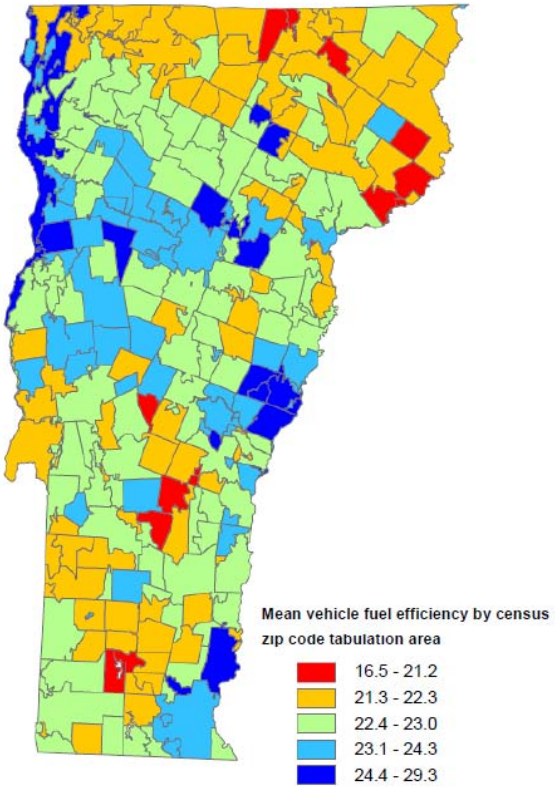

Figure 28: Vehicle Efficiency in Vermont (blue is higher efficiency, red is lower efficiency)[44]

[43] VT TER at 13 UVM TRC 10-017

[44] UVM TRC Report #11-007, Vermont Transportation Energy Report, Sears & Glitman, Data source: VT DMV

Fuel efficiency of commercial vehicles (trucks) varies greatly by vehicle type (Figure 29 and Figure 30). Changes in Chittenden County's economy may affect the type and number of vehicles used for business, therefore affecting the overall average county's vehicle efficiency and fuel consumption.

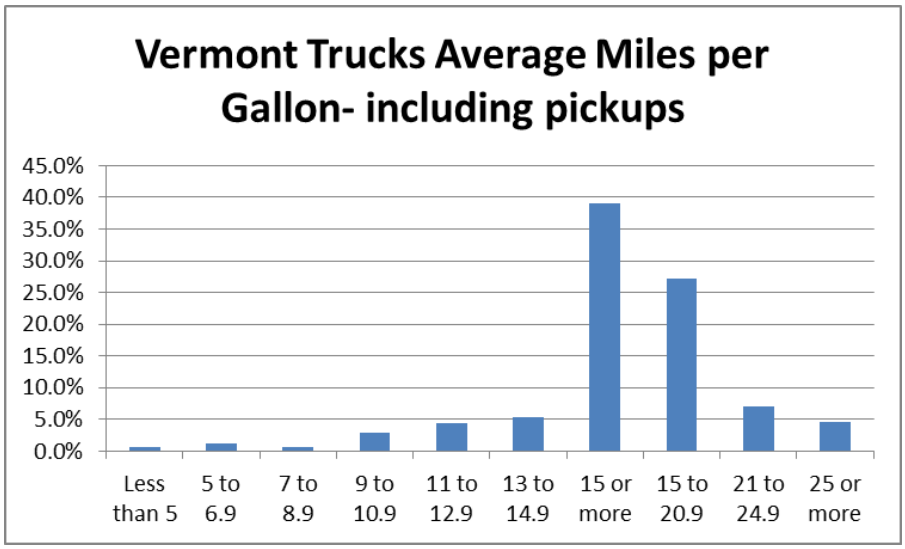

Figure 29: All trucks fuel efficiency[45]

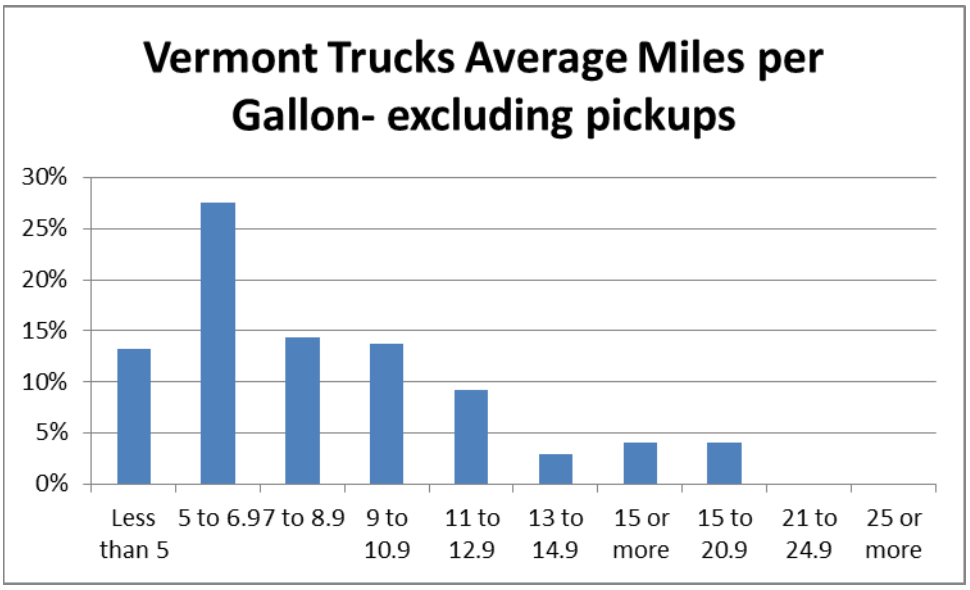

Figure 30: Non-pickup truck fuel efficiency[46]

[45] Data source: VTrans HPMS Data, Chittenden County VTrans Vehicle Miles of Travel (VMT) History, CCMPO 2009,

[46] CAFÉ fuel economy standards: average gas mileage of new cars sold from 1978 to 2010, **Commercial gas mileage**: 2002 Census data: http://www.census.gov/prod/ec02/ec02tv-vt.pdf

The Environmental Protection Agency (EPA) and National Highway Traffic Safety Administration (NHTSA) are now jointly managing the Corporate Average Fuel Economy (CAFE) standards for new vehicles (http://www.nhtsa.gov/fuel-economy). The Obama administration finalized rules in April 2010 running from model year 2012-2016 which would bring car and light truck fuel economy from 29.2 mpg in 2010 to 34.1 mpg in 2016. On Nov 16, 2011 EPA and NHTSA issued a joint notice of proposed rule-making in November with increased CAFE standards from 2017-2025. These are awaiting publication in the federal register. If these become final, then combined car and light truck fuel economy will go from 34.1 mpg in 2016 to 49.6 mpg in 2025.[47] As vehicle fuel efficiency plays an important role in total fuel consumption, changes to fuel efficiency standards have the potential to greatly reduce transportation fuel consumption in Chittenden County. Fuel efficiency standards have not improved between the 1980s and 2004, and stricter fuel efficiency standards would be an important step forward from an energy point of view.

