A Report from the University of Vermont Transportation Research Center

The Vermont Transportation Energy Report

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Vermont Clean Cities Coalition

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Disclaimer

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Table of Contents

List of Tables

List of Figures

1. Introduction

This annual report aims to provide policy makers with relevant and timely data on a variety of topics related to transportation energy use in Vermont. Topics include levels of fuel consumption, vehicle purchases, transportation expenditures, and travel behavior in Vermont. This information is intended to form the basis of data-driven policy discussions and initiatives and is a publication of the Vermont Clean Cities Coalition (VCCC), whose mission is to reduce the state's reliance on fossil fuels for transportation. The VCCC is funded by the U.S. Department of Energy and the University of Vermont Transportation Research Center (UVM TRC), which has served as the host of the VCCC since July 2007. Nationwide, there are 87 local Clean Cities Coalitions in 46 states. VCCC stakeholders include fleet managers, state and local officials, auto dealers, students, and academics.

The transportation sector remains the largest energy user in Vermont, and thus a primary focus in reducing the state's energy and fossil fuel use (Figure 1-1).[1, 2] Vermont's total energy usage is the lowest of any state (Table 1-1) and per capita energy usage is ranked 43rd.[3] In the nation as a whole, and in most states, the industrial sector is generally the largest single consumer of energy. This is not the case in Vermont due to the lack of large scale industry.

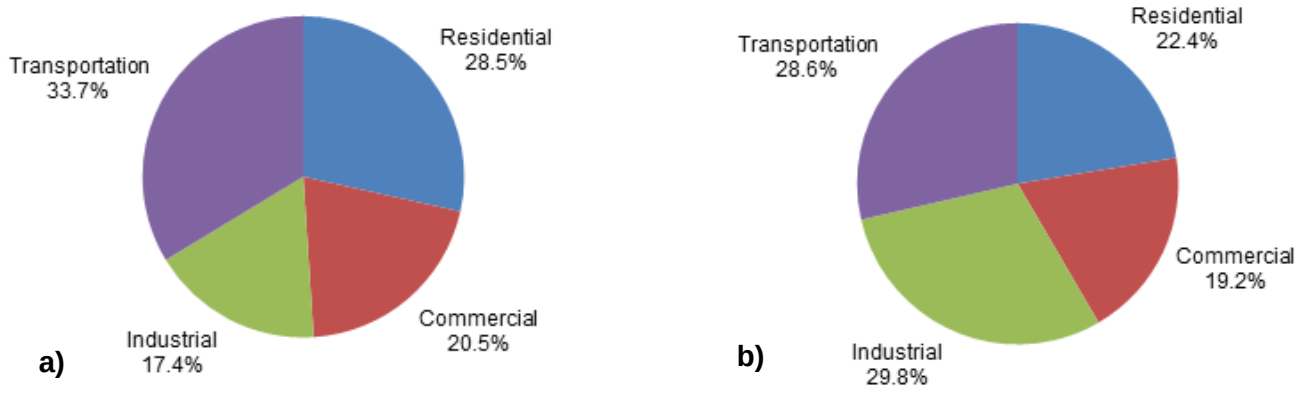

Figure 1-1 Energy Use by Sector in Vermont (a) and the U.S. (b), 2008

Table1-1 Total Energy Use by State, 2009

State	Rank	Energy Consumption (trillion Btu)
Maine	41	430.5
North Dakota	42	426.8
Montana	43	411.5
South Dakota	44	359.9
New Hampshire	45	303.0
Hawaii	46	269.8
Delaware	47	254.7
Rhode Island	48	219.3
District of Columbia	50	182.4
Vermont	51	158.1

Energy use is closely linked to greenhouse gas emissions. As of 2008, Vermont's transportation sector was also the largest source of greenhouse gas emissions (47%; Figure 1-2). [4] In contrast, nationally, transportation accounts for only 27% of the greenhouse gas emissions from fossil fuel combustion.[5] The large percentage of emissions generated by the transportation sector in Vermont makes it an important policy focus within the state.

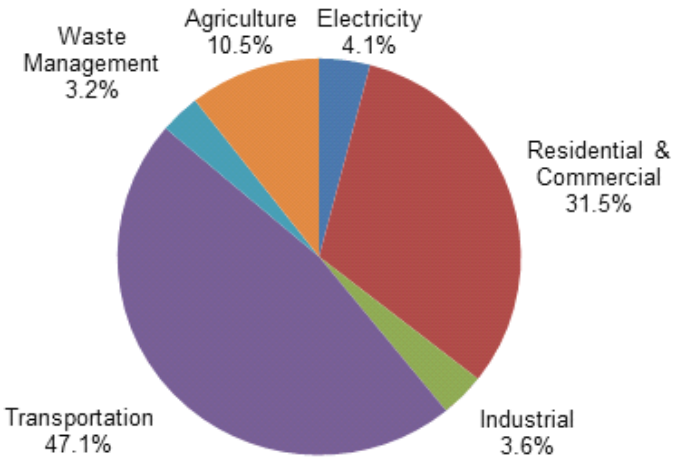

Figure 1-2 Vermont GHG Emissions by Sector, 2008

In this report, we focus on factors that impact transportation energy demand, including trends in vehicle fleet composition and Vermonters' travel patterns, as well as transportation expenditures. Aviation is excluded because information on energy use by this sector was not available.

2. Fuel Sales

2.1 Gasoline and Diesel Sales

Gasoline sales continued to drop in 2010 while diesel sales rose slightly from 2009 levels (Table 2-1). Approximately 85% of the fuel sold in Vermont was gasoline, nearly all of which is used for personal travel.[6] Of the 60.5 million gallons of diesel sold in Vermont, an estimated 7 million gallons were for agricultural rather than transportation uses. [7]

Currently, there are no available estimates of biofuel sales in Vermont. Much of the biodiesel used in the state is blended with heating oil and used for residential and commercial purposes. In Vermont, there may be more promise in small scale biodiesel production for on-farm use than in a large-scale fuel shift to biodiesel. Prices of B-5 blends (5% biodiesel, 95% conventional diesel) are generally three to five cents per gallon higher than conventional diesel. In the current economic climate, even such a small price differential may be enough to discourage expanded use of biodiesel. However, the federal tax credit of $1/ gallon was reinstated (and retroactive) in December 2010, which may improve or stabilize biodiesel sales in the near future. Generally, there has been a shift away from B-20 and towards B-5 biodiesel blends in Vermont.[8]

Table 2-1 Gasoline and Diesel Sales in Vermont (millions of gallons)

	2006	2007	2008	2009	2010	% change 2006-2010
Gasoline [9]	344	348	337	337	332	-3.4%
Diesel [9]	72	70	64	59	60.5	-16%
Biodiesel [8]	0.8	1.1	1.2	--	--	--
Total	418	418	401	396	392.5	-6%

Both gasoline and diesel prices in Vermont spiked in the summer of 2008, fluctuating by more than $1.25 per gallon over the course of the year. In 2010, gasoline prices fluctuated less dramatically (~$0.25 per gallon) and rose steadily at the year's end to $3.41 per gallon in December. Gasoline prices in Vermont hovered slightly below the national average between 2006 and 2009 and in 2010 the two converged at $2.83 per gallon. Diesel prices in Vermont remained consistently above the national average in 2010 (Table 2-2).

Table 2-2 Average Annual Costs of Petroleum in Vermont and the U.S., 2006-2010 [10]

	2006		2007		2008		2009		2010	
	VT	U.S.	VT	U.S.	VT	U.S.	VT	U.S.	VT	U.S.
Gasoline Price/Gallon	$2.59	$2.62	$2.81	$2.84	$3.35	$3.29	$2.34	$2.41	$2.83	$2.83
Diesel Price/Gallon	$2.86	$2.71	$3.02	$2.89	$4.13	$3.81	$2.70	$2.47	$3.16	$2.99

Total annual spending on gasoline and diesel increased in 2010, from $941 million in 2009 to $1.1 billion in 2010 (Figure 2-1). With the exception of state taxes and a small profit margin retained by gas stations, the bulk of money spent on transportations fuels is sent out of the state. In Vermont, each gallon of gasoline is taxed an average of 44.1¢ per gallon, consisting of a state tax of 20¢ per gallon plus 2% of the average quarterly retail price, and federal taxes of 18.4¢ per gallon. Revenue generated from the 2% tax is deposited into the Transportation Infrastructure Bond Fund. Of the 20¢ per gallon state tax, the Transportation Fund receives 18.24¢ per gallon, and the remaining tax revenue is split among the DUI Fund, the Fish and Wildlife Fund, and the Petroleum Clean Up Fund. Diesel is taxed at a higher rate, 53.4¢ per gallon, including 29¢ in state taxes, and 24.4¢ of federal tax.[9]

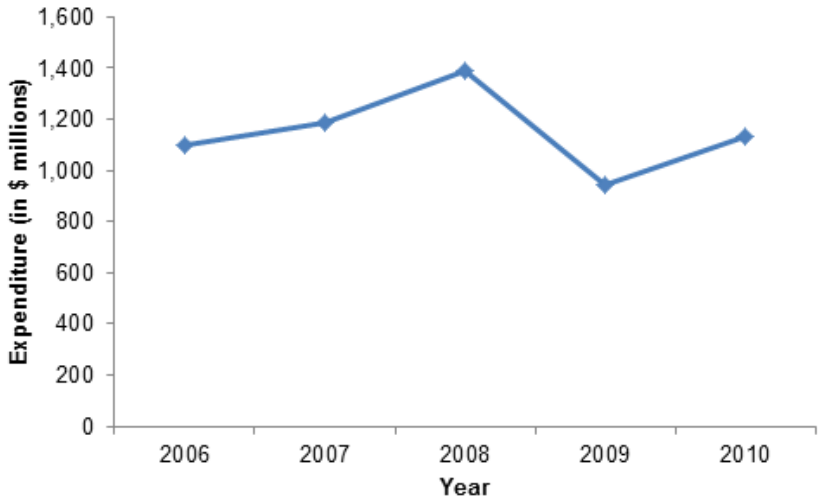

Figure 2-1 Total Annual Spending on Gasoline and Diesel in Vermont, 2006-2010

These estimates of fuel sales are derived from tax revenue and do not include fuel purchased by tax exempt entities such as schools and hospitals, and for use in school buses, fire trucks, ambulances, and police cars, among others, nor fuel purchased outside of Vermont.

