Electric Vehicle Fleet Case Studies

Prepared for: Chittenden County Regional Planning Commission
110 West Canal St, Suite 202
Winooski, VT 05404

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Vermont Energy Investment Corporation

DISCLAIMER
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Executive Summary

Plug-in electric vehicles (EVs) are increasingly popular options in public sector vehicle fleets. EVs have many attractive characteristics including reduced fuel expenses and maintenance costs as well as, significant environmental benefits. Many Chittenden County communities have started to add EV options to their fleets. This report provides an introduction to EVs and real-world results from their applications in Vermont.

In general, EVs have a higher purchasing price than vehicles with internal combustion engines but their operating costs are significantly lower. This report demonstrates a number of real-world situations where EVs can have a lower lifetime cost compared to traditional vehicles. The fleets that have chosen to operate EVs have experienced some difficulties operating the vehicles in the winter months. EVs tend to have a more limited range in the winter and need to be operated regularly (approximately once every two weeks) to avoid freezing issues. The majority of the fleets that operated the EVs regularly have found them to be a good alternative to traditional vehicles.

There are a number of organizations that choose to use mileage reimbursements for employee travel. At the current federal mileage reimbursement rate of $0.54 per mile, it can be difficult to make up the cost of operating a vehicle, particularly when a vehicle is driven less than 10,000 miles a year. Even when owning a vehicle maybe more expensive than mileage reimbursement, organizations should still consider offering fleet vehicles. There are significant nonmonetary reasons to offer fleet vehicles to employees including -

- Allowing employees to avoid vehicle usage for commuting and enable employees to bike, walk, or take transit to work.
- Insuring the cost of driving is not placed on the employee.
- Fleet vehicles enable more control over employee safety.
- Providing fleet vehicles can give an organization a competitive edge in hiring employees.

As discussed above, if an organization is going to offer fleet vehicles they should consider EVs because of their significant environmental benefits and reduced fuel costs.

Introduction to Electric Vehicles

Plug-in electric vehicles (EVs) receive energy from the electric grid to recharge a battery used to power a motor. All Electric Vehicles (AEVs, also referred to as battery electric) are powered solely by energy stored in a battery; Plug-in Hybrid (PHEV) vehicles can be powered by battery for a distance, but also have a gasoline or diesel engine for extended range operation. AEVs have no tailpipe emissions, greatly reducing their impact on our environment and health.

In Vermont, 46 percent of the state's greenhouse gas emissions come from the transportation sector. Since Vermont's electric portfolio is one of the cleanest in the nation, converting to an electric vehicle can have significant economic and environmental benefits, including:

- Improved public health and reduced environmental impact – Electric vehicles have reduced or no emissions compared to traditional vehicles powered by combustion engines. Reducing our emissions, including greenhouse gases, will help mitigate the most damaging health impacts from a long list of harmful pollutants emitted from tailpipes, including carbon dioxide, carbon monoxide, nitric oxide, nitrogen dioxide, sulfur oxides, and metallic compounds.
- Insulation from fluctuating gas prices - In Vermont, electric prices have been stable for nearly 20 years and even at current low prices for gasoline there are still significant savings when driving on electricity.
- Supporting Vermont's economy - Most of the cost of charging electric vehicles stays within New England. Savings on gasoline can be spent on other household needs and rather than sending gasoline dollars out of the region, electric powered vehicles support Vermont energy independence and the local economy.

In order to meet renewable energy goals, reduce greenhouse gas emissions, improve air quality and save consumers money, electric vehicles are a key strategy of the State of Vermont's Comprehensive Energy Plan (CEP). The CEP is developed by the Department of Public Service to examine Vermont's energy requirements across all end use sectors, develop strategies to increase efficiency, and move towards a future with greater amounts of renewable energy. The CEP's primary recommendation is to put Vermont on a path to obtain 90% of total energy from renewable sources by 2050. Within this goal, the CEP calls for 10% of Vermont's transportation energy to be renewable by 2025 and at least 80% by 2050. According to the CEP, as of 2016, only 6% of Vermont's transportation energy is renewable, this is primarily in the form of corn-based ethanol. Since Vermont's electricity supply is increasingly generated from renewable sources, electric vehicles are a key component to reaching the CEP goals.

In addition to the CEP, Vermont's Governor has signed a memorandum of understanding (MOU) with seven other states to bring 3.3 million zero emission vehicles including EVs, and hydrogen fuel-cell-electric vehicles to their roads by 2025. In order to support this MOU, the State of Vermont has developed the *Vermont ZEV Action Plan* which outlines specific steps and strategies to support the proliferation of ZEVs in the state, including the use of these vehicles in fleet applications.

Cost of Owning an Electric Vehicle

While many electric vehicles may have higher sticker prices compared to their internal combustion engine counterparts, they tend to have much lower operating costs, providing opportunities for savings. Driving in an electric mode provides the equivalent of paying a little over $1 per gallon of gasoline. EVs guard against rising fuel prices since the price of gasoline is much more volatile than Vermont utility electricity rates.

All Electric Vehicles (AEVs) have a fraction of the moving parts of gasoline vehicles and are very reliable. That means no oil changes, no spark plugs, catalytic converters or other emissions equipment. As a result, they generally only need servicing once or twice a year to check vehicle systems and rotate the tires.

Plug-in Hybrid Electric Vehicles (PHEVs) have internal combustion engines but still require less maintenance than typical gasoline cars since the engines are used less often and regenerative braking systems save wear and tear on the brakes.