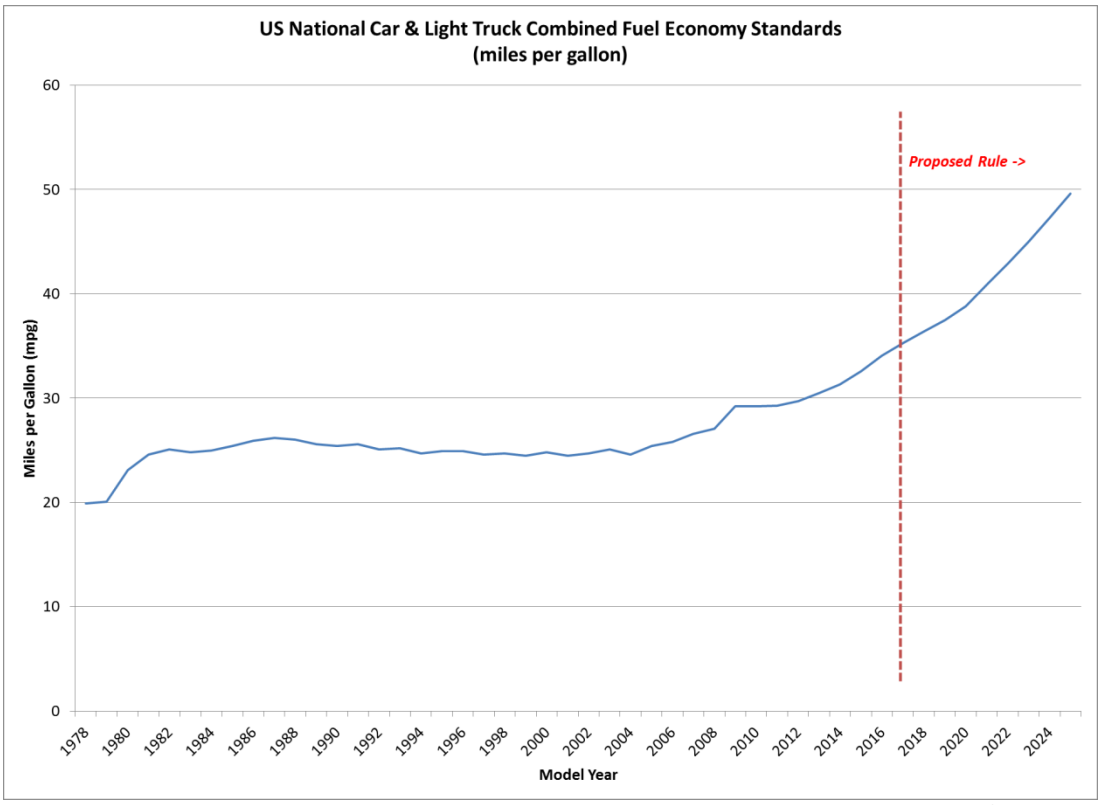

Figure 31: Fuel Efficiency Standards (CAFE) Historical Trends and Proposed Rule[48]

Using average fuel efficiency and annual VMT in Chittenden County, the UVM Transportation Research Center estimated transportation fuel consumption in Vermont's counties. The analysis placed Chittenden County as the largest consumer of total gasoline of all Vermont Counties, but with an overall lower per capita gasoline consumption than other Vermont counties (Table 13).[49]

[47] David Roberts, CCRPC/CCMPO personal communication
[48] http://www.census.gov/prod/ec02/ec02tv-vt.pdf
[49] UVM TRC Report #11-007, Vermont Transportation Energy Report, Sears & Glitman

Table 13: VMT, Vehicle Efficiency, and Gasoline Consumption by Vermont County

County	Total VMT (in million miles)	Mean Vehicle Efficiency (mpg)	Total estimated gasoline use (million gallons)	Per capita estimated gasoline use (gallons)	Per capita estimated gasoline use (MMBTU) [50]	Percent of total statewide VMT	Percent of statewide total estimated gasoline use
Addison	399	23.3	17,116,435	466	58	6%	5%
Bennington	398	22.5	17,693,899	486	61	6%	6%
Caledonia	388	22.5	17,225,179	569	71	5%	5%
Chittenden	**1,486**	**23.2**	**64,035,444**	**420**	53	**21%**	**20%**
Essex	66	21.6	3,052,044	477	60	1%	1%
Franklin	462	22.3	20,712,834	430	54	6%	7%
Grand Isle	85	22.7	3,755,879	491	61	1%	1%
Lamoille	262	22.4	11,701,978	451	56	4%	4%
Orange	406	23.1	17,557,238	608	76	6%	6%
Orleans	289	21.9	13,207,669	484	61	4%	4%
Rutland	647	22.4	28,882,566	458	57	9%	9%
Washington	670	23.3	28,742,319	490	61	9%	9%
Windham	634	23.2	27,331,488	629	79	9%	9%
Windsor	985	23	42,844,204	758	95	14%	14%

The distance that Chittenden County residents have to travel to reach their destinations has a major effect on VMT and total fuel consumption. Mean commute length in Chittenden County is 9.1 miles, which is less than the average for many Vermont counties and partially explains the County's lower per capita fuel consumption.

Table 14: Mean Commute Length by County[51]

County	Mean Commute Length (miles)	% VT population
Addison	14.4	5.9
Bennington	8.2	5.9
Caledonia	9.3	4.9
Chittenden	**9.1**	**24.5**
Essex	10.7	1.0
Franklin	12.2	7.7
Grand Isle	15.9	1.2

[50] http://www.spe.org/industry/docs/UnitConversion.pdf assuming conventional gasoline: 5.253 MMBTU/barrel, 1 gallon = 0.0238095 barrel

[51] VT TER at 15 UVM TRC 10-017

Lamoille	14.9	4.2
Orange	11.6	4.6
Orleans	10.9	4.4
Rutland	7.2	10.1
Washington	8.8	9.4
Windham	7.3	7.0
Windsor	9.6	9.1

Park and Ride facilities provide an opportunity for travelers to use public transportation or maximize vehicle efficiency. Trends in utilization of Park and Ride facilities are indicators of changes in vehicle occupancy factors.

Table 15: Chittenden County Park and Ride Parking Lot Capacity[52]

	Percent Capacity			
Facility	2007	2008	2009	2010
Charlotte	--	--	53%	--
Colchester	44%	46%	--	29%
Charlotte	--	--	53%	--
Colchester	44%	46%	--	29%
Richmond	103%	143%	--	143%

Public transportation provides an alternative to single vehicle occupancy transportation or carpooling; bus ridership has increased by 22% in Chittenden County between 2006 and 2010 (Table 16). Passenger train ridership in Chittenden County is available on the Vermonter rail line (Washington, D.C. - St Albans), and is used exclusively for trips into and out of Chittenden County (there is only one stop in Chittenden County). Passenger rail transit in Vermont has increased by 50%[53] overall between 2006 and 2010, and is it likely that boarding and alighting in Chittenden County also increased.

Table 16: Bus Ridership 2006-2010[54]

Transit Provider	2006	2007	2008	2009	2010	Percent Change 2006-2010
Chittenden County Transportation Authority	2,009,371	2,120,451	2,206,828	2,514,562	2,455,731	22%

The number of miles of sidewalk and bike path is an indication of the availability of access to non-fossil fuel transportation options. This data is available at the Town level (Table 17) and shows variable level of pedestrian and biking infrastructure in different towns, which could be tracked as an indicator of progress towards providing alternative transportation options.

[52] UVM TRC Report #11-007, Vermont Transportation Energy Report, Sears & Glitman
[53] Ibid..
[54] Ibid..

Table 17: Bicycling and Pedestrian Facilities in Chittenden County[55]

Town	On road (miles)	Sidewalk (miles)	Shared Use (miles)	Total Roads (miles)*	% Bike/ Pedestrian Facilities of Total Road Miles
Bolton	3.9	.	.	31.9	12%
Buels Gore	.	.	.	3.2	0%
Burlington	21.9	133.0	13.4	95.1	177%
Charlotte	10.2		0.8	80.8	14%
Colchester	14.5	31.7	7.8	110.7	49%
Essex	1.3	74.7	3.3	132.54	60%
Hinesburg	.	2.5	0.3	60.88	5%
Huntington	.	.	.	43.96	0%
Jericho	.	1.8	.	68.24	3%
Milton	3.7	19.61	.	118.737	20%
Richmond	6.69	2.17	0.5	62.1	15%
Shelburne	9	10.02	2.9	56.9	38%
South Burlington	5.8	43.3	22.4	94.9	75%
St. George	.	.	.	5.3	0%
Underhill	.	0.3	.	57.4	1%
Westford	.	.	.	48.71	0%
Williston	5.8	18.4	4.2	89.02	32%
Winooski	0.1	17.4	.	18.8	93%
Grand Total	**82.8**	**355.0**	**55.8**	**1,179.3**	**42%**

On the commercial side, merchandise is typically transported within, in, and out of Chittenden County primarily by truck and rail. Evaluating freight transportation by air for an area as small as Chittenden County is difficult due to the small proportion of a trip that can be attributed to the County itself. The value of such an analysis is also arguable; therefore, the following section only reviews truck and rail commercial transportation. In many cases, data was only available at the state level, wherever this is the case it is clearly indicated in the chart or table title.