2.2 Alternative Fuel Vehicles

Natural Gas Vehicle

As of 2010 there were two compressed natural gas (CNG) filling stations in Vermont, maintained by Burlington Department of Public Works and Vermont Gas. An additional fill station was built in 2011 by Casella Waste Management. These stations are used primarily by fleets such as the University of Vermont and Vermont Gas. In 2010, a total of 2.6 million cubic feet of CNG was sold at these stations, the equivalent of over 20,000 gallons of gasoline or 19,500 gallons of diesel.[11]

Electric Vehicles

Due to both the energy efficiency of electric motors and the ability to generate electricity from sources that emit relatively low levels of greenhouse gases, electric vehicles are often looked to as a means of reducing travel-related greenhouse gas emissions.[12,13] While estimates of greenhouse gas savings vary widely across the U.S., depending on the particular mix of electricity available (e.g., coal, hydropower, nuclear), in Vermont the greenhouse gas benefits are estimated to be especially high, because of the high proportion of hydro and nuclear power used in Vermont.

As electric vehicle and plug-in hybrid electric vehicle technology continues to develop and become commercially available, it is of interest to consider the potential fuel cost savings they may provide. Assuming an average vehicle efficiency of 0.32 kilowatt hours per mile, current electricity prices of 15.57¢ per kWh[14] and 2009 levels of travel (approximately 5.5 billion miles of vehicle travel[*]), the total annual energy costs for an entirely electric fleet would be approximately $274 million for the state of Vermont, which is less than one third the amount spent on petroleum fuels in 2010. Because some portion of the fuel sold in Vermont is sold to vehicles that are passing through the state and the estimated 5.5 billion miles of vehicle travel includes only Vermont residents, this comparison is not perfectly parallel but, nonetheless, gives a sense of the relative costs of these two fuel types. These cost estimates only include fuel costs, not capital and infrastructure investments that would be required to electrify the Vermont fleet.

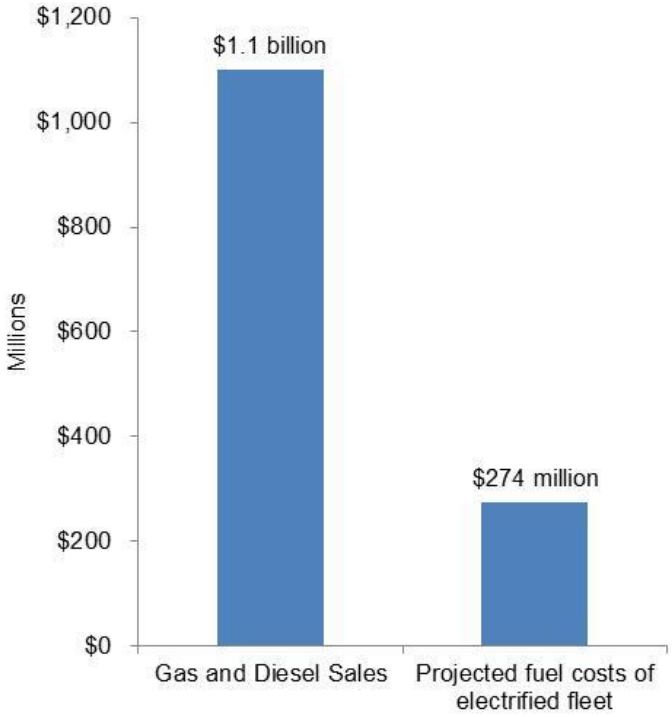

Figure 2-2 2010 Petroleum Expenditures and Projected Fuel Costs of Electrified Fleet at December 2010 $/kWh

**This estimate of Vermonters' vehicle miles traveled was derived from the Vermont National Household Travel Survey, described in Section 4.2 of this report.*

3. Vehicle Fleet

3.1 Vehicle Fleet Composition

The total energy consumed for transportation in Vermont is a function of the fuel efficiency of the vehicles used in the state, the number of vehicles in use, and the number of miles those vehicles travel. After declines in 2008 and 2009, the number of registered vehicles in Vermont increased in 2010.The ratio of vehicles per capita remained stable, however, as the population also grew slightly in 2010 (Table 3-1).

Table 3-1 Vehicle Registrations and Driver's Licenses in Vermont, 2006-2010

	2006	2007	2008	2009	2010
Vehicle Registrations* [15]	575,163	574,370	569,728	568,468	571,900
Driver's Licenses [16]	532,041	538,372	545,336	509,317	518,460
Vermont Population [17]	620,778	621,254	621,270	621,760	625,741
Vehicles per Licensed Driver	1.08	1.08	1.04	1.12	1.10
Vehicle per Capita	0.93	0.92	0.92	0.91	0.91

***Registrations include state vehicles, municipal vehicles, trucks, and autos. This table does not include bus, agricultural vehicle, dealers, handicap placard, motorcycle, or trailer registration.*

Vehicle registration data were obtained for the entire Vermont fleet from the Vermont DMV in July 2010 and July 2011[18] and include information on vehicle date of acquisition, model, and fuel type. In all tables and figures, data obtained in July 2010 were used to characterize the 2009 fleet and data obtained in July 2011 were used for the 2010 fleet. In prior years, similar data were obtained from the Polk Consulting Group.

According to Vermont DMV data, the number of vehicles registered to new owners in 2010 was higher than 2009: ~104,000 in 2010 versus ~87,000 in 2009 (Figure 3-1). New vehicle registrations increased from ~22,000 in 2009 to ~30,000 in 2010, and the number of used vehicle registrations also increased from ~60,000 to ~74,000. Because the DMV database does not distinguish new vehicle purchases from used purchases, we assumed that all vehicles purchased in their model year or later were new vehicles and all others were used vehicles, e.g., for 2010, all 2010 and 2011 vehicle models were assumed to be new purchases while all earlier models were assumed to be used vehicles.

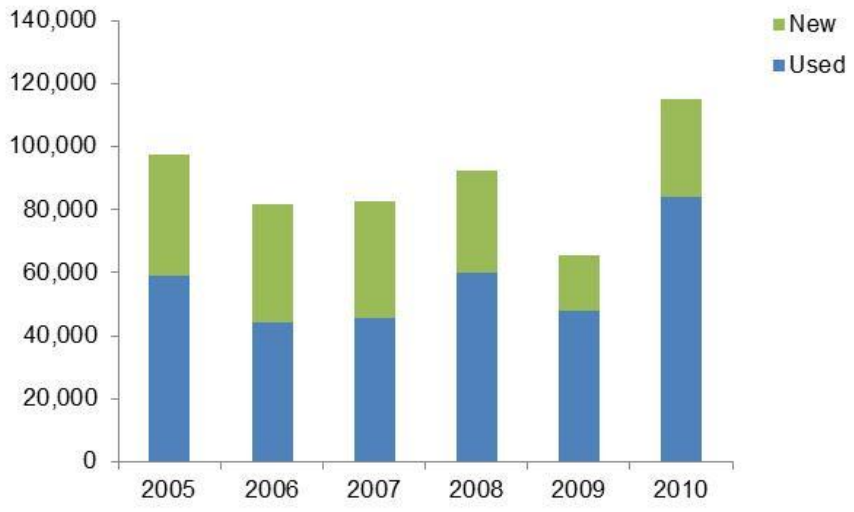

Figure 3-1 Newly Registered Vehicles in Vermont, 2006-2010

3.2 Spatial Patterns in Hybrid Vehicle Registrations and Vehicle Fuel Efficiency

A variety of vehicle drive trains and fuel types are now available to Vermont consumers, including conventional and hybrid gasoline vehicles. Although hybrid vehicles continue to comprise only a small portion of the Vermont fleet, the number of hybrids in the state has grown consistently since 2007 (Table 3-2). Hybrid vehicles comprised 4% of new vehicle purchases in 2010 and approximately 1.2% of the total Vermont fleet.

Table 3-2 All Vehicles Registered in Vermont by Fuel Type

Fuel/Vehicle Type	2007	2008	2009	2010	Change 2007-2010
Hybrids	3,651	4,565	5,473	6,335	73%
Electric	106	101	94	77	-27%
Propane	93	75	69	40	-56%
Diesel	31,648	32,140	30,724	25,025	-21%
Gasoline	583,568	578,881	528,930	514,894	-11%

The spatial distribution of hybrids is not uniform throughout the state. As of July 2010, the proportion of hybrid ownership was highest in Chittenden County, where hybrids comprised 1.5% of all registered vehicles. Essex County had the smallest proportion of registered hybrids at 0.3% of registered vehicles. Likewise, the spatial distribution of vehicle fuel efficiency is not uniformly distributed across the state (Figure 3-2). The vehicle fuel efficiency estimates presented here were provided by Manukyan et al. and were calculated based on vehicle year and model from the Vermont DMV. Data on vehicle fuel efficiency were from the website cars.com.[19] Fuel efficiency estimates were not available for all vehicle models and, consequently, the overall fuel efficiency values reported here were based on data from 206,807 of the state's ~598,000 vehicles.