Purchasing an Electric Vehicle

Over the last five years, the number of electric vehicles available on the market has grown significantly. Today there are many different types of AEVs and PHEVs on the market ranging in size, style, and price. The majority of these models can be found at local dealerships throughout Vermont or in neighboring New York and New Hampshire. While the first generation of EVs had high purchase prices, today's EVs can be found for prices equivalent to many internal combustion engine counterparts. A current list of EVs available in Vermont is available on Drive Electric Vermont's vehicle comparison page[1]. Leasing is a very popular option as approximately 60% of EVs registered in Vermont were leased as of April 2016.[2]

Types of Electric Vehicle Charging

To be recharged, electric vehicles must be plugged in to a source of electric power through Electric Vehicle Supply Equipment (EVSE). There are three types of EVSE:

- **Level 1** uses a 120V AC connection to a standard residential/commercial electrical outlet capable of supplying 15-20 amps of current, for a power draw usually around 1.4 kW when charging. EVs come equipped with Level 1 chargers from auto manufacturers. All electric vehicles with 60-80 miles of range will require 10-14 hours for a full charge using Level 1 EVSE.

- **Level 2** requires a 208/240V AC connection to supply increased power to the vehicle, reducing the amount of time required to charge the EV battery. Most EVs can charge at 3.3 to 6.6 kW. This is similar to the power draw of an electric clothes dryer appliance. AEVs with 60-80 miles of range will usually require 3-7 hours for a full charge using Level 2 EVSE.

[1] http://www.driveelectricvt.com/buying-guide/compare-vehicles
[2] Leasing benefits are described in more detail on the Drive Electric Vermont blog: http://www.driveelectricvt.com/blog/leasing-versus-purchasing-an-electric-car

- **DC Fast Charging**, sometimes referred to as Level 3, delivers a high volume of DC power into EVs battery system, enabling rapid charging. Typically, an 80% charge can be provided in 30 minutes or less for many all electric vehicles.

EVSE options include networked and non-networked systems. A networked system offers communication between the user and charging station operator to allow for access control, fee collection, and data logging. Network stations tend to be more expensive to purchase then non-networked stations. Non-networked stations can be purchased starting around $400. More information on EVSE installation can be found on the Drive Electric Vermont Charging Station Installation Guide[3].

Electric Vehicles in Vermont

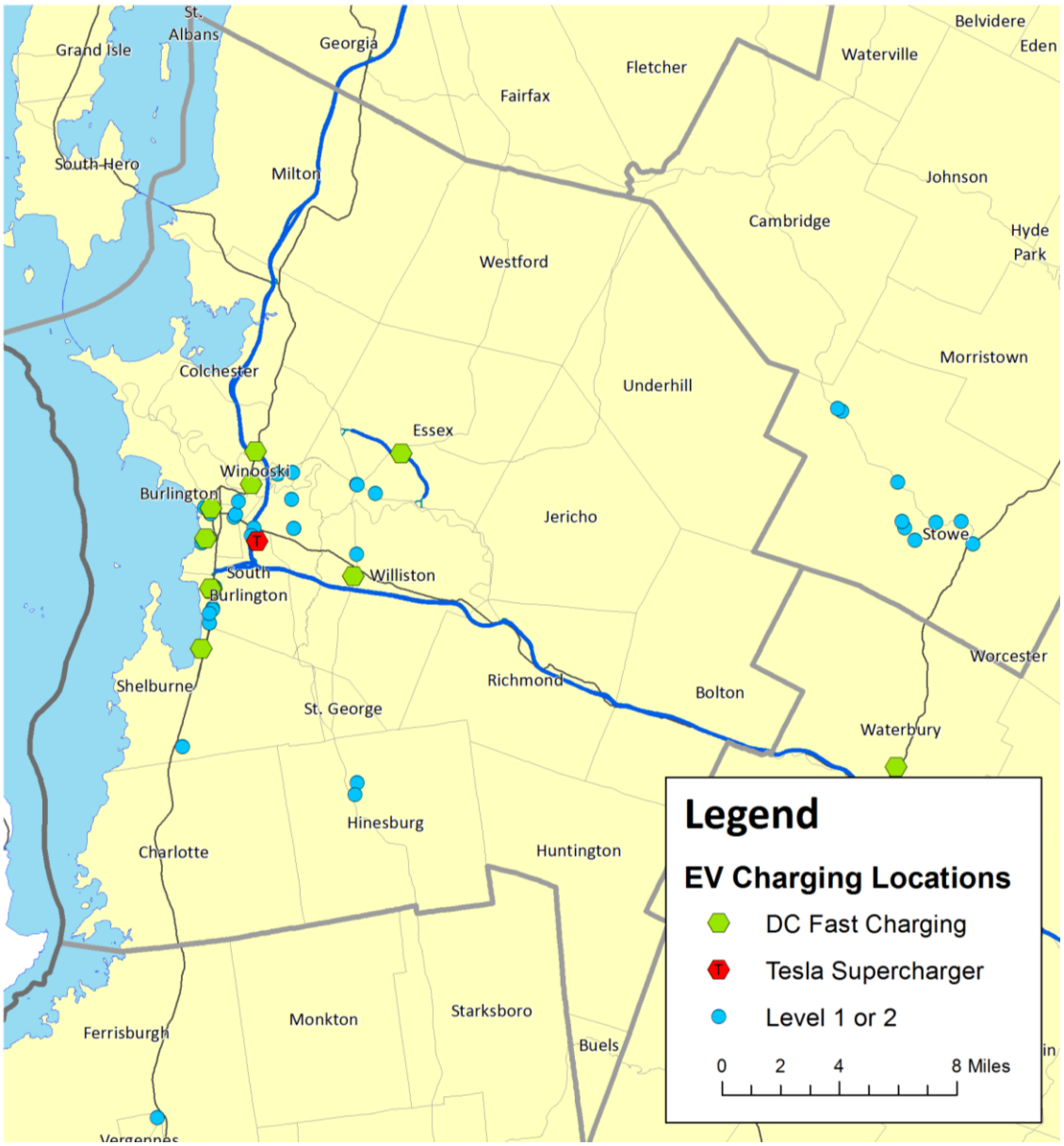
Electric vehicle popularity is growing due to their many benefits and potential cost savings. As of April 2016, there were approximately 1,140 EVs registered in the state and they comprise about 1% of new vehicle sales. The State of Vermont has adopted the California Zero Emission Vehicle (ZEV) program which requires automakers to increase their EV sales to about 15% of new vehicles over the next 10 years[4]. As a result many more EV models and improvements are anticipated as the technology continues to develop and automaker requirements ramp up.