Overall the CCMPO freight study indicated that the majority of freight is transported by truck rather than train (Table 18). [56] The merchandise transported by rail rather than truck tend to be heavy, non-perishable items, such as minerals, clay, concrete, glass and stone, and chemicals (Table 19). Any

[55] UVM TRC Report #11-007, Vermont Transportation Energy Report, Sears & Glitman

comprehensive sustainability plan to reduce commercial transportation energy use will have to incorporate the needs of different industries and the transportation means that they currently employ into the plan.

Table 18: Freight transportation in Chittenden County

Mode Share for all freight (percent by weight)	Into, out of, and internal	Into	Out of	Number of Freight Trips Annually (into, out of, and internal
Truck	91.4%	87.7%	99.6%	42,668,500
Rail	5.7%	8.2%	0.2%	
Air	0.1%	0.0%	0.2%	
Water	0.0%	0.1%	0.0%	
Other	2.8%	4.1%	0.1%	

Table 19: Merchandise transported by truck and rail

Top Commodities in Chittenden County (into, out of, and within)	Truck	Rail
Primary Metal Products	3%	0%
Fabricated Metal Products	3%	
Electrical Equipment	4%	
Petroleum and Coal Products	4%	5%
Chemicals or Allied Products	5%	7%
Lumber or Wood Products	11%	1%
Other	9%	0%
Food or Kindred Products	23%	3%
Warehouse, Distribution, Intermodal	15%	
Clay, Concrete, Glass or Stone	12%	11%
Pulp, Paper, or Allied Products	11%	3%
Crude Petroleum or Natural Gas		3%
Transportation Equipment		1%
Non-metallic Minerals		67%

The type of merchandise transported by truck in Vermont is presented in Figure 32; a similar breakdown for Chittenden County was not available but may share many similarities.

[56] Chittenden County Regional Freight Study ~ Final Report, Prepared for: Chittenden County Metropolitan Planning Organization, Prepared by: Cambridge Systematics, Inc., August 2001, http://www.ccmpo.us/library/freight/index.php?rept=2

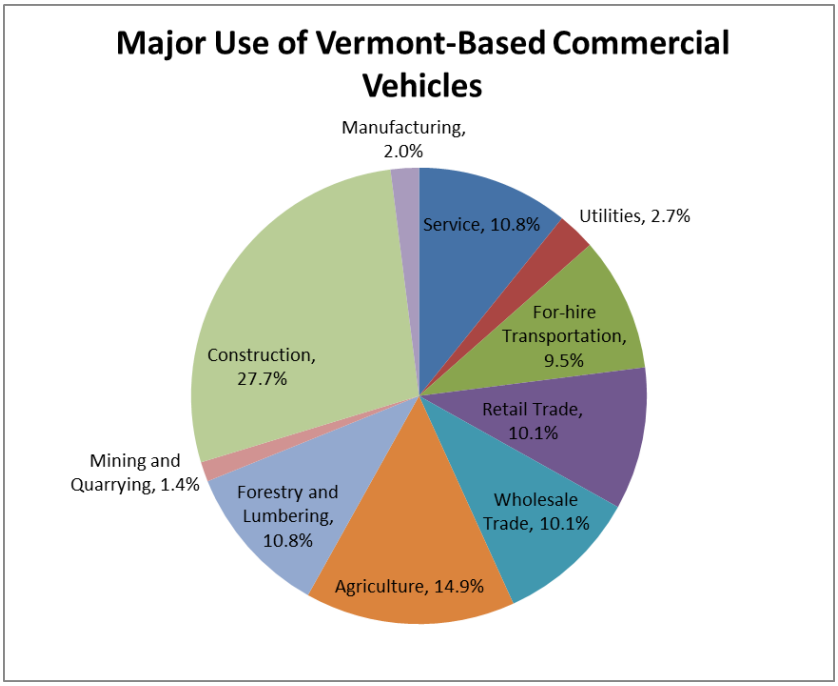

Figure 32: Type of merchandise transported in Vermont

Transportation accounts for the highest share of overall energy use in Vermont (33.7%) [57] higher than the national average. Chittenden County being more densely populated than the rest of Vermont is likely to have a smaller share of its energy consumption originating from transportation. However, the share of transportation in the overall energy use in the county is still very likely to be large and should be addressed in sustainability plans.

Energy Supply

Chittenden County imports all fossil fuel resources. Natural gas is supplied by Vermont Gas through its network of pipelines and supply channels. Other fossil fuels arrive to Vermont homes and businesses from truck deliveries. Consumers and businesses purchase natural gas from Vermont Gas and all other fossil fuels are purchased through fuel distributors whose prices are unregulated.

With respect to electricity, determining exactly where an electron comes from and exactly where it is consumed is a tricky science and it is difficult to determine if the electricity produced locally is used locally, especially for utility owned generation. Therefore we separate the issues of power plants that physically supply the local grid and the power plants that make up the power supply portfolio of the local utilities. This section discusses the power supply portfolios of the utilities in Chittenden County.

Electricity is supplied to Chittenden County by four electric utilities: Burlington Electric Department (BED), Central Vermont Public Service (CVPS), Green Mountain Power (GMP) and Vermont Electric Coop (VEC). Each utility purchases electricity from a variety of power producers through short and long term

[57] State Energy Plan
http://www.vtenergyplan.vermont.gov/sites/cep/files/Vol%202%20Public%20Review%20Draft%202011%20CEP.pdf

contractual agreements. The power generators use a variety of fuel sources to create the electricity. In this section we are using the following categories to describe the fuel sources:

- Hydroelectric – This category includes both large and small scale hydroelectric plants.
- Nuclear – Vermont Yankee supplies nuclear power to the state of Vermont
- Wood – McNeil is the primary source of wood power
- Wind – are variety of wind turbines throughout the state
- Oil and natural gas – electric plants using oil and natural gas
- Other renewables – includes landfill gas, CVPS cow power
- Market Purchases – this category represents a variety of suppliers and fuel sources

When looking at the state level, the source of electricity is from a variety of sources.

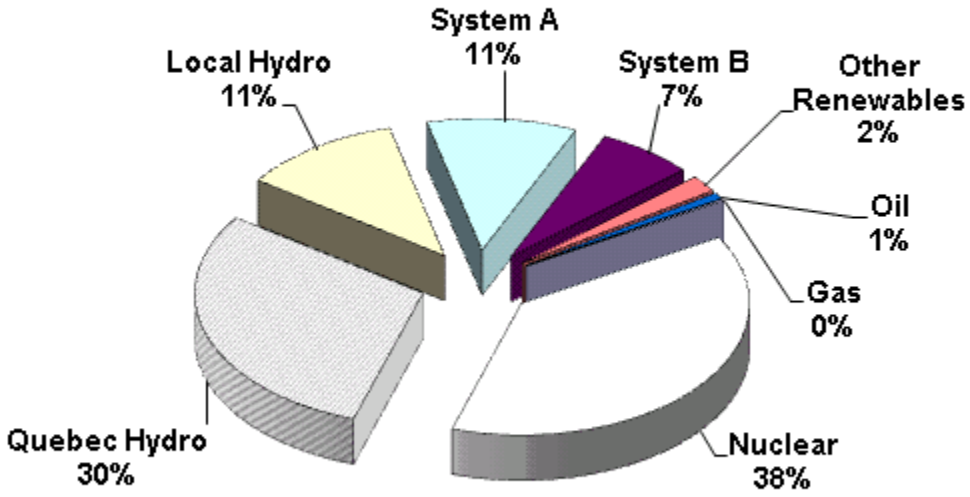

Figure 33: Vermont Electricity Generation[58]

The four utilities serving Chittenden County each have a different mix of fuels from which their electricity is generated. The percent distributions are shown in Figure 34 through Figure 37.