The majority of those vehicles for which fuel efficiency estimates were available achieve between 20 and 30 miles per gallon (Figure 3-3, Table 3-3).

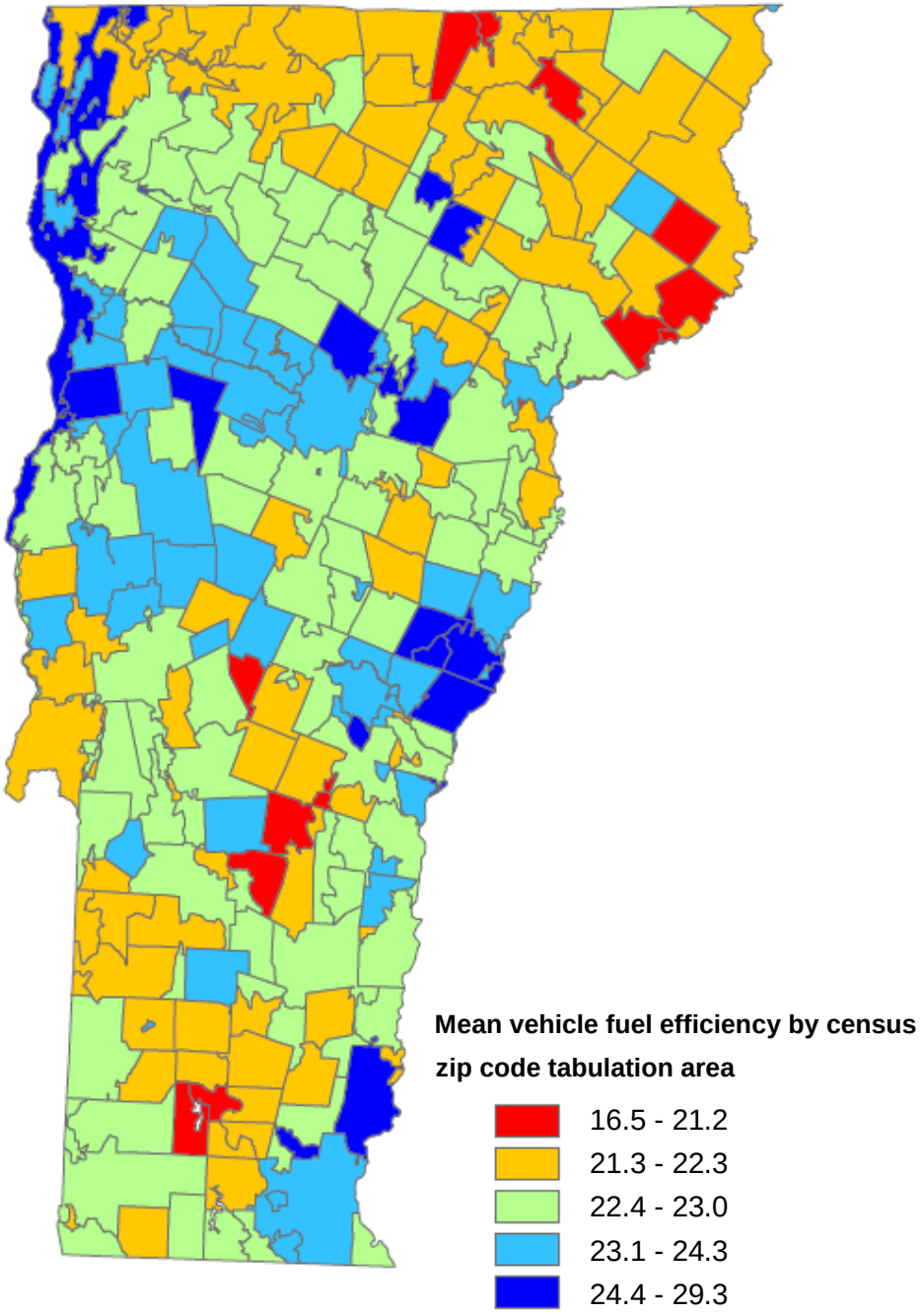

Figure 3-2 Mean Vehicle Fuel Efficiency (mpg) by Zip Code Tabulation Area*

**Zip Code Tabulation Areas (ZCTAs) are approximations of the U.S. Postal Service zip code areas, developed by the aggregation of Census 2000 block groups. In most cases, the ZCTA closely approximates the zip code area.*[20]

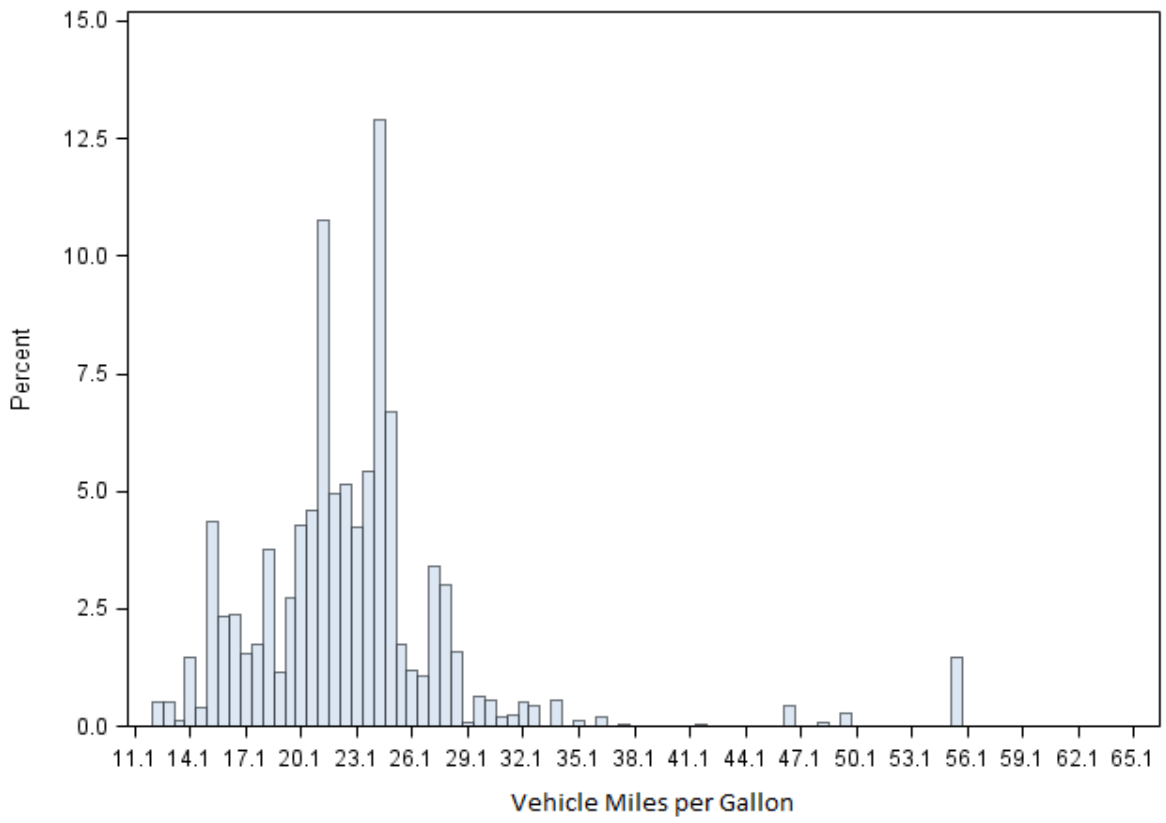

Figure 3-3 Frequency Distribution of Vehicle Fuel Efficiency (mpg) for the Vermont Fleet

Table 3-3 Vehicle Fuel Efficiency (mpg) for the 2010 Vermont Fleet

Vehicle Efficiency in miles per gallon	% Vermont 2010 Vehicle Fleet
Less than 15 mpg (Dodge Durango, Toyota Land Cruiser)	3.2 %
15-20 mpg (Lincoln Town Car, Chevy Blazer)	25.5 %
21-30 mpg (Honda Civic, Saturn Ion)	66.4 %
31-40 mpg (Volkswagen Golf, Toyota Yaris)	2.5 %
40+ mpg (Toyota Prius)	2.5 %

4. Travel Patterns

4.1 Vehicle Miles Traveled in Vermont

Total annual vehicle miles traveled (VMT) is an important input for highway planning and management, as well as being a common measure of roadway use. Along with other data, VMT is often used in estimating congestion, air quality, and potential gasoline tax revenues, and can provide a general measure of economic activity. Sample counts of vehicles are collected through the use of fixed and temporary counters on a variety of road types (e.g., interstate, local road, arterial road) and then extrapolated out to the town, county and state levels. Annual VMT is thus an estimate and not an actual count of vehicles traveling on the roadway. VMT is also 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 [21]).

VMT is a major factor affecting Vermont's transportation energy use. VMT estimates were not available for Vermont for 2010 (as of August 2011), but nationally VMT increased to levels close to those seen in 2007 (Table 4-1). In Vermont, total VMT declined between 2006 and 2009, although VMT per licensed drivers increased in 2009. Reducing VMT would clearly reduce energy use, but alternatives for travel, especially in a rural state, are limited. Increasing vehicle occupancy is one way to decrease VMT without reducing personal travel.