EV Charging in Vermont

In order to support the number of electric vehicles growing on the Vermont roads, private and public charging stations have been installed throughout the state and more are coming online all the time. As of June 2016, there were 132 public electric vehicle charging stations in Vermont installed by public and private entities. Figure 1 below shows the locations of 35 public charging locations in Chittenden County offering 73 charging ports with Table 1 below further documenting the individual locations. Several communities in Vermont have installed charging for the general public to support greater use of EVs, including government and business fleet use.

[3] http://www.driveelectricvt.com/charging-stations/installation-guide
[4] http://www.arb.ca.gov/msprog/zevprog/zevprog.htm

Figure 1. Chittenden County Electric Vehicle Charging as of June 2016 [5]



[5] Based on Data from the US Dept of Energy Alternative Fuel Data Center

Table 1. Chittenden County Electric Vehicle Charging as of June 2016

Station Name	Street Address	City	Level 1 Ports	Level 2 Ports	DC Fast Ports
BED Offices Pine St	585 Pine St	Burlington		2	1
Church & Main	175 Main St	Burlington	1	1	
City Market	82 S Winooski Ave	Burlington		1	
Healthy Living	222 Dorset St	Burlington		2	
Homewood Suites	5 Dorset St	Burlington		1	
Lakeview Garage	45 Cherry St	Burlington		4	
Marketplace Garage	75 S Winooski Ave	Burlington			1
University Mall South Burlington	155 Dorset St	Burlington		2	
UVM Davis Center	81 Carrigan Drive	Burlington		2	
UVM Johnson House	617 Main St	Burlington		2	
UVM Trinity Campus	210 Colchester Ave	Burlington		2	
VEIC	128 Lakeside Ave	Burlington		4	
CVS Pharmacy	69 Mountain View Dr	Colchester			1
Saint Michaels College	One Winooski Park	Colchester		1	
UVM Medical Center Fanny Allen	802 College Pkwy	Colchester		2	
Essex Outlet Center	21 Essex Way	Essex		2	1
Essex Police	145 Maple St	Essex		1	
Essex Junction Village Offices	2 Lincoln Street	Essex Jct		1	
CVU High School	369 C V U Road	Hinesburg		2	
Renewable NRG	110 Riggs Road	Hinesburg		2	
Burlington International Airport	1200 Airport Dr	S Burlington	2		
Burlington Mitsubishi	1835 Shelburne Rd	S Burlington		1	
Cummings Electric	82 Ethan Allen Dr	S Burlington		2	
Freedom Nissan	1095 Shelburne Rd	S Burlington		1	1
Healthy Living Market - Tesla	222 Dorset St	S Burlington			8
Heritage Ford	1600 Shelburne Rd	S Burlington		2	
Heritage Toyota	1620 Shelburne Rd	S Burlington		2	
Shearer Chevrolet	1675 Shelburne Rd	S Burlington		1	
Shearer Volkswagen	1030 Shelburne Rd	S Burlington		2	
Automaster BMW	3328 Shelburne Rd	Shelburne		3	
Automaster Mini	74 Champlain Dr	Shelburne			2
Vermont Teddy Bear	6655 Shelburne Rd	Shelburne		1	
Hannaford Williston	78 Marshall Avenue	Williston		2	1
VSECU Williston	1755 Essex Road	Williston		2	
Winooski Garage	20 Cascade Way	Winooski			1
Total			**3**	**53**	**17**

Vermont Municipal Case Studies

The potential benefits of electric vehicles are well documented in industry literature, but no recent studies exist on their use in Vermont. In 2013, Vermont municipalities were presented with an opportunity to lease Mitsubishi i-MiEVs through a special leasing program offering the vehicles at $110 a month for three years with no down payment. The i-MiEV is a small light duty vehicle that can seat 4 people. According to the US FuelEconomy.Gov website, the i-MiEV has a range of 62 miles on a full charge and a 112 miles per gallon equivalent gasoline efficiency. The municipalities of Jericho, Milton, Winooski, and the Chittenden County Regional Planning Commission all took advantage of this offering and their experiences are detailed below.

Chittenden County Regional Planning Commission

In October of 2013, the Chittenden County Regional Planning Commission (CCRPC) began leasing two i-MiEVs for employee and intern travel. Prior to obtaining the i-MiEVs, employees used their own vehicles and were reimbursed at the federal rate (currently $0.54 per mile). After receiving the i-MiEVs, employees had the option of either using the EV or driving their own car, especially when their trips were further than the range of the i-MiEV.