[58] System A is market purchases of energy by Vermont utilities. System B is energy produced by Vermont renewable facilities where the renewable energy certificates (RECs) have been sold to third parties who now own and claim those environmental attributes http://www.vtenergyplan.vermont.gov/sites/cep/files/2011%20CEP_Volume%202.pdf

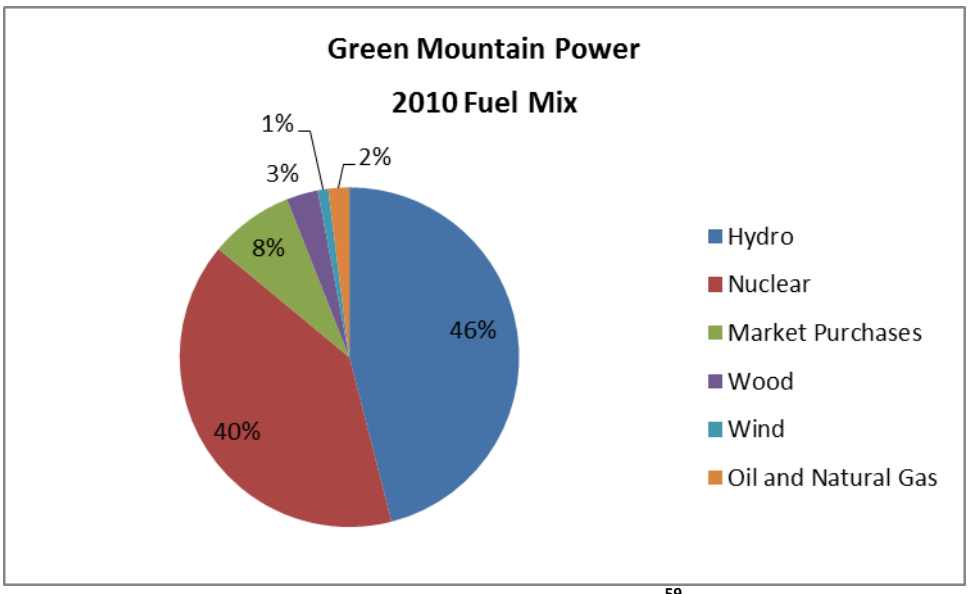

Figure 34: Green Mountain Power[59]

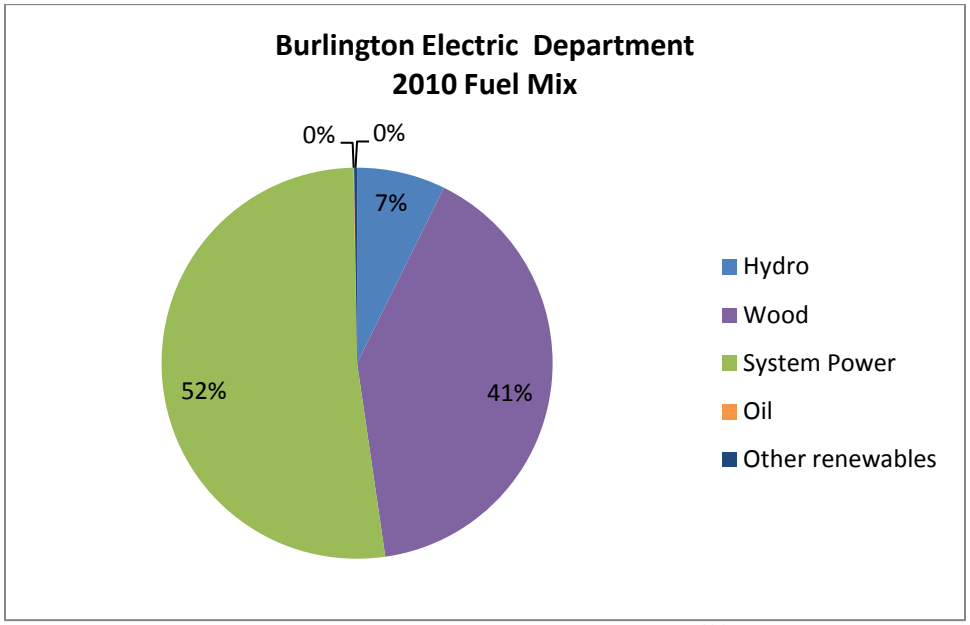

Figure 35: Burlington Electric Department[60][61]

[59] http://www.greenmountainpower.com/about/commitment/sustainability-report/footprint.html#_Toc179788483

[60] https://www.burlingtonelectric.com/page.php?pid=128&name=BED%27s%20Power%20Supply

[61] "System Power" is defined as a purchase composed of a mix of resources with the fuel and emissions characteristics of the ISO New England "residual mix" those resources left after all compliance and voluntary retirement of renewable sources is complete.

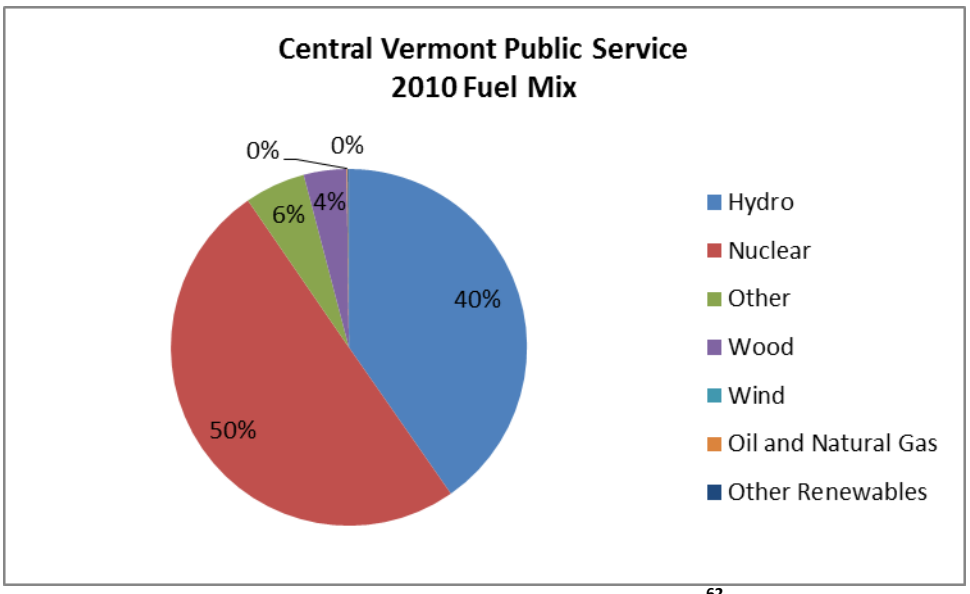

Figure 36: Central Vermont Public Service[62]

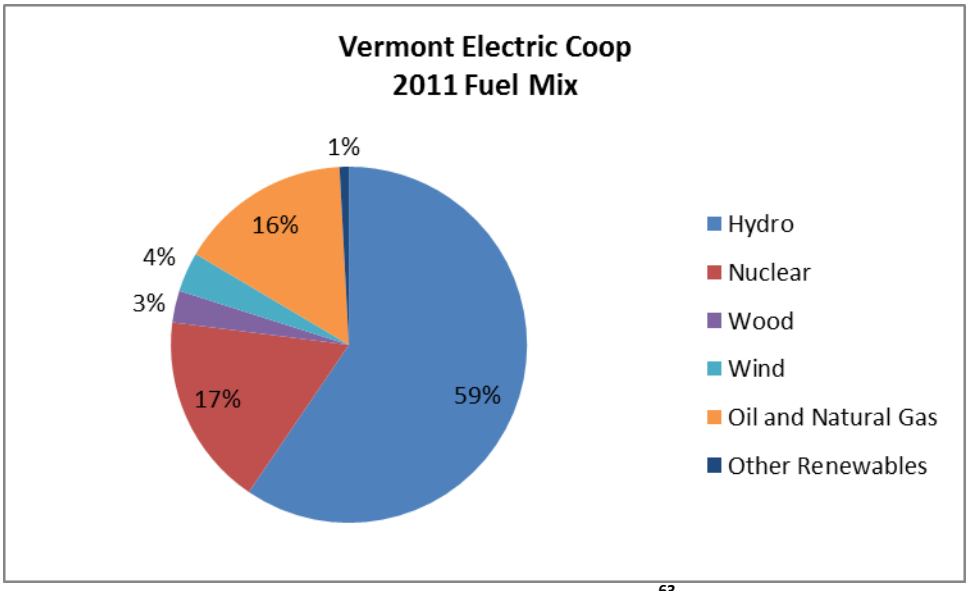

Figure 37: Vermont Electric Coop[63]

Very little power is generated by oil and natural gas fired plants. VEC has the highest percent of hydroelectric and the highest percent of oil and natural gas. BED has the highest percent of wood and no nuclear. GMP has the second highest percent of hydroelectric and CVPS has the highest percent of nuclear.