Table 4-1 Vermont and U.S. Annual Vehicle Miles Traveled by Calendar Year, 2006-2010

	2006	2007	2008	2009	2010
U.S. [22]	3.0 trillion	3.0 trillion	2.92 trillion	2.98 trillion	2.99 trillion
Vermont [23]	7.69 billion	7.52 billion	7.18 billion	7.15 billion	Not avail.
Vermont VMT per Licensed Driver	14,454	13,968	13,166	14,038	Not avail.
Vermont VMT per Capita	12,388	12,105	11,557	11,500	Not avail.

We also estimated total gasoline use for each county by multiplying the total 2009 VMT by the mean vehicle efficiency (miles per gallon; derived using the methods described in Section 3-2). Table 4-2 is only meant to serve as an estimate of county-level gasoline use. Not all miles attributed to a given county were driven by residents of that county; an unknown number of miles are due to out of state vehicles driving through Vermont.

Table 4-2 Estimated Gasoline Usage by Vermont County, 2009

County	Total VMT (in million miles)	Mean Vehicle Efficiency (mpg)	Total estimated gasoline use (million gallons)	Per capita estimated gasoline use (gallons)
Addison	399	23.3	17,116,435	466
Bennington	398	22.5	17,693,899	486
Caledonia	388	22.5	17,225,179	569
Chittenden	1,486	23.2	64,035,444	420
Essex	66	21.6	3,052,044	477
Franklin	462	22.3	20,712,834	430
Grand Isle	85	22.7	3,755,879	491
Lamoille	262	22.4	11,701,978	451
Orange	406	23.1	17,557,238	608
Orleans	289	21.9	13,207,669	484
Rutland	647	22.4	28,882,566	458
Washington	670	23.3	28,742,319	490
Windham	634	23.2	27,331,488	629
Windsor	985	23.0	42,844,204	758

4.2 Active Transport: Walking and Bicycling

Walking and bicycling are among the least energy-intensive modes of travel. Active transport is also an important part of obesity prevention and public health. Frequencies of walking and bicycling in Vermont and the nation were estimated using the Vermont portion of the Federal Highway Administration's 2009 National Household Travel Survey (NHTS). The Vermont portion of the NHTS is a comprehensive survey of travel in the state. In Vermont, 1,600 households were surveyed, with data collected from at least 22 households in every county.[24] Surveys were conducted throughout the year to avoid any seasonal bias. Trips include one-way journeys for all purposes, including work, recreation, school, shopping and exercise. Rates were similar between Vermonters and the nation, with both groups biking relatively rarely. In both groups, a quarter to a third of people surveyed reported taking more than 5 walking trips a week (Table 4-3). New research at the UVM TRC is working to estimate pedestrian miles traveled in the state through the use of cameras. Preliminary results suggest that in Chittenden County, cyclist and pedestrians may travel more than 70 million miles annually.[25]

Table 4-3 Vermonter Bicycling and Walking Trips in the Previous Week

	Vermont		Nationwide	
Number of Trips in the Past Week	Bike	Walk	Bike	Walk
0	85.4%	24.6%	87.2%	32.1%
1-2	6.9%	16.9%	8.2%	16.2%
3-5	4.2%	26.3%	4.4%	24.1%
5+	3.6%	31.6%	2.2%	26.6%

Of approximately 10,800 unique trips recorded in the Vermont NHTS dataset, 39% are 2 miles or less and 28% are 1 mile or less, suggesting that many of these trips could be made by bicycle or on foot. Most commonly these trips are for shopping, a trip purpose which may not lend itself well to non-motorized modes of travel. Other common trip purposes for short trips included work and recreation, purposes which may be more amenable to a shift in transport mode.

Presumably, the availability of bicycle and pedestrian infrastructure is a major factor affecting rates of walking and biking. Although data on such facilities are often not collected, estimates of sidewalk and trail facilities in Chittenden County are provided by the Chittenden County Municipal Planning Organization (CCMPO). Town-by-town estimates of miles of existing bicycling and pedestrian facilities in Chittenden County are shown in Table 4-4. On road facilities are areas designated for biking by signs and or pavement markings, and may include bike lanes and paved shoulders. Shared use facilities are typically open to both bicyclists and pedestrians and physically separated from vehicle traffic.

Table 4-4 Bicycling and Pedestrian Facilities in Chittenden County [26]

Town	On road (miles)	Sidewalk (miles)	Shared Use (miles)	Total Roads (miles)*	% Bike/Ped 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%**

**Total Road Mileage includes Class 1, 2, 3 roads and state highways.*

4.3 Travel Demand and Electric Vehicle Range

As mentioned in Section 2.2, electric vehicles have the potential to reduce Vermont's statewide greenhouse gas emissions relative to conventional vehicles because of their overall energy efficiency and relatively low greenhouse gas emissions associated with the electricity used in the state. Electric vehicles come in multiple forms: pure electric vehicles, such as the Nissan Leaf; plug-in hybrid electric vehicles, such as the Chevy Volt; and hybrid electric vehicles, such as the Toyota Prius. Pure electric vehicles are powered entirely by electricity from the electrical grid while plug-in hybrid electric vehicles can be powered both by grid electricity and by gasoline or other liquid fuels. The power for hybrid electric vehicles is derived exclusively from liquid fuels, though a portion of this energy is converted into electricity by generators and regenerative breaking. The all-electric Nissan Leaf is estimated to have a range of 100 miles while Chevy

Volt, one of the first commercially available plug-in hybrids, is estimated to be able to travel ~40 miles on electric power before consuming any gasoline.

Researchers, policy makers and the press have raised questions regarding electric vehicles' ability to meet current travel demand given their limited mileage range. To estimate what proportion of Vermont's travel needs could be served by these vehicles, we used the Vermont portion of the National Household Travel Survey (NHTS) was used to examine the length of vehicle trips in the state. Almost all, 96%, of one-way trips were shorter than 40 miles and therefore within the electric range of a vehicle such as the Volt. However, since public charging infrastructure is currently extremely limited, vehicles will often be unable to charge between trips, which could cause problems for drivers of pure electric vehicles. Consequently, we also examined the length of home-based tours, the group of all trips from the time a vehicle leaves the home until the time it returns home again. As shown in the bottom row of Table 4-5, our analysis suggests that the majority of the state's travel demand could be electrically powered, even if charging is only available at people's homes.

Table 4-5 Percentages of one-way vehicle trips, daily vehicle travel, and home-based vehicle tours within 40 and 100 mile ranges

40 mile electric range		**100 mile electric range**	
% one-way trips < 40 miles	96%	% one-way trips < 100 miles	99%
% vehicles with daily travel < 40miles	68%	% vehicles with daily travel < 100 miles	92%
% home tours < 40 miles	82%	% home tours < 100 miles	96%

Of course the popularity of electric vehicles in the state will depend in part on the availability of vehicle charging. While most charging will presumably occur when a car is parked at home, there may be a need for away from home charging to accommodate longer trips, especially in rural areas. Table 4-6 presents common destination types where people reported staying for at least one hour, enough time to allow for a useful amount of vehicle charging to take place. These destination types may have a high potential to serve as sites for vehicle charging stations. We estimate that with widely available work place charging, ~ 90% of the Vermont fleet could be replaced with some form of electric vehicle while still meeting current daily travel demand.

Table 4-6 Common destinations with a dwell time of one hour or greater (excluding home)

Destination	Frequency
Work	40%
Recreation	24%
School or religious worship	11%
Shopping	8%
Meal out	7%
Medical appointment	2%
Other	8%

Some characteristics of good charging locations would include:

- parking structures already equipped with electricity infrastructure (e.g., lighting)
- destinations where trip distance and/or dwell time are long (recreation, tourism, work)
- areas with robust electric grid/smart grid capability [27]

In Figure 4-1, exact locations of stops greater than one hour long made on vehicle tours greater than 40 miles are presented. Clusters of these destinations may serve as optimal sites for vehicle charging stations.