The CCRPC tracks the usage of the i-MiEVs and provided the mileage of both vehicles for this analysis. As of June 3, 2016, the total mileage of the EV's was 6,556 and 6,519, for a total of 13,075 miles across both vehicles. On average, each vehicle was used to travel approximately 198 miles monthly; however, the usage of both vehicles tended to be much higher in the summer months in comparison to the winter months. This is the result of two factors; one, the CCRPC interns tend to use the vehicles the most and they are only there during the summer and two, the vehicles' battery range is reduced in the winter months due to cold temperatures and cabin heating requirements.

When doing a direct comparison between the cost of operating the i-MiEVs and the cost of reimbursing employees for mileage it appears CCRPC is not fully covering the expense of operating the electric vehicles. If the CCRPC were to reimburse employees at the federal rates[6] for the total mileage of both vehicles it would have cost the organization approximately $7,360. Conversely, the cost of operating the two i-MiEVs would have been approximately $17,248[7] for the same mileage over three years, not including the cost of charging[8]. These costs however, do not reflect the full benefits and true cost to the CCRPC for operating the i-MiEVs.

The CCRPC is a federally managed and funded transportation policy making organization. The federal mileage reimbursement payments that they receive from state and federal grantors go straight through to employees when they incur mileage in their own cars. When operating the i-MiEVs the CCRPC is able

[6] The federal mileage reimbursement rate was $0.565 per mile in 2013, $0.56 per mile in 2014, $0.575 per mile in 2015, and $0.54 per mile in 2016.
[7] See Appendix B to see the full calculations of these costs.
[8] The cost of charging was not included in this analysis because the majority of the i-MiEV's charging is done at a stations located at their building where charging is currently free.

to use the mileage reimbursement payments to directly offset the cost of operating the vehicles. As a result over the past two years, the CCRPC has only contributed $9,352 to operating the i-MiEVs.

Additionally, the CCRPC does not pay to charge the i-MiEVs because the majority of the i-MiEV's charging is done at the stations located at their building. The CCRPC worked with their building's owner, Redstone, to install a Level 2 charging station at their offices to be used by the organization and the public. Charging at this station is currently free, but according to electrical bills provided for this analysis it would have cost the CCRPC $604 to charge the vehicles if they were paying the per kWh rate of $0.14[9]. Redstone also covered the cost of purchasing and installing the station and therefore these costs were not included in our analysis.

It should also be noted that the CCRPC's insurance rate of $1,300 per vehicle per year, totaling $7,800 for both vehicles over the 3-year lease period, is quite high. If the CCRPC were able to reduce this rate, or only operate one vehicle, they could save thousands of dollars on future operations. Despite these costs, the CCRPC continues to provide vehicles for employee use because this:

- Allows employees to avoid vehicle usage for commuting and enable employees to bike, walk, or take transit to work when they need access to a vehicle for travel away from the office;
- Ensures the cost of driving is not placed on employee;
- Provides a needed resource for the summer interns; and
- They are able to use federal mileage reimbursements to offset their costs.

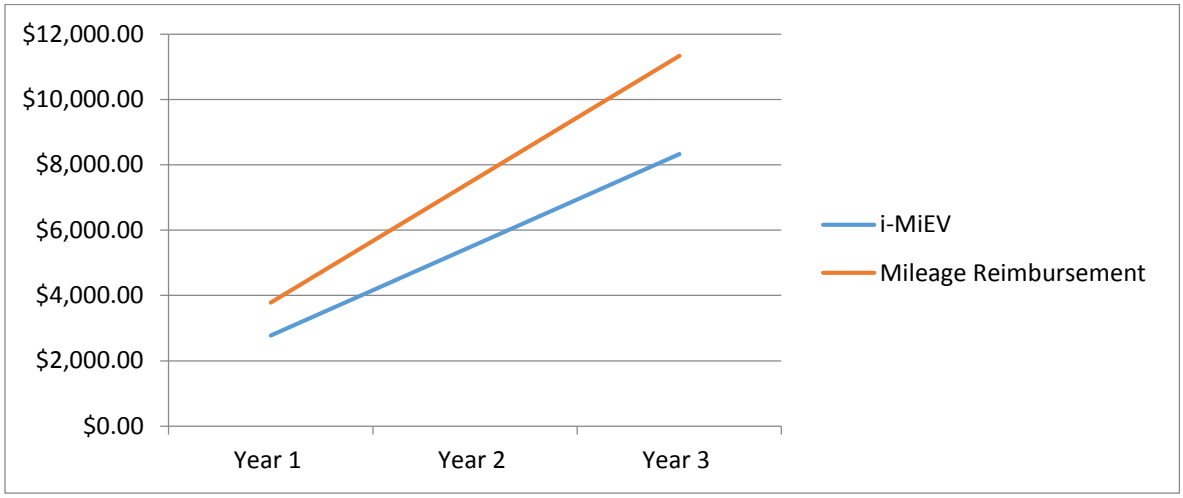
Additionally, the CCRPC is dedicated to operating electric vehicles because they wish to

- Make progress in meeting regional and state climate and energy goals;
- Demonstrate the feasibility of deploying electric vehicle technology; and
- Save money – operating an EV is less expensive then operating a traditional vehicle powered by a combustion engine.

In addition, if the CCRPC increased the use of each i-MiEV, the vehicles would become more cost effective, even when doing a direct comparison to the costs of mileage reimbursements. Figure 2 below demonstrates what CCRPC could save with greater utilization of a vehicle compared to mileage reimbursement at the current rate of $0.54 per mile. At 7,000 miles per year, the CCRPC's savings would be around $3,000 over the 3-year life of the lease. Currently, the CCRPC's lease limits the vehicles use to 5,000 miles per year. Therefore, in any future leases, the CCRPC should consider negotiating a higher mileage allowance, particularly if the range of travel increases as vehicle technology improves. CCRPC would then be able to utilize the vehicles for more long distance trips. Most manufacturer's standard lease programs offer mileage allowances of 10,000-12,000 miles per year.