Renewable Electricity Generation Located in Chittenden County

Chittenden County has several locations generating electricity which are owned by utilities, municipalities and private parties.

[62] http://www.cvps.com/ProgramsServices/EnergySources.aspx
[63] http://www.vermontelectric.coop/energy-portfolio

Many private and municipally owned systems (e.g. wind, solar and farm methane) in Chittenden County tie into the grid through net metering which allows a utility customer to own and operate a small generator on the customer side of the meter. Net metered systems generate electricity that is used by the customer and excess is fed onto the grid.

Chittenden County has the following private, municipal and utility owned systems generating electricity. The tables show the capacity of the system, not the actual electricity produced annually.

Table 20: Private Renewable Systems[64]

	Capacity	Number of Sites
Solar PV (kW)	4977	320
Wind (kW)	486	26
Methane Digesters (kW)	84	3

Table 21: Municipal Renewable Systems[65]

	Capacity	Number of Sites
Solar PV (kW)	972	18
Wind (kW)	5	2

Table 22: Utility Owned Renewable Systems[66]

	Capacity	Number of Sites
Solar PV (kW)	152	2
Wood (MW)	50	1
Hydro (kW)	35,800	6

The McNeil Generating station, which is the one wood fired plant listed in Table **22** is located in the Interval section of Burlington and uses a combination of wood chips and waste wood from sawmills to generate electricity. The plant is jointly owned by BED at 50 percent, CVPS at 20 percent, Vermont Public Power Supply Authority at 19 percent and GMP at 11 percent[67]. McNeil generates about 55 megawatt hours annually.

There are six utility owned hydro stations located in Chittenden County. Three are on the Lamoille River and the other three are on the Winooski River. Combined they generate about 152,000 MWh annually.

Thermal energy for heat and hot water is also a way to harness renewable energy. Similarly to the rest of the region, use of wood as the primary heating source has increased by 25-40% in Vermont[68]:

[64] http://www.vtenergyatlas.com/ Personal Communication with Scott Sawyer 10-12-11
[65] Ibid.
[66] Ibid.
[67] https://www.burlingtonelectric.com/page.php?pid=75&name=mcneil
[68] Transforming Wood Heat in America, A Toolkit of Policy Options, July 2011, Alliance for Green Heat

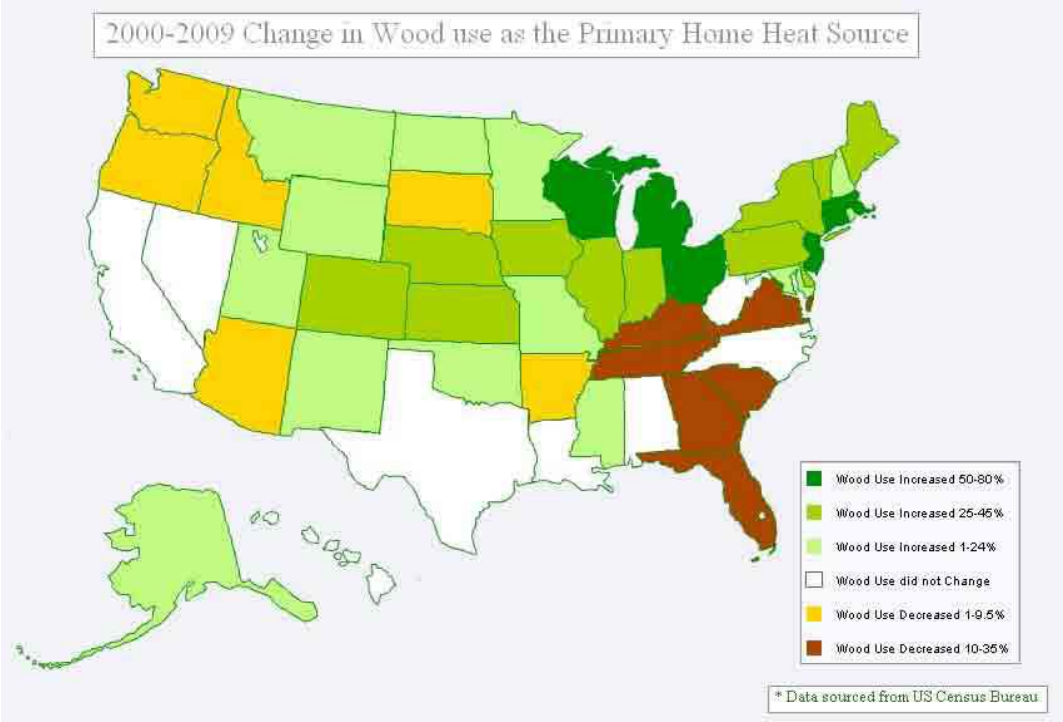

Figure 38: Wood Use for Primary Home Heating[69]

Vermont is the state where the percentage of houses heating with wood as primary heat source is highest[70]:

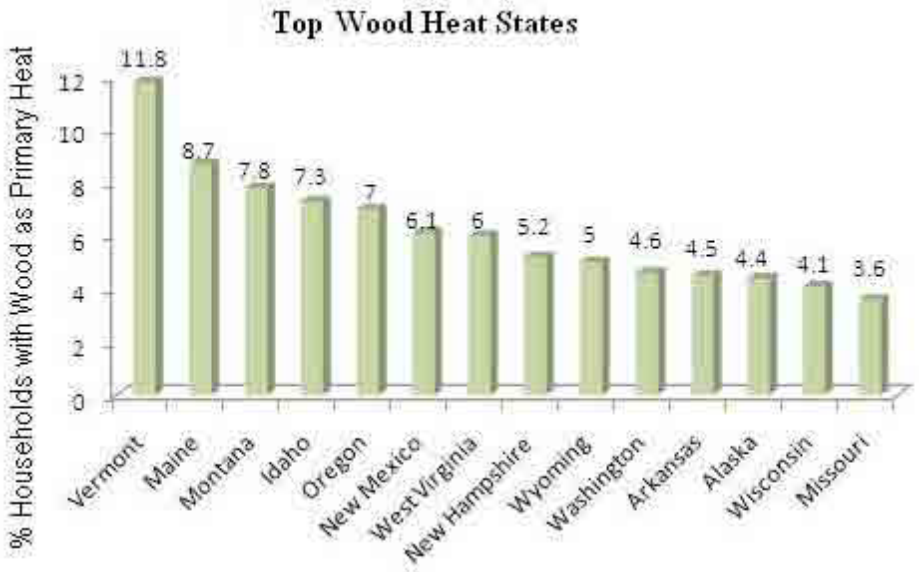

Figure 39 Top Wood Heat States

Chittenden County has solar thermal for domestic hot water and wood heat sites throughout the county. The woody biomass sites are wood chip boilers run by school districts and private parties.

[69] Ibid.
[70] Ibid.