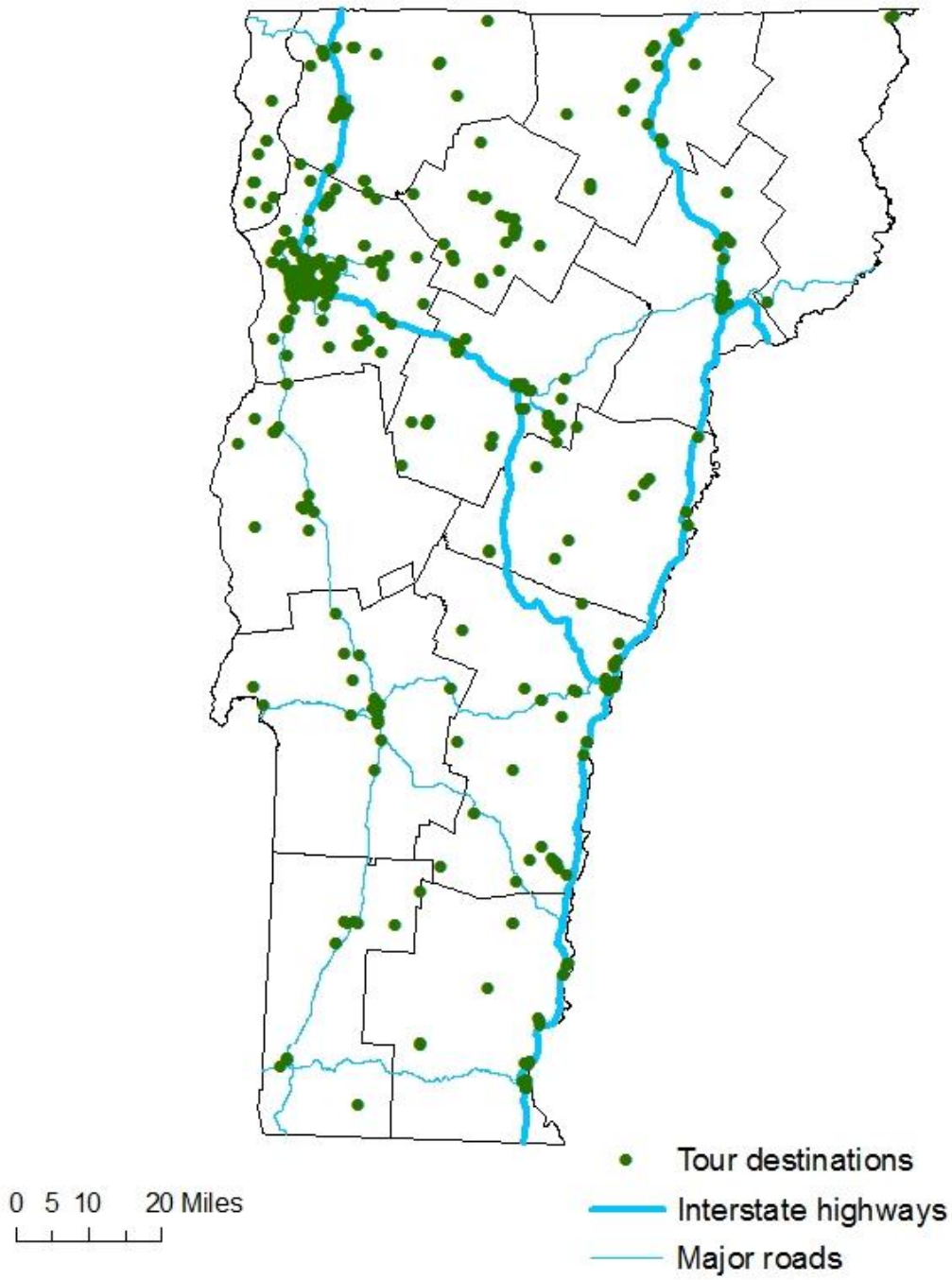

Figure 4-1 Destinations on home-based tours > 40 miles with dwell times of at least one hour

5. Transportation Expenditures: Costs of the Current System

5.1 The Cost of Vehicle Ownership

When calculating the cost of vehicle ownership, people often consider only the vehicle's purchase price and fuel costs. However, when factors such as maintenance, depreciation, and insurance are also accounted for, this cost grows substantially. Each year, the American Automobile Association (AAA) estimates the total cost of car ownership (Table 5-1). For 2010, this cost was estimated to vary between $6,496 for a small sedan and $11,085 for an SUV. [28]

Table 5-1 Annual Vehicle Ownership and Operating Expenses, 2010

Type of Cost	Small Sedan	Medium Sedan	Large Sedan	Sport Utility Vehicle	Minivan
Gas and Oil/Mile	9.2 ¢	11.8 ¢	12.9 ¢	16.4 ¢	17.7 ¢
Maintenance/Mile	4.2 ¢	4.4 ¢	5.0 ¢	4.9 ¢	4.9 ¢
Tires/Mile	0.6 ¢	0.9 ¢	0.9 ¢	1.0 ¢	0.8 ¢
Operating Costs/Mile	**14.1 ¢**	**17.3 ¢**	**18.8 ¢**	**22.3 ¢**	**19.3 ¢**
Insurance	$1,005	$1,004	$1,084	$964	$934
License and Registration	$427	$583	$745	$735	$618
Depreciation	$2,384	$3,451	$4,828	$5,003	$3,995
Finance Charges	$565	$803	$1,050	$1,036	$857
Ownership Costs per Year	**$4,381**	**$5,841**	**$7,707**	**$7,738**	**$6,404**
Total Cost for 15,000 Miles per Year	**$6,496**	**$8,436**	**$10,530**	**$11,085**	**$9,301**

5.2 State Expenditures

Table 5-2 outlines expenditures by the Vermont Agency of Transportation (VTrans) since 2006. Overall expenditures increased over this period, from $338 million to $459 million. Items in bold are programs and infrastructure devoted exclusively to non-single occupancy vehicle (SOV) transportation options, such as Park and Ride facilities and public transit. The combined proportion of budget expenditures on such programs declined from an estimated 11% in 2009 to 8% in 2010.

Table 5-2 Vermont Agency of Transportation Expenditures by Fiscal Year, 2006-2010 [29]

Budget Line Items*	2006	2007	2008	2009	2010
Total Transportation Expenditures (in millions)	$338	$388	$385	$395	$459
Paving and Maintenance	28 %	29 %	33 %	34 %	32 %
Roadway	15 %	14 %	10 %	9 %	10 %
Bridges (incl. Maintenance)	8 %	9 %	6 %	7 %	14%
Town Programs	15 %	17 %	17 %	16 %	13%
Finance, Planning, DMV	11 %	12 %	12 %	11 %	8%
Public Transit	***4 %***	***4 %***	***5 %***	***5 %***	***4 %***
Pedestrian and Bike	***1 %***	***1 %***	***<1 %***	***1 %***	***1 %***
Park and Ride	***<1 %***	***<1 %***	***<1 %***	***1 %***	***<1 %***
Multi-Modal	***<1 %***	***<1 %***	***0***	***<1%***	***0***
Rail	***2 %***	***3 %***	***3 %***	***3 %***	***2%***
Percent Budgeted to Non-SOV Options	***8 %***	***8 %***	***9 %***	***11 %***	***8%***

**Bold italicized items are considered line items for alternatives to the SOV. This table does not include all budget categories.*

Estimating Vermonters' Access to Personal Vehicles

We estimate that the proportion of Vermonter's with limited access to personal vehicles may be substantially larger than the percentage of the VTrans budget devoted to modes of transport other than the SOV. To assess Vermonters' access to personal vehicles, we calculated the number of Vermonters over 16 years of age who are non-drivers and have legal restrictions on their ability to drive, or who lived in a household with fewer vehicles than licensed drivers. The NHTS, described in Section 4.2, was used to estimate the number of people in the state older than 16 years who identify themselves as 'non-drivers'. For a more complete estimate of Vermonters more than 16 years of age whose ability to drive is limited, we also included the number of drivers with learner's permits and those people with suspended licenses. We then used the NHTS again Vermont drivers' vehicle access. Respondents were asked how many drivers lived in their household, as well as the number of vehicles at the household. We used this data to estimate the number of Vermont drivers living in households with fewer vehicles than drivers (Table 5-3).

We estimate that approximately 92,000 Vermonters over 16 years old (approximately 15 % of the total population), do not have full time vehicle access. This portion of the population would presumably benefit from a diverse set of transportation options, including bicycle and pedestrian infrastructure and well developed public transit and car pool programs. This estimate does not include Vermonters younger than 16 years of age, who presumably also have transportation needs, nor does it account for those people who may have a vehicle but lack the resources to purchase fuel, or those individuals with a vehicle in a state of disrepair.

Table 5-3 Estimating Vermonter Vehicle Access

Vermont population 2010 [20]	**625,741**
Estimated # non-drivers ≥ 16 years old	37,397
Total permitted drivers [15]	17,392
Suspended licenses [30]	16,313
Estimated # drivers living in a household with no vehicles	2,618
Estimated # drivers living in a household with a driver: vehicle ratio of 2:1 or more	4,756
Estimated # drivers living in a household with a driver: vehicle ratio greater than 1:1	18,992
Total estimated number of Vermont drivers without full time vehicle access (permitted drivers + unlicensed people ≥ 16 years old + suspended licenses + # drivers at households with >1 driver per vehicle)	**92,094**

Medicaid Transportation Expenditures

The Office of Vermont Health Access (OVHA), part of the Agency of Human Services, contracts a number of public transit providers for Non-Emergency Medical Transportation (NEMT) and presents another transportation cost to the state. NEMT is a covered service for eligible beneficiaries enrolled in traditional and Primary Care Plus Medicaid and the Dr. Dynasaur programs. As shown in Table 5-4, transportation spending by OVHA increased steadily between 2006 and 2009, but declined in 2010.

Table 5-4 Medicaid Transportation Expenditures, Fiscal Year 2006-2010 [31]

	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
Expenditures	$9,424,484	$9,900,218	$10,663,296	$11,694,573	$10,644,485

Federal Stimulus Funds

VTrans received $125 million in federal stimulus money from the American Recovery & Reinvestment Act (ARRA). The bulk of this money has been devoted to paving projects. Vermont also received $5.6 million of ARRA funds to be spent on public transit. These funds will be used to replace some of the CCTA bus fleet. In addition, ARRA appropriated $8 billion to rail projects, of which Vermont received $52.7 million. Fifty million dollars of these funds will be used for track, bridge, and crossing upgrades along the Vermonter route (Washington, D.C.-New York-St. Albans). Additional funds will be used for a rail planning study of development of a new route in southern Vermont. [32]

5.3 Municipal Transportation Expenditures

Municipal expenditures may be sizable and to our knowledge are not compiled for the state in total. To present a more comprehensive view of transportation spending, we contacted each of Vermont's 261 municipalities requesting a copy of their town budget. Usable data were obtained from 178 of these municipalities. We then calculated the amount spent by each town on

transportation. Generally this consisted of the municipalities' total highway budget, but when applicable we added transportation-related expenses found in other categories, such as Park and Ride facility upkeep, street lights, and bike and walking path maintenance. Although variation exists in town budget tabulation, we attempted to standardize as much as possible among towns to allow for meaningful comparisons. For each town, we recorded total dollars expended and total dollars expended on transportation.