[9] Prior to January 2016 CCRPC's electricity rate was $0.13964. In 2016 this rate was increased to $0.14096. The rate used for this analysis is an average of these two rates of $0.140075.

- **Figure 2. Potential Cumulative CCRPC Operating Costs - Mileage Reimbursements vs. i-MiEV (7,000 miles per year)** [10]



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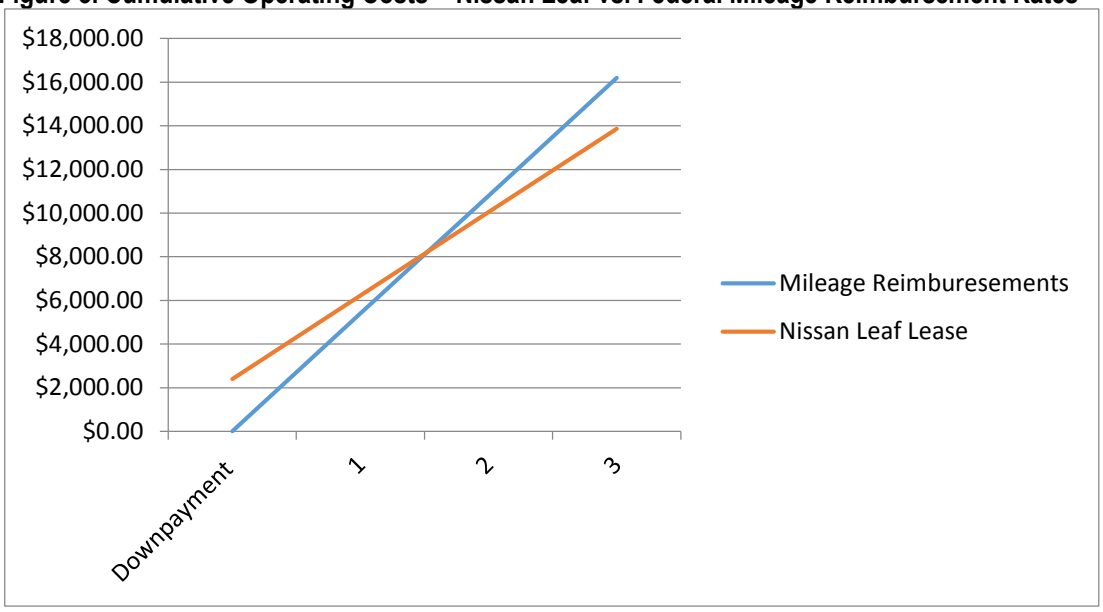
As EV technology improves and battery ranges increase, the CCRPC anticipates greater use of their fleet which could result in significant cost savings. Figure 5 illustrates the potential savings the CCRPC could realize with leasing a Nissan Leaf compared to offering the federal reimbursement rates. The Leaf is one of the most popular AEVs on the market. It is a four door, five passenger sedan that has up to 107 mile range and can be leased for $199 a month with a $2,399 down payment. When factoring in the cost of maintenance, lease payments, insurance, and fuel costs a Nissan Leaf would cost approximately $13,865 to travel 30,000 miles over three years. Conversely, paying out this mileage at the current federal reimbursement rate of $0.54 per mile would cost $16,200. Therefore, a town could save approximately $2,335 in fuel costs by operating the Leaf instead of paying out mileage reimbursements. Additional EV models expected to begin arriving in late 2016 will offer more range at similar price points which should further improve utility of AEVs in fleet applications.

[10]See Appendix C to see the full calculations of these costs.

Figure 3. Cumulative Operating Costs – Nissan Leaf vs. Federal Mileage Reimbursement Rates[11]