Table 23: Private Solar Thermal[71]

	Capacity	Number of Sites
Solar Thermal (Thousand Btus)	2,975	42

Table 24: Private and Municipal Woody Biomass Thermal

	Capacity	Number of Sites
Municipal Woody Biomass Thermal (Tons of Wood Consumed)	3805	6
Private Woody Biomass Thermal (Tons of Wood Consumed)	200	2

Energy Efficiency

The State of Vermont has a long tradition of supporting efficiency programs. Currently three organizations run programs supporting the installation of high efficiency equipment in the commercial and residential sector Burlington Electric Department, Vermont Gas and Efficiency Vermont. The three programs operate in a collaborative manner and often support join initiatives that save electricity, natural gas, fossil fuels and water. Other benefits include reduced energy bills and reduced capacity requirements. In 2010 alone Efficiency Vermont installations produced over $115 million in total resource benefits[72] to the residents of Vermont[73]

New for Vermont efficiency planning is a process called the Demand Resource Plan (DRP). The DRP is a statewide plan that develops a set 20 year targets for energy reductions and other associated benefits. The first three years of the forecast are the operating targets and goals for the efficiency programs of Burlington Electric, Efficiency Vermont and Vermont Gas. The first three years have more specifics and granularity and generally could be considered more accurate than the years further out on the time scale.

Chittenden County Electric Savings from Efficiency Vermont is shown in Figure 40. The years 2005 to 2009 are actual results and then forecasted out to 2031. The 2005-2009 data is available down to the town level at the Efficiency Vermont web page[74]. The data for 2011 is based on annual goals. The subsequent years 2012 – 2031 are taken from the most recent draft proposal from the statewide DRP process and proportioned down to Chittenden County.

[71] http://www.vtenergyatlas.com/

[72] Total Resource Benefits are the benefits to the rate payer using the avoided cost of energy and the cost of running the programs

[73] Efficiency Vermont 2010 Annual Report
http://www.efficiencyvermont.com/docs/about_efficiency_vermont/annual_reports/2010_Savings_Claim.pdf

[74] http://www.efficiencyvermont.com/about_us/energy_initiatives/vt_town_energy.aspx

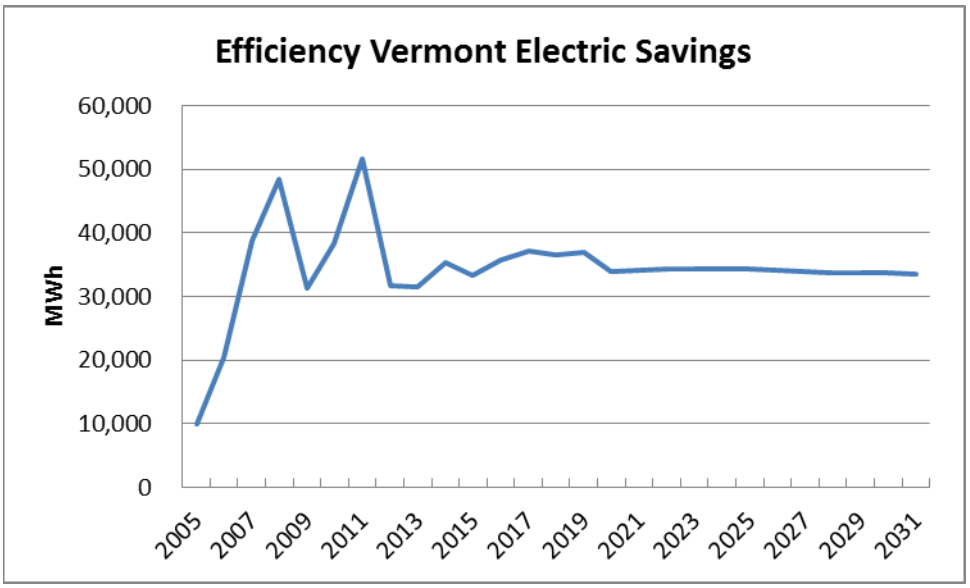

Figure 40: Efficiency Vermont Chittenden County Electric Savings

Figure 41 shows the electric savings as a percent of the retail electric sales in Chittenden County. The data used for 2005 – 2010 is the actual electric savings claimed as compared to the retail electric sales in Vermont. For 2011 – 2031 forecasted electricity sales was compared to forecasted electricity savings**.**

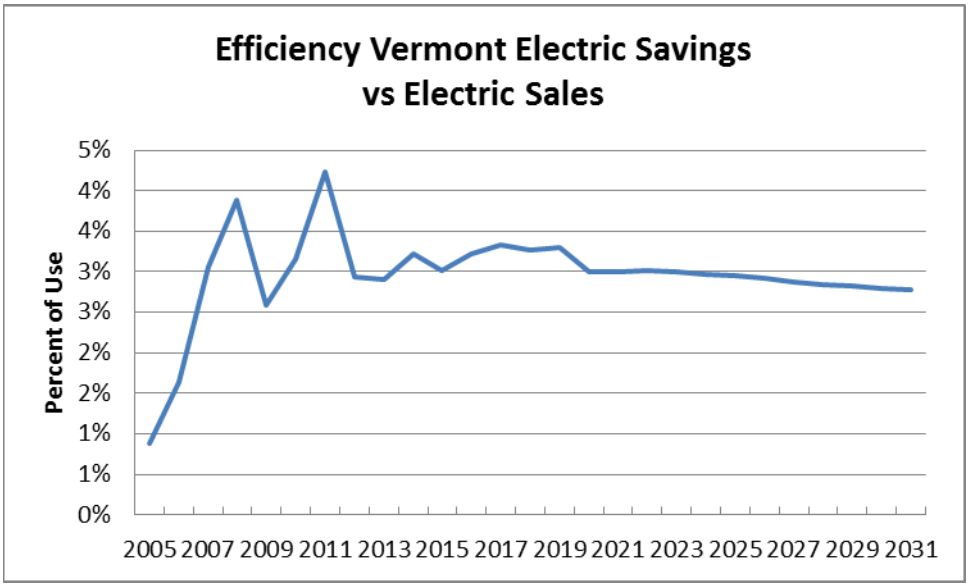

Figure 41: Percent Chittenden County Electric Savings as a Percent of Electric Sales

Burlington Electric Department efficiency program started in 1990 and has invested $15.6 million in programs and incentives over the years. The result of these efforts Burlington customers save over $9.5 million in retail electric costs annually.

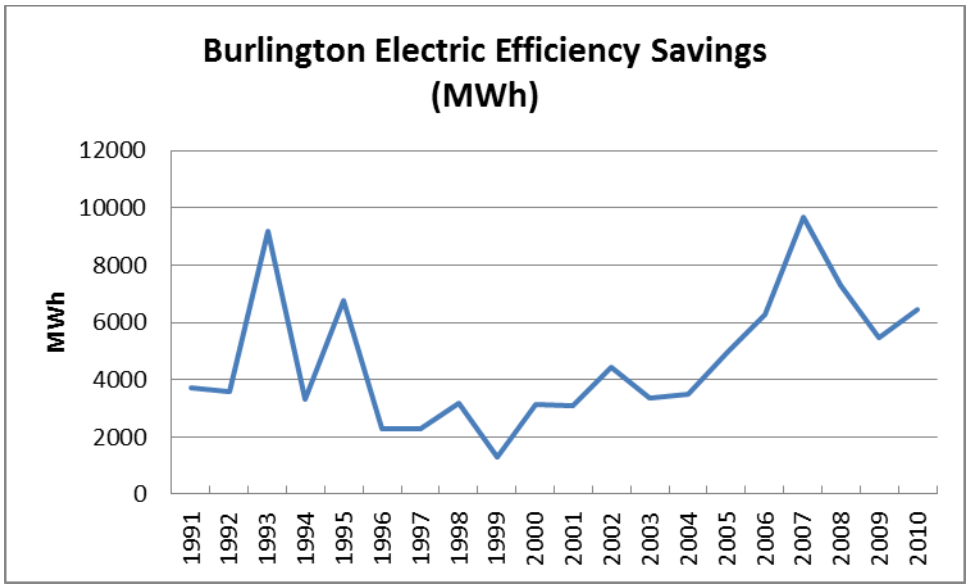

Figure 42: Burlington Electric Department Electric Efficiency Savings[75]

Vermont Gas Systems also has a successful efficiency program that invests about $2 million annually in commercial and residential projects that reduce consumption of natural gas for space and water heating as well as commercial and industrial process.