The proportion spent on transportation varied widely among towns, with three of the towns reporting transportation costs of more than 80% of total expenditures. Three towns reported transportation expenditures less than 10%. The mean percentage of total budget spent on transportation costs in 2010 was 41% ± 19. Per capita, spending on transportation averaged $395 ± $359 and ranged from over $3,000 spent per town resident to $8 spent per resident. As might be expected, transportation expenditures were correlated with total miles of road maintained by each town, although this relationship varied considerably (Figure 5-3). On average, each town spent $11,000 ± 4,900 per mile of town road. Figure 5-4 presents a spatial depiction of municipal transportation expenditures (expressed as % of total expenditures). (See Appendix A. for complete list of towns included in this analysis).

Table 5-5 Municipal Transportation Expenditures, 2010

Total Municipal Expenditures on **Transportation (n=175)**	**Mean per capita Municipal Expenditures on Transportation**	**Mean % of total budget spent on Transportation**
$117 million	$395± 359	41%± 19

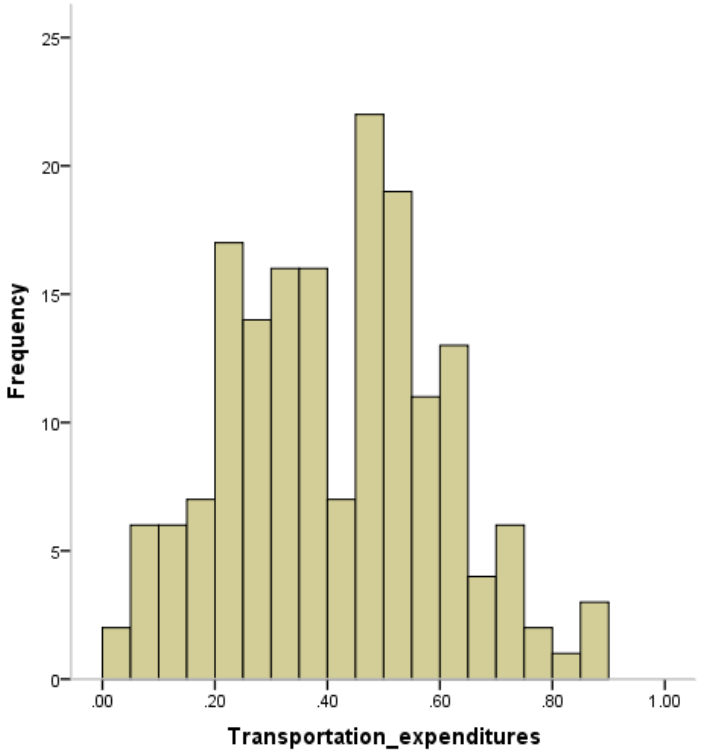

Figure 5-1 Municipal Transportation Expenditures (% of total expenditures)

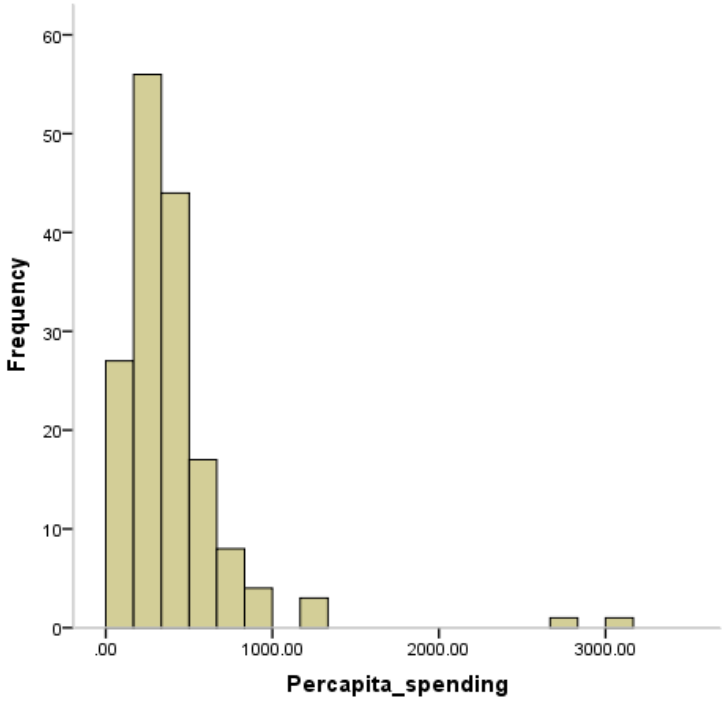

Figure 5-2 Per Capita Municipal Transportation Expenditures ($)

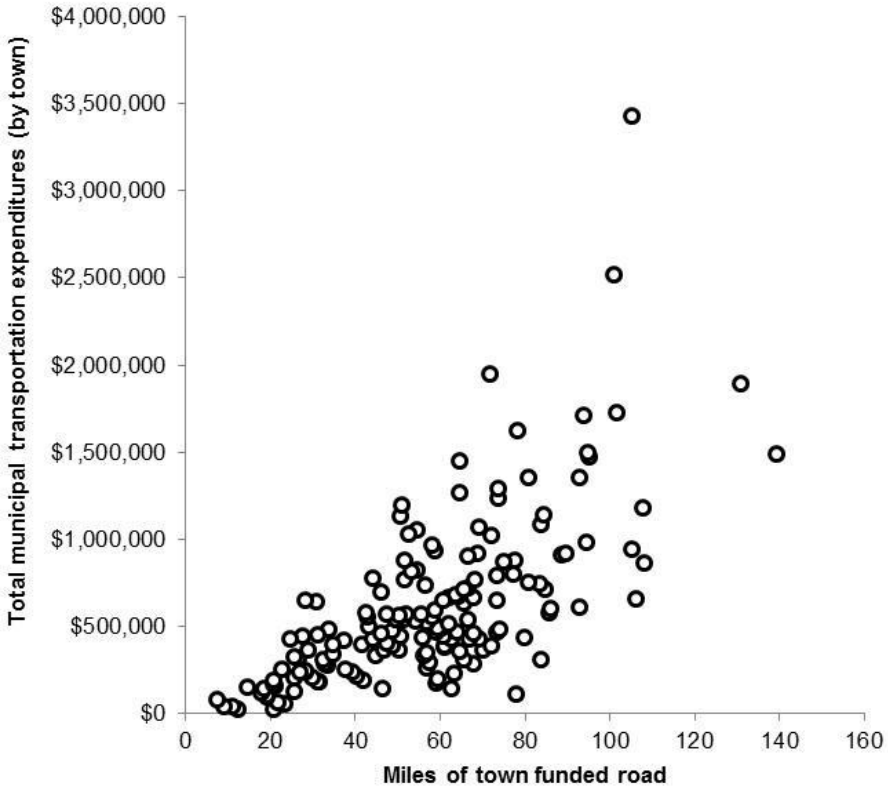

Figure 5-3 Total Municipal Transportation Expenditures by Town vs. Miles of Town Funded Roads

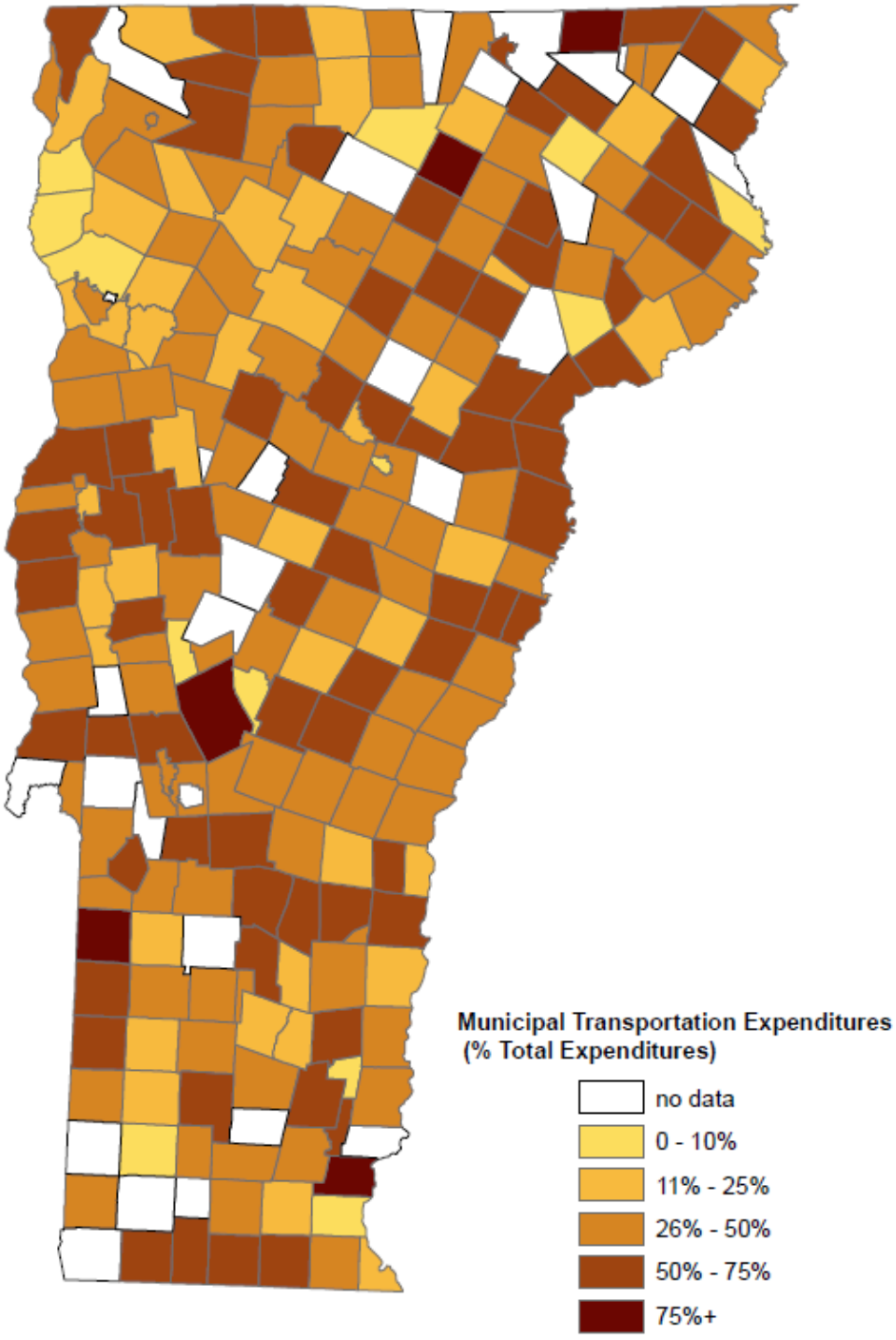

Figure 5-4 Spatial Distribution of Municipal Transportation Expenditures (% of Total Expenditures)