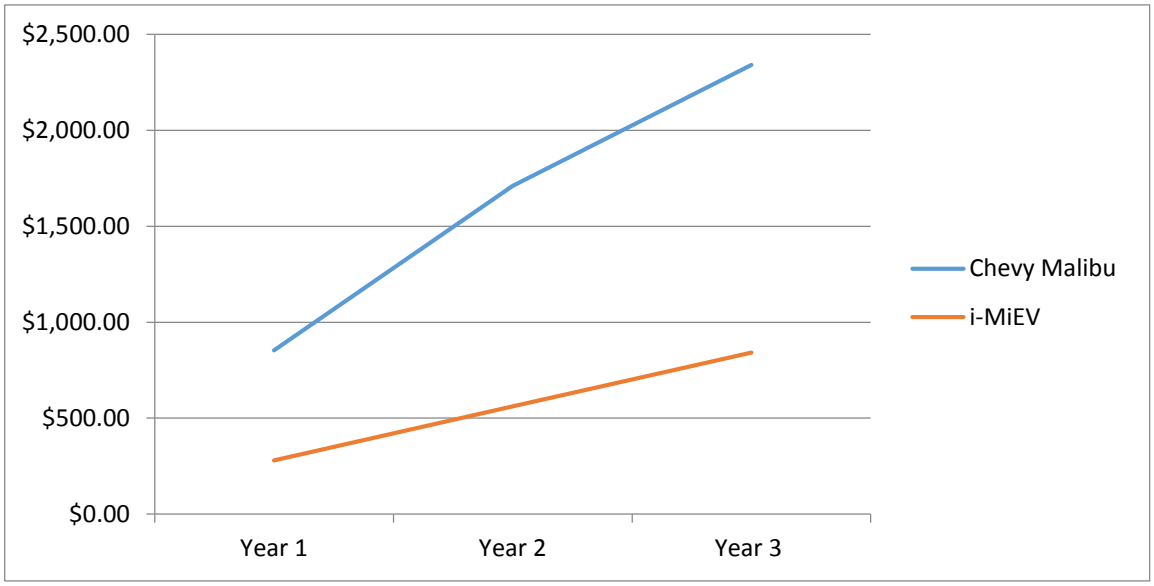
Town of Milton

In 2013, the Town of Milton replaced an aging 2002 Chevrolet Malibu with a 2013 i-MiEV. According to FuelEconomy.Gov, a 2002 Malibu averages 21 miles per gallon. While the town does not collect mileage data for their vehicles, their pooled vehicles travel approximately 5,000 miles a year. Figure 3 compares the cost of fueling a 2002 Malibu to the i-MiEV. In total, the town saved approximately $1,500 in fuel costs[12].

[11] See Appendix D for the full calculations related to these costs.

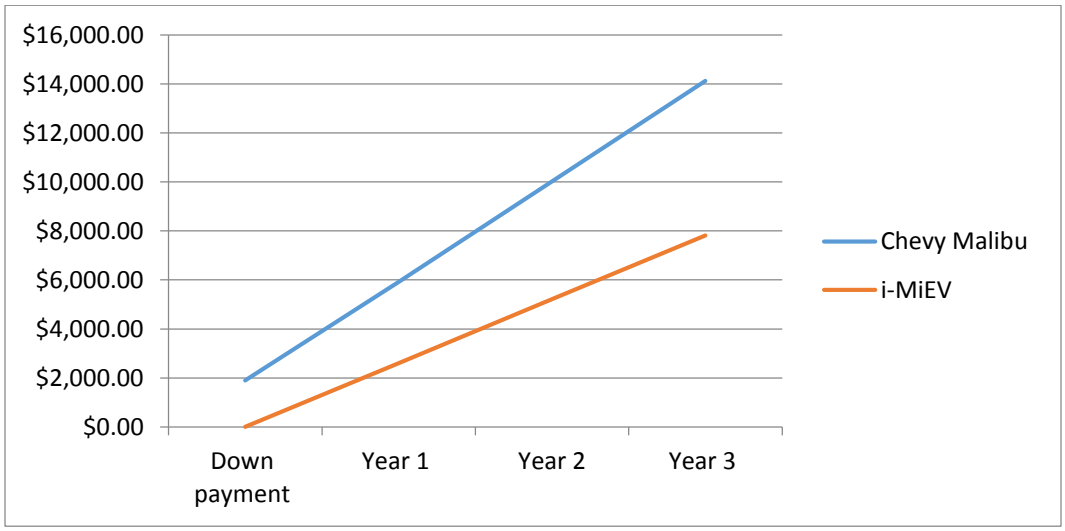
[12] Fuel prices were calculated using the average price of the first month of each year and were as follows January 2013 $3.584 a gallon; January 2014 $3.603 a gallon; January 2015 $2.646 a gallon.

Figure 4. Town of Milton Cumulative Fuel Cost Comparison October 2013 - October 2016[13]



The town also saved by not replacing the 2002 Malibu with a new model. According to Chevrolet's website, as of June 2016 a new Malibu can currently be leased for $199 a month with a $1,879 down payment for up to 10,000 miles per year. As demonstrated in Figure 4, with a three-year lease the town would potentially save $6,000 with the i-MiEV instead of a new Malibu.

Figure 5. Town of Milton Cumulative Operating Costs – 2016 Chevy Malibu Lease vs. i-MiEV Lease[14]



[13] See Appendix E for the full calculations related to these costs.
[14] See Appendix F for the full calculations related to these costs.

City of Winooski

The City of Winooski is a one square mile city located north of Burlington, VT just over the Winooski River. Winooski updated their fleet by leasing Mitsubishi i-MiEVs through the special leasing program. The city removed five older vehicles from their fleet including an unmarked police car, a diesel truck, a sedan and two pick-up trucks and replaced them with four i-MiEVs. The i-MiEVs have been a great success for the city; they yielded significant cost savings and they fit the city's needs perfectly. Since the city is compact the limited range of the vehicles is not an issue, plus residents appreciate how quiet they are in the residential areas.

It is difficult to estimate exactly how much Winooski has saved by adopting the i-MiEV's since they replaced five traditional internal combustion engine (ICE) vehicles with four all electric vehicles. All of the vehicles Winooski removed from their fleet were older and experiencing maintenance issues. Winooski has experienced lower fuel costs with the i-MiEV's than they would have with a traditional ICEs. Winooski is a small city, and as a result their vehicles do not travel very far. The city estimates that on average their vehicles travel approximately 1,200 miles per year. If the city had purchased another pick-up truck instead of an i-MiEV, they would have spent approximately $525 fueling that vehicle compared to $200 in electricity powering the i-MiEV between October 2013 and October 2016.[15]

The City of Winooski installed a charging station in their Department of Works' garage. This charger cost the city a total of $1,600 for the unit and installation. This unit is an investment in their future, allowing them to more easily invest in electric vehicles as the cost of the vehicles decrease and the technology improves.

General Experiences

Overall, each municipality has had a relatively easy time transitioning to including EVs in their fleets. At the time of lease each town was given a general overview of the i-MiEV and how to operate it. Most have found the i-MiEV drives similarly to other small light-duty vehicles. Due to the i-MiEV's limited range, they are mostly used for in-town travel between town offices. None of the towns reported complaints from their employees regarding the driving performance of the vehicles. The Town of Milton developed a one-page summary of the vehicle including its range, driving modes, as well as how to charge the vehicle. The staff at the Chittenden County Regional Planning Commission created a map demonstrating the i-MiEV's travel radius on a single charge from the CCRPC's office.