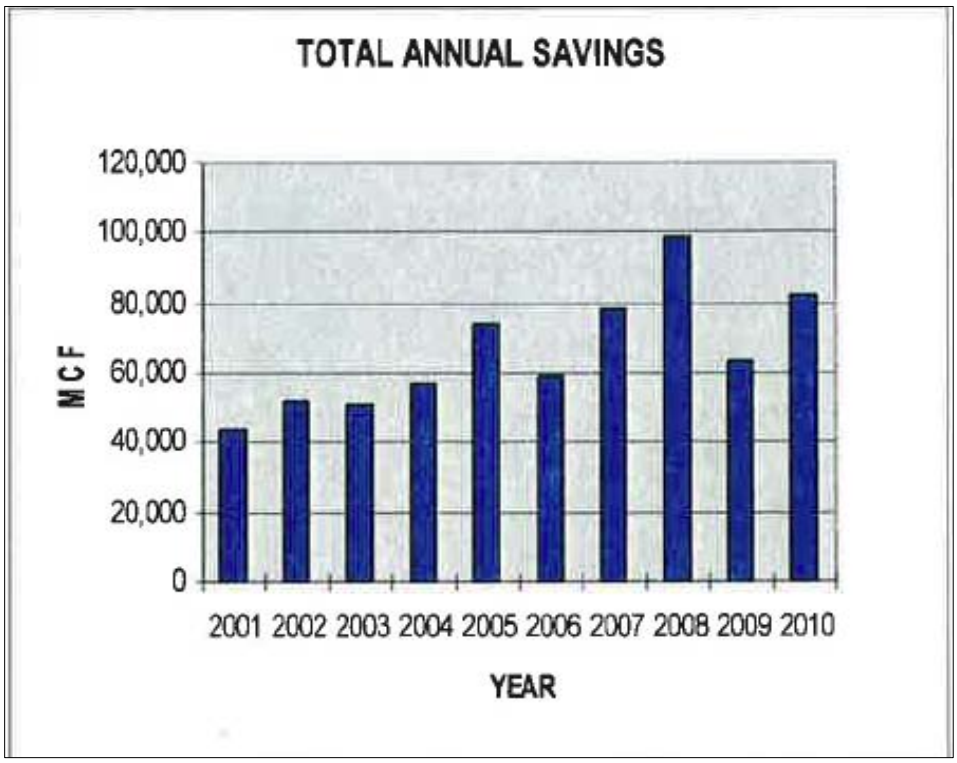

Figure 43: Vermont Gas Efficiency Program Savings

[75] https://www.burlingtonelectric.com/ELBO/assets/energy%20efficiency/2010%20DSM%20Annual%20Report%20Master.pdf

Resources for Municipal Planners

Municipal Planners in Vermont have many resources available to help them pursue reducing energy consumption in their facilities and throughout their city or town.

The Energy Planning Implementation Guidebook for Vermont Communities[76] was developed by the Vermont Natural Resources Council and the Vermont League of Cities and Towns and was completed in April, 2011. This is a very useful "how to" document that maps out, step by step, a process to develop a municipal energy plan and also discusses strategies and resources available to communities to help implement the plan.

Another important document for municipal planners is the Communities Tackling Vermont's Energy Challenges[77] which is a compilation of case studies covering topics including community engagement, efficiency and conservation, renewable energy, transportation and waste reduction. Each chapter of this document has several examples of Vermont communities that planned and implemented innovative projects with the aim of reducing energy consumption. Several of these example projects are in Chittenden County.

Other guidebooks designed to help municipal planners tackle energy planning are also located on the VNRC web page[78] include:

- GUIDE TO MUNICIPAL ENERGY PLANNING, Vermont Department of Public Service, 1993
- EARTHRIGHT INSTITUTE'S GUIDE TO TOWN ENERGY PLANNING IN VERMONT (with Model Town Energy Plan), 1992
- TOWN ENERGY PLANNING: A FRAMEWORK FOR ACTION, Paul Markowitz
- TOWN ENERGY AND CLIMATE ACTION GUIDE, VECAN, 2007

State Policies Supporting Sustainability

Vermont has several distinctive state-level policies and incentives in place that support the development of renewable energy and energy efficiency technologies. In 2010 Vermont ranked highest for electric efficiency program spending per capita[79] and has been ranked within the top ten states by American Council for an Energy Efficient Economy (ACEEE) in their annual State Energy Efficiency Scorecard over the past several years[80]. These policies have established Vermont as a leader nation-wide with a proven record of success in achieving energy savings and progress toward renewable energy installations and power purchases. Regional and town planners can leverage these initiatives in their local long and short term planning activities.

[76] http://www.vnrc.org/energy/resources/energy-planning-implementation-guidebook-for-vt-communities/
[77] Ibid..
[78] http://www.vnrc.org/article/view/21572/1/580/
[79] 2010 State of the Efficiency Program Industry. CEE
http://www.cee1.org/files/2010%20State%20of%20the%20Efficiency%20Program%20Industry.pdf
[80] The 2011 State Energy Efficiency Scorecard. ACEEE
http://www.aceee.org/sites/default/files/publications/researchreports/e115.pd

Energy Efficiency - Efficiency Vermont, Vermont Gas and Burlington Electric Department provide technical support and financial incentives for energy efficiency new construction, equipment purchases and retrofit projects.

- **Over $35 million a year** combined to support energy efficiency activities for electricity, natural gas and unregulated fuels[81]**.**

- **GeoTargeting (GT)** - The objective of GeoTargeting implementation is to determine the extent to which energy efficiency can help defer or delay the capital investment in growth-related electrical infrastructure improvements to transformers, distribution system circuits and feeders projected to require significant upgrades in the next five to ten years.

- **Community Energy Initiatives (CEI**). Efficiency Vermont employs several approaches to work with communities to expand energy efficiency in homes and businesses. Speakers , educational materials and help promoting do-it-yourself energy efficiency measures, direct installation of lighting and water conservation measures, and encouraging greater efficiency investment available to communities and schools

- **Unregulated Fuel Initiative –** Promotes initiatives to help Vermonters reduce heating fossil fuel consumption through weatherization, heating system replacements and Incentives and services for agricultural facilities, including incentives for hot water conservation and water heating efficiency, including heat exchangers to pre-heat water with compressor waste heat .

- **Municipal Street Lighting Program** is designed to help Vermont municipalities upgrade their older, less efficient lighting technologies in street and public spaces with energy-efficient light emitting diode (LED) lighting

Renewable Energy – There are several policies to promote renewables as well as financial incentives and loan programs to facilitate equipment installation.

- **Local Option – Property Tax Exemption** - Vermont allows municipalities to offer an exemption from the municipal real and personal property taxes for certain renewable energy systems including "windmills, facilities for the collection of solar energy or the conversion of organic matter to methane, net-metered systems ... and all component parts thereof including land upon which the facility is located, not to exceed one-half acre."

- **Sustainably Priced Energy Development Program (SPEED)** – The goal of the SPEED program is to promote the development of in-state energy sources which use renewable fuels and provide a standard offer for pricing.

- **The clean energy development fund (CEDF)** – Established in 2005 to promote the development and deployment of cost effective and environmentally sustainable electric power resources offers low interest loans for projects based in Vermont. The CEDF was funded through an MOU with Entergy through 2012.

[81] Ibid..

- **Vermont Small Scale renewable Energy Incentive Programs** offers incentives for solar and wind energy projects. Technical assistance and consumer information on solar and wind as well as a list of solar and wind partner installers is found on the companion site Renewable Energy Resource Center.

- **Corporate tax credit** - Vermont offers a corporate tax credit for equipment that uses solar energy for water heating, process and photovoltaic installed on business properties. The credit is 24% of the Federal Vermont property portion and is in effect from 2011- to 2016.

- **Net Metering** – customer generation allowed to be fed on the grid and credited to customer's next bill at retail rates.