5.4 Department of Education Transportation Expenditures and Travel to School

The Vermont Department of Education tracks transportation expenditures, as well as the number of school buses and miles traveled by those buses. Between the 2009 and 2010 school years, the number of buses increased by 6%, while miles traveled by buses increased nearly 30% (Table 5-6).[33] Total expenditures have increased steadily since 2006, presumably due to increased fuel costs and miles traveled. The consistent increase in school expenditures on transportation is somewhat puzzling given declines in overall enrollment and an increasing percentage of students traveling to school via personal vehicle.

Table 5-6 School Bus Transportation Data, 2005-2010

	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	Percent Change 2005- 2010
Number of School Buses	1,194	1,084	1,176	1,103	1,150	-3%
Number of School Bus Miles Traveled	12,199,177	10,902,941	12,103,914	13,575,807	14,081,750	15%
Total **Expenditures**	**$42,243,897**	**$44,684,921**	**$48,388,374**	**$50,204,260**	**$53,450,211**	**26%**

Additional information on Vermont student travel to school is available in the Vermont NHTS. The NHTS collected journey to school information on 220 Vermont students. Respondents were asked how they (or their child) 'usually' traveled to school, as well as how they traveled to school on the day the survey was administered. The difference between the two is pronounced, with 23% more respondents using a personal vehicle than reported that they usually do so (Figure 5-5). Mean journey to school distance of respondents was 5.1 miles.

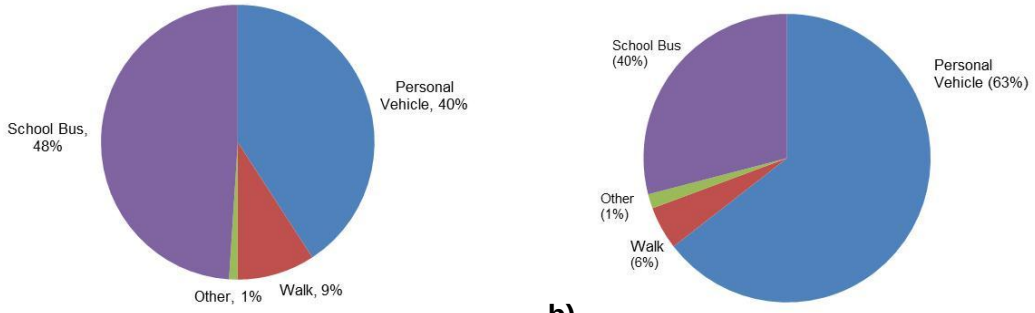

Figure 5-5 a) Reported 'Usual' and b) 'Actual 'Transportation Mode of Vermont Students

Safe Routes to School Program

Safe Routes to School (SRTS) is a federal program that aims to increase the number of children walking and biking to school. SRTS promotes active transportation through education and works to remove barriers that may prevent such transport to school. Barriers may include lack of or unsafe infrastructure, such as sidewalks, bike lanes, and crossing guards. The program focuses on kindergarten through Grade 8 and provides a way to improve public health and reduce VMT. Nationwide, rates of walking and biking to school have declined dramatically in the past few decades and rates of children being driven to school by parents have increased. A majority of Vermont NHTS respondents reported that distance to school, speed of traffic, and amount of traffic were all serious impediment to their child either biking or walking to school.

The Vermont SRTS program funds projects throughout the state, including surveys, pedestrian and bike safety education, and the development of pedestrian and bike infrastructure. This program has received approximately $1 million in federal funding each year between 2005 and 2009. In 2010, an estimated $1.3 million dollars in infrastructure grants were awarded to 22 Vermont schools. As of December 2010, seven infrastructure projects had been completed in the state and three were underway. Infrastructure projects include sidewalk construction and improved signs in areas close to schools. [34]

5.5 Estimating Total Transportation Expenditures in Vermont

It is also of interest to estimate the total amount expended on transportation in the state, by government agencies, residents, tourists, and other entities, as a proxy for energy use. This estimate is by no means complete but rather is intended to demonstrate what portion of the Vermont economy transportation comprises, with relevance to all sectors and falling under the jurisdiction of a variety of agencies and entities. According to the most recent economic data available through the U.S. Department of Commerce, between 2007 and 2009, Vermont's total gross domestic product approximated $25 billion annually (in 2010 dollars).[35] By our estimates, at $3.85 billion dollars, transportation may comprise approximately a sixth of the state's economy (Table 5-7).

This estimate of total transportation expenditures does not include non-taxable fuel purchases. Inclusion of spending on transportation by Vermont's colleges is limited to the University of Vermont, the state's largest university, and includes only spending on parking and transportation services (such as the university shuttle services).[36] It does not include transport of students to athletic or other extra-curricular events. Similarly, transit fares paid by passengers for bus and train service were included, but only those reported by Chittenden County Transportation Authority (CCTA), the state's largest provider of bus service, [37] and Amtrak.[38] Estimates were not available from other transit providers. This estimate of transportation expenditures does not include expenditures associated with aviation or freight.

Table 5-7 Total Estimated Transportation Expenditures in Vermont, 2010

Expenditure	Amount
Gas and diesel sales	$1.1 billion
Municipal spending	$117 million
VTrans total budget	$459 million
Car maintenance, operation and ownership*	$2.15 billion
CCTA passenger fares	$1.29 million
Amtrak fares	$2.4 million
Transport to/from school (school buses)	$53.45 million
Medicaid transportation costs	$10.64 million
University of Vermont Parking and Transportation Services	$353,000
Estimated Total Transportation Expenditures	**$3.85 billion**

**Derived from AAA estimates in Table 5-1. Assumes an average vehicle of type of small sedan and excludes fuel costs (included in gas and diesel sales) and vehicle depreciation ($2,384). 10% of registered vehicles are assumed to be out of use: 514,710 vehicles * [$3,457 annual ownership costs + ($0.05 /mile operating cost * 14,600 average VMT/vehicle)].*

6. Programs and Services that Impact Transportation Fuel Use

6.1 Transit Ridership

Buses

A variety of public transit options are available to Vermonters throughout the state. As documented in Table 6-1, ridership has fluctuated among transit providers from the past five years. These fluctuations are due in part to changes in bus routes.[39] For example, route cuts are believed to account for some of the reduced ridership on Marble Valley Regional Transit buses between 2006 and 2010. Overall, those providers for which data are available, ridership increased between 2006 and 2010. Estimates were not available for all providers and do not include dial-a-ride services.

Table 6-1 Bus Ridership for Vermont Transit Providers, 2006-2010

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%
Green Mountain Transit Agency	237,287	243,244	297,160	339,345	334,394	44%
Addison County Transit	65,362	70,690	77,464	78,755	78,401	20%
Advance Transit (Fixed Route)	730,567	688,628	784,078	843,245	802,962	10%
Brattleboro Beeline	50,652	57,800	--	47,753	--	--
Connecticut River Transit	34,066	39,408	52,391	--		--
Deerfield Valley Transit	199,410	182,286	207,835	227,017	--	--
Green Mountain Community Network (Started 2007)	--	--	21,210	24,190	54,913	159%
Marble Valley Regional Transit District	751,311	628,882	597,277	584,999	540,306	-28%
Rural Community Transit	208,329	215,692	239,537	--	--	--
Stagecoach	93,708	95,476	97,681	58,184	--	--

Rail

At present, Amtrak runs two passenger rail lines in Vermont: the Ethan Allen Express (New York-Albany-Rutland) and the Vermonter (Washington, D.C. - New York - St. Albans). Amtrak ridership increased by more than 50% between 2006 and 2010, suggesting Vermonters and visitors to the state may be seeking alternatives to vehicle and air travel. On average, the energy efficiency of rail travel is greater than the single occupancy vehicle and comparable to air travel.[40] See the 2009 Vermont Transportation Energy for further discussion of transport mode and energy efficiency.

Table 6-2 Total Vermont Amtrak Station Boardings and Alightings, 2006-2010

2006	2007	2008	2009	2010	Percent Change, 2006-2010
64,647	72,822	82,216	82,667	97,256	50.4%

6.2 Personal Vehicles

Park and Ride Facilities

Park and Ride facilities give Vermonters another choice of transport mode, providing a safe, free parking spot where cars can be left by those who carpool or take the bus. These facilities are funded through the VTrans Municipal Park and Ride Program which has been in operation since 2004 and has made 52 awards to 34 facilities with a total of 700 parking spaces. Every November, occupancy is assessed at most Park and Ride facilities in order to evaluate how heavily this resource is being used (Table 6-3). [41] Occupancy rates tend to be high, suggesting that if the infrastructure is made available, Vermonters are amenable to carpooling and public transit use. In 2010, occupancy rates declined at most facilities.