Winter Performance

As mentioned above, electric vehicles normally require less maintenance than a vehicle powered by a traditional internal combustion engine. The i-MiEV's do not have all-wheel drive capabilities and snow tires are generally recommended to improve traction in Vermont winter conditions. However, none of the towns in this report installed winter tires on did not report difficulty with the cars in the winter months with the exception of decreased range. The Town of Milton replaced the starting, lighting, and ignition (SLI) LI battery in the vehicle as it froze after being outside for an extended period of time, costing $250. With most EVs it is best to operate the vehicle regularly and plug it in during periods of extreme cold to help avoid maintenance issues in Vermont winter conditions.

[15] Fuel prices were calculated using the fuel economy of a 2013 F-150 and the average price of the first month of each year. See Appendix G for full calculations.

Conclusions

In general, the CCRPC, Winooski, and Milton have had both positive and negative experiences with their EVs. Both Milton and Winooski have seen economic savings from operating the vehicles compared to operating a non-electric vehicle. Milton however, has struggled to find practical applications for the i-MiEV in cold weather months. The CCRPC has enjoyed having the i-MiEVs for their employees and have found them to be a valued resource to their interns. They have however, experienced higher operating costs compared to mileage reimbursements. As discussed above it is costing the CCRPC approximately $10,000 more a year to operate the i-MiEVs compared to mileage reimbursement. These increased costs are driven by insurance costs and less than optimal utilization.

Higher Mileage Equals More Savings

All the towns kept relatively low mileage on the i-MiEVs (around 5,000 miles a year). Due to the fuel savings of EVs, the towns could experience significant financial savings from higher utilization of the vehicles.

The i-MiEV's were acquired by the towns through a special low cost lease deal that did not require a down payment and had a low monthly payment ($110 a month). Even without this special arrangement, another municipality could see significant savings with an electric vehicle. As demonstrated above, a town could save approximately $2,335 in fuel costs by operating a Leaf instead of paying out mileage reimbursements for 30,000 staff miles over three year period. When factoring in the cost of maintenance, lease payments, insurance, and fuel costs a Nissan Leaf would cost approximately $13,865 to travel 30,000 miles over three years. Conversely, paying out this mileage at the current federal reimbursement rate of $0.54 per mile would cost $16,200.

Benefits of Electric Vehicles

While it is true that at lower mileage towns will not realize the same cost savings as they would with higher mileage, there still other reasons to operate an electric vehicle. As outlined above some of the benefits of electric vehicles include:

- **Improved public health** – Electric vehicles have reduced or no emissions compared to traditional vehicles powered by combustion engines. Reducing our emissions, including greenhouse gases, will help mitigate the most damaging health impacts from a number of harmful pollutants emitted from tailpipes, including carbon dioxide, carbon monoxide, nitric oxide, nitrogen dioxide, sulfur oxides, and metallic compounds.
- **Insulation from fluctuating gas prices -** In Vermont electric prices have been stable for nearly 20 years and even at current low prices for gasoline there are still significant savings to driving on electricity.
- **Supporting Vermont's economy** - Most of the cost of charging electric vehicles stays in New England. Rather than sending gasoline dollars out of the region, electric powered vehicles keep more revenues locally, contributing to energy independence for Vermont, and supporting Vermont's economy.
- **Employee Transportation Demand Management –** providing fleet vehicle options for employees allows greater flexibility for employees to reduce automobile ownership and use non-single occupant vehicle options for commuting.

- **Workplace Charging Availability-** Including EVs into an organization's fleet can also encourage employees, or visitors, to make the switch to driving electric as the charging infrastructure is in place and could be made widely available to increase the convenience of driving electric.

Since electric vehicles pose significant benefits to Vermont they are also used by municipalities to provide:

- **Educational opportunities** – Towns could utilize electric vehicles for public events to educate their citizens on the many benefits of electric vehicles.
- **Green branding opportunities** - EVs offer a great opportunity to act as a moving demonstration of a town's commitment to the environment. The City of Winooski for example has chosen to wrap their i-MiEVs with graphics that demonstrate how the vehicles are a part of a large effort to modernize the city and make it more environmentally friendly.
- **Increased public satisfaction** – Electric vehicles are extremely quiet when they operate and create no tailpipe emissions, which means they are more pleasant to be around. The public will be less impacted by the sound of a town official's vehicle that may drive regularly past homes and businesses.

Benefits of Fleet Vehicles

Even when owning an EV maybe more expensive than mileage reimbursement, an organization should still consider offering a fleet vehicle. There are significant nonmonetary reasons to offer fleet vehicles to employees including

- **Allowing employees to avoid vehicle usage for commuting.** When a work vehicle is provided for employees it enables them to commute to work with non-motorized transportation options and to use a fleet vehicle for work-related travel. This is especially welcoming for interns or low-income staff who may not have access to dependable transportation.
- **Insuring the cost of driving is not placed on the employee**. As the calculations in the above case studies demonstrate, owning and operating a vehicle is expensive and the federal mileage reimbursement rate does not cover all these cost. By providing a fleet vehicle an organization ensures that an employee is not unfairly responsible for the cost of driving for work.
- **Fleet vehicles enable more control over employee safety.** When an organization does not offer a fleet vehicle they cannot ensure that an employee's vehicle is safe. Employees driving older vehicles with maintenance issues can expose the driver or other employees to a higher risk of serious injury in the case of a crash. With a fleet vehicle, an organization can ensure the vehicle is up to date and safe to operate.
- **Providing fleet vehicles can give an organization a competitive edge in hiring employees**. This is especially true if key competitors do not offer a fleet vehicle.