Property Assessed Clean Energy (PACE) [82]**–** Act 45 was passed by the Vermont State Legislature in May 2009 allowing Vermont communities to establish property assessed clean energy (PACE) districts to make it easier for building owners to invest in energy efficiency and / or renewable energy projects in existing homes and businesses. This new program will allow for re-payment terms that are longer, which may encourage more customers to undertake energy efficiency projects. It also allows for electric, thermal and renewable energy projects to be funded in a way that keeps both the benefits and the payment obligation tied to the property should it change hands.

Vermont Comprehensive Energy Plan – Energy Plan describes Vermont's current energy demands, sources of energy, policies and programs that address energy use and long term goals for the future including attaining 90% of Vermont's energy from renewable sources by 2050[83]**.**

Vermont's Low Income Weatherization Services – Stably funded program that provides more comprehensive services than other states with whole house assessments, state of the art building diagnostics and full service retrofits with air sealing, insulation and heating system upgrades.

Vermont Clean Cities Coalition –promotes vehicle fuel efficiency, alternative fueled vehicles including electric vehicles, transportation alternatives, anti-idling campaigns and programs that reduce vehicle miles travelled. This initiative is housed at the UVM Transportation Research Center.

Building Energy Codes – Vermont has both residential and commercial minimum energy efficiency standards for new construction and major renovation.

Burlington District Energy System – is a plan for the McNeil Station to produce and transport steam to close by facilities (e.g. University of Vermont, Fletcher Center) to use for space heating and domestic hot water, eliminating the need for individual systems**.** This system would provide environmental benefits by displacing fossil fuels and using wood from Vermont forests.

[82] http://www.efficiencyvermont.com/about_us/energy_initiatives/pace.aspx
[83] http://www.vtenergyplan.vermont.gov/

Conclusions

As has become evident throughout the report, a large number of factors affect energy consumption, supply, and needs. These range from population growth, economics, fuel choices, technology advances, public policy and regulations, to land use. Needs are different by sectors, and different for rural and urban areas.

The results of this report highlight strengths and weaknesses of available energy data. For example electricity and gas consumption is tracked by utilities and can be reported at the town level. Other fossil fuels are tracked at the state level and many assumptions need to be made to assign then to the town level. For commercial and industrial this is impossible without more research to identify the types of business that are located in each town, and even with that it would be difficult to produce town level results. As planners choose indicators and baselines from which to measure progress of initiatives and plans, careful understanding of data quality will be important to choose the appropriate indicator.

Municipal planners in Vermont have extensive resources to use while developing and implementing an energy plan. Vermont leads the nation with respect to initiatives that support efficiency and renewables including incentive programs and technical assistance that can be leveraged by municipalities. The Vermont legislature has put in place enabling legislation to adopt PACE which would promote more weatherization in a town. The state has developed a progressive comprehensive energy plan that municipalities can align activities with the state long term goals of energy reductions and renewable energy production.

Planning for the energy section of a sustainability plan cannot be done in isolation from other key components of society, such as the economy, housing, health, land use, transportation, etc. This is where the ECOS project gains its strength by bringing together the many different sectors that influence the path toward sustainability.

Appendix A: Overview of Data Sources and Assumptions Use in Report Analysis and Appendix B

Energy Trends by Fuel 1990-2009 for residential, commercial and industrial, and transportation sectors: Energy Information Agency (EIA), http://www.eia.gov/state/state-energy-profiles.cfm?sid=VT. Data was extrapolated for Chittenden County using the ratio of households in Chittenden County vs. Vermont (25%) and businesses in Chittenden County vs. Vermont (33%).

Energy End-use Analysis

Residential Assumptions: Electrical consumption by end use was calculated using market penetration data adjusted for towns that do not have access to natural gas service. Consumption was calculated by multiplying the number of household by the penetration rate and the unit energy consumption (UEC).

Due to assumptions made regarding the penetration rate of technologies in Chittenden County, and assuming that they are the same in Vermont as a whole, and estimating these rates in towns without natural gas leads to imprecision when reporting the sum of all end uses for each town.

Therefore, aggregated town level consumption data from the Efficiency Vermont Website should be used when considering the sum of all electrical end-uses in Chittenden County

References used for electricity consumption:

- Efficiency Vermont Town level data, 2009, http://www.efficiencyvermont.com/about_us/energy_initiatives/vt_town_energy.aspx
- Market Penetration: "Overall Report for Existing Homes in Vermont FINAL, Submitted to : Vermont Department of Public Service, Submitted by: Nexus Market search, Inc., RLW Analytics, Inc., Dorothy Conant, June 8, 2009", and professional judgment where indicated.
- ACS 2006: American Community Survey, Census Bureau, 2006
- Energy Information Agency, Residential Energy Consumption Surveys, 2009, Appliances and Consumer Electronics in Northeast Region.
- Combination of the end use and fuel type assumptions were used to calculate the thermal fuel split by end use and Town.

Thermal fuels consumption by end use was calculated differently for natural gas and other fuels, because Town level consumption data was only available for natural gas. For natural gas, the Town's consumption is multiplied by the percentage attributed to each end use. For other thermal fuels, the statewide consumption data was multiplied by each Town's proportion of non-natural gas customer's to the total number of households in Vermont. This Town level consumption was then multiplied by the percentage attributed to each end use for each fuel. Town specific data was provided by Vermont Gas for Chittenden County Towns.

Due to the high level data source used for thermal fuels (state level data for all fuels but natural gas), and assumptions regarding what proportion of households using one fuel for heat and/or hot water, the end-use results by Town must be taken cautiously with a clear understanding of the limitation of the data and the resulting low precision of the Town level data for fuels other than natural gas.

References used for thermal fuel consumption:

- Town level residential consumption data provided by Vermont Gas, 2010
- Number of households: Efficiency Vermont Town level data, 2009, http://www.efficiencyvermont.com/about_us/energy_initiatives/vt_town_energy.aspx
- Energy Information Agency, Residential Sector Energy Consumption Estimates, 1960-2009, Vermont (http://www.eia.gov/state/seds/hf.jsp?incfile=sep_use/res/use_res_VT.html&mstate=Vermont)
- Professional judgment where data was not avialble

Commercial Assumptions

- Obtained EIA data for commercial and industrial for "Non-Electric Fuel Use" in Vermont
- Used available information and professional judgment to allocate percent of specific fuel use to Chittenden County
- Obtained CBECS data which determines the percent of energy, by end use by fuel type.
- Used distribution of energy used between building type to allocate energy by building, then used percent distribution to end use.
- CBECS building types and Industrial were merged into the building types used by the electric study.
- Number of businesses is census category called "private number of non-farm establishments" 2008

Transportation

- **Annual Trips**: Base year trip Production model: CCRPC (formerly CCMPO), data from PowerPoint presented for CCRPC Transportation Model Training Session, September 7, 2011.
- **VMT:** Data source: VTrans HPMS Data, Chittenden County VTrans Vehicle Miles of Travel (VMT) History, CCMPO 2009
- **Cars gas mileage** CAFÉ fuel economy standards: average gas mileage of new cars sold from 1978 to 2010
- **2009 road miles by town**: http://www.aot.state.vt.us/Planning/Documents/HighResearch/Publications/2009HwyMiles_town.pdf , Figures reported as of February 10, 2009
- **Number of workers who did not work at home**: http://www.ccmpo.org/data/ctpp/Chittenden_County.pdf
- **Number of trips annually annual miles** : **residential** : U.S. Department of Transportation, Federal Highway Administration, 1990 Nationwide Personal Transportation Survey: Summary of Travel Trends, FHWA-PL-92-027, Washington, DC, March 1992, Table 7. 1990 adjusted data - Oak Ridge National Laboratory, Oak Ridge, TN, August 1998. 1995 NPTS, 2001 and 2009 NHTS data were generated from the Internet site nhts.ornl.gov . (Additional resources: www.fhwa.dot.gov , www-cta.ornl.gov/npts)
- **Commercial:** CCMPO freight study

Appendix B – Excel spreadsheets