Table 6-3 Park and Ride Parking Lot Capacity, 2009

	Percent Capacity			
Facility	2007	2008	2009	2010
Barre Town (East)		10%	20%	40%
Barre Town (South)	50%	82%	--	24%
Berlin	78%	68%	38%	73%
Bradford	135%	117%	79%	96%
Bristol	30%	50%	104%	60%
Cambridge	37%	37%	70%	11%
Charlotte	--	--	53%	--
Colchester	44%	46%	--	29%
Ferrisburgh - Vergennes	17%	25%	18%	25%
Georgia	92%	92%	102%	84%
Hartland	63%	70%	78%	73%
Manchester	10%	3%	3%	3%
Middlesex	46%	63%	46%	92%
Montpelier	58%	69%	44%	49%
Morrisville-Stowe	50%		83%	50%
Randolph*	133%	24%	28%	18%
Richmond	103%	143%	--	143%
Royalton	40%	87%	27%	60%
Sharon	83%	92%	104%	96%
Springfield	167%	196%	133%	171%
St. Albans	55%	77%	74%	57%
St. Johnsbury	37%	60%	51%	46%
Thetford	40%	48%	48%	36%
Waterbury	65%	103%	80%	57%
Weathersfield	120%	136%	--	71%
West Danville	18%	41%	71%	53%
Williamstown	92%	71%	117%	63%

**In 2008, the Randolph Park and Ride was expanded from 15 to 89 parking spots.*

Carpool rates in Vermont, as in the rest of the U.S., have fallen since the 1980's, and are currently estimated at around 12%, down from nearly 20% in 1980.[42] This decline may be attributed to a number of factors, including increased rates of vehicle ownership, relatively low fuel prices, and changing settlement patterns. In 2008, the State of Vermont established GoVermont, an initiative to reduce single occupancy trips through increased carpooling, transit use, biking, and walking. This initiative includes a website to link potential carpool participants and provide information for those seeking to share rides to work and meetings and conferences.[43]

Transportation Management Associations (CATMA and UVTMA)

Transportation Management Associations (TMA's) are non-profit organizations that work to meet transportation needs through alternatives to the single occupancy vehicle, including coordination of car- and van-pools. There are two TMA's in Vermont, the Campus Transportation Management Association (CATMA) [44] and the Upper Valley Transportation Management Association (UVTMA).[45] Both of these TMA's are partnerships among some of the region's largest employers (such as Fletcher Allen, UVM, and Dartmouth Hitchcock Medical Center) and coordinate planning and parking needs. Programs provided by the CATMA and UVTMA include coordination of car pools, public transit discounts, and incentives for biking and walking to work for employees at participating entities.

Eco Driving

"Eco Driving" is a strategy to reduce greenhouse gas emissions, fuel consumption, and crash rates by altering driving style and vehicle maintenance. Eco Driving techniques include driving the speed limit, inflating tires properly, avoiding idling, and keeping excess weight out of the vehicle among other measures. Eco Driving can result in up to a 33% improvement in gas mileage, as well as corresponding reductions in greenhouse gas emissions, air pollution, dependence on fossil fuels, and the amount of money spent on fuel. The Vermont Clean Cities Coalition launched an Eco Driving Initiative in 2010. As of December 2010, it is estimated that over 300 drivers have been trained in Eco Driving techniques through 20 workshops. Target audiences for workshops include private and public fleets, driver's education programs, and the general public.[46]

Anti-Idling Legislation

The Vermont State Legislature is currently considering statewide anti-idling legislation that would prohibit idling by any vehicle over 10,000 pounds for longer than five minutes (with the exception of public service vehicles such as ambulances and fire trucks). Such ordinances already exist in multiple municipalities throughout the state (and are increasingly common in other states, as well). Proponents of the bill cite it as way to strengthen existing local anti-idling laws and as a means of reducing fuel consumption and greenhouse gas emissions statewide. Little information is available on current rates of idling in Vermont by either 10,000 pound vehicles or personal vehicles.

7. Summary

By our estimate, at $3.85 billion, expenditures on transportation approximated 15% of Vermont's economy in 2010. The bulk of these expenditures were related to travel via personal vehicle: vehicle maintenance and ownership costs totaled $2.15 billion and gasoline and diesel sales totaled $1.1 billion. Other prominent costs included the VTrans operating budget, the majority of which was spent on road and bridge projects, and municipal transportation expenditures, the bulk of which, again, was spent on road paving and maintenance. Despite the relatively high proportion of expenditures devoted to personal vehicle travel, we also estimate that approximately 92,000 Vermonters more than 16 years of age (15% of the total population) do not have full time vehicle access and thus may require other forms of transport.

Fuel sales dropped between 2009 and 2010 but price increases resulted in an overall increase in expenditures. Expenditures by the VTrans totaled over $450 million in 2010, an increase of more than $60 million from 2009. The proportion of funds budgeted to public transit, Park and Ride facilities, and the rail system decreased from 2009 to levels seen in 2007 (approximately 8% of the total budget). On average, municipalities spent ~ 41% of their town budget and $395 per capita on transportation related costs.

As of 2008, the transportation sector remained both Vermont's largest energy consumer and largest source of greenhouse gases. Although VMT data was not yet available for Vermont for 2010, national VMT returned to 2007 levels after a two year dip. Vehicle sales rose in Vermont in 2010, with hybrid vehicles rising faster than total vehicle sales. Hybrids comprised 4% of new vehicles purchased and now comprise 1.2% of the total fleet. Our analysis suggests that pure electric and plug-in hybrid electric vehicles could meet the majority of the state's daily travel demand, even with charging available only at home, or home and work. We estimate that fuel expenditures (exclusive of capital costs) would be considerably less for electric vehicles than conventional vehicles, $274 million vs. $1.1 billion, at current gasoline and electricity prices and levels of annual travel).

Appendix A

Towns included in section 5.3, Municipal Expenditures on Transportation

ADDISON	COLCHESTER	JOHNSON	RICHFORD	WEST WINDSOR
ALBANY	CONCORD	JOHNSON VILL	RICHMOND	WESTFORD
ALBURGH	CRAFTSBURY	KIRBY	RIPTON	WESTMORE
ANDOVER	DERBY	LEICESTER	ROCKINGHAM	WESTON
ATHENS	DERBY CNTR VILL	LEMINGTON	ROXBURY	WEYBRIDGE
BALTIMORE	DERBY LINE VILL	LINCOLN	ROYALTON	WHEELOCK
BARNARD	DORSET	LONDONDERRY	RYEGATE	WHITING
BARNET	DUMMERSTON	LUDLOW	SALISBURY	WILLIAMSTOWN
BARRE TOWN	DUXBURY	LUNENBURG	SHARON	WILLISTON
BARTON	ELMORE	LYNDON	SHEFFIELD	WILMINGTON
BENNINGTON	ENOSBURGH	MAIDSTONE	SHELDON	WINDHAM
BENSON	ESSEX	MANCHESTER VILL	SHOREHAM	WINDSOR
BERKSHIRE	FAIR HAVEN	MARLBORO	SHREWSBURY	WOLCOTT
BERKSHIRE	FAIRFAX	MENDON	SOUTH HERO	WOODBURY
BERLIN	FAYSTON	MIDDLEBURY	SPRINGFIELD	WOODSTOCK
BETHEL	FERRISBURGH	MIDDLETOWN SPR.	ST. ALBANS TOWN	WOODSTOCK VILL
BLOOMFIELD	FLETCHER	MILTON	STAMFORD	OLD BENNINGTON VILL
BOLTON	FRANKLIN	MONKTON	STANNARD	EAST MONTPELIER
BRADFORD	GEORGIA	MONTGOMERY	STARKSBORO	BURLINGTON
BRAINTREE	GLOVER	MORETOWN	STOCKBRIDGE	DOVER
BRANDON	GRAFTON	MORRISTOWN	STOWE	CALAIS
BRATTLEBORO	GRANBY	MOUNT HOLLY	STRAFFORD	
BRIDGEWATER	GRAND ISLE	MOUNT TABOR	STRATTON	
BRIDGEWATER	GREENSBORO	NEW HAVEN	SUNDERLAND	
BRIDPORT	GUILDHALL	NEWARK	THETFORD	
BRIGHTON	GUILFORD	NEWBURY	TINMOUTH	
BROOKFIELD	HALIFAX	NEWFANE	TOPSHAM	
BROOKLINE	HARTFORD	NORTH BENN VILL	TOWNSHEND	
BROWNINGTON	HARTLAND	NORTH TROY VILL	TUNBRIDGE	
BURKE	HINESBURG	NORWICH	UNDERHILL	
CABOT	HOLLAND	ORWELL	VERNON	
CANAAN	HUBBARDTON	PAWLET	VICTORY	
CAVENDISH	HUNTINGTON	PEACHAM	WALDEN	
CHARLESTON	HYDE PARK	PERU	WARREN	
CHARLOTTE	IRASBURG	PITTSFIELD	WATERBURY	
CHELSEA	ISLE LA MOTTE	PLAINFIELD	WATERVILLE	
CHESTER	JAMAICA	PLYMOUTH	WELLS	
CHITTENDEN	JAY	POULTNEY	WEST FAIRLEE	
CLARENDON	JERICHO	PROCTOR	WEST RUTLAND	

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