Future EV Fleet Options

While municipal experience was mixed with the i-MiEVs, it is important to consider these are older EVs with limited range and capability. As the EV market continues to develop many new models will be available with over 200 miles of electric range at affordable price points. These vehicles are likely to be

more suitable for a broader portion of fleet transportation needs. Continued growth in charging infrastructure will also provide greater range confidence to EV drivers traveling longer distances away from their base of operations.

Appendix A

Definitions

1. **Electric Vehicle (EV):** a vehicle that plugs into the electric grid to recharge a battery used to provide motive power. Includes all electric (also referred to as battery electric) vehicles that are powered solely by energy stored in a battery as well as **Plug-in Hybrid (PHEV)** vehicles that can be powered by battery as well as gasoline or diesel for extended range.
2. **Electric Vehicle Supply Equipment (EVSE)**: refers to an EV charging station; a device used to provide electricity to an EV for the purpose of charging the vehicle's onboard battery. The EVSE is designed to provide a safe connection between the source of electricity and the vehicle and communicates with the vehicle's control system to ensure electricity flows at the proper voltage and current.
3. There are three types of EVSE depending on their power output as described in the table below.

Charge Method	Supply Voltage	Branch Circuit Breaker Rating (Amps)	Approximate Charging Power	Power Supply Connector	Vehicle Plug Connector
AC Level 1	120 VAC	20 A	1.5 kW	Charger comes with vehicle and plugs into standard 120 V outlet, or hardwired	J1772 or Telsa
AC Level 2	208 to 240 VAC	20-80 A	3.3 -7.7 kW for most EVs	Hardwired or NEMA standard 208/240V outlet	J1772 or Tesla
DC Fast Charging*	208 to 480 VAC	Up to 200 A	25-50 kW for most EVs	Hardwired	CHAdeMO, SAE Combo or Tesla Supercharger

a) *DC Fast charging is sometimes referred to as Level 3, but is technically known as DC Level 2 in the standard.
b) Additional information on charging devices, including approximate costs and location recommendations, is available on the Drive Electric Vermont EV Charging Installation guide: http://driveelectricvt.com/charging-stations/installation-guide
c) **Networked EVSE or Smart EVSE:** offers communication with the user, site host, utility grid, and/or the Internet, depending on model and manufacturer. They also offer the option of collecting fees for the charging session and detailed reporting capabilities.

d) **Basic EVSE or Non-networked EVSE**: means a charger that communicates only with the vehicle as the charger begins the session and ends when the vehicle's charger completes the session or the charge is interrupted by the EVSE or uncoupling. It doesn't need any connection other than the electrical infrastructure and is usually adequate for fleet charging, employee parking, or where fee collection and usage monitoring is not a priority.

Appendix B

Operating Costs – Nissan Leaf vs. Federal Mileage Reimbursement Rate ($0.575 per mile)

Table B1 - Vehicle Cost Summary 2015 Nissan Leaf	
Registration (per year)	$69.00
Inspection (per year)	$45.00
Insurance (per year)	$1,300.00
Misc. Costs (per year)	$20.00
Lease Down Payment	$2,399.00
Lease Monthly Payment	$199.00

Table B2 – Total Operating Costs			
	Mileage	**Federal Reimbursement Rate ($0.54 per mile)**	**Leaf Total Operating Costs**
Down payment			$2,399.00
Year 1	10,000	$5,400.00	$3,822.00
Year 2	10,000	$5,400.00	$3,822.00
Year 3	10,000	$5,400.00	$3,822.00
Totals		$16,200.00	$13,865.00

Appendix C

CCRPC's Operating Costs of i-MiEV Compared to Federal Mileage Reimbursement Rates

Table C1 - i-MiEV Costs Compared to the Federal Mileage Reimbursement Rate				
CCRPC Vehicle #1	Miles	Fuel Costs*	Total Operating Costs	Mileage Reimbursement
10/2013-10/2014 (12 months)	2,384	$0	$2,884.20	$1,341.00
10/2014-10/2015 (12 months)	2,384	$0	$2,884.20	$1,352.92
10/2015-06/2016 (9 months)	1,788	$0	$2,856.65	$996.81
CCRPC Vehicle #2				
10/2013-10/2014 (12 months)	2,371	$0	$2,883.58	$1,333.43
10/2014-10/2015 (12 months)	2,371	$0	$2,883.58	$1,345.28
10/2015-06/2016 (9 months)	1,778	$0	$2,856.18	$991.18
Total	**13,075**	**$0**	**$17,248.40**	**$7,360.63**

*Fuel costs are not included because CCRPC does not pay to charge the vehicle at their facility.

Table C2 - i-MiEV Maintenance and Other Costs	
i-MiEV Maintenance	**Per year**
Inspection	$45
Insurance	$1,300
Registration	$69
Misc. Cleaning	$40
Total	$1,454

Appendix D

Operating Costs – Nissan Leaf vs. Federal Mileage Reimbursement Rate ($0.575 per mile)

Table D1- Vehicle Cost Summary 2015 Nissan Leaf	
Registration (per year)	$69.00
Inspection (per year)	$45.00
Insurance (per year)	$1,300.00
Misc. Costs (per year)	$20.00
Lease Down Payment	$2,399.00
Lease Monthly Payment	$199.00

Table 2 – Total Operating Costs			
	Mileage	**Federal Reimbursement Rate ($0.54 per mile)**	**Leaf Total Operating Costs**
Down payment			$2,399.00
Year 1	10,000	$5,400.00	$3,822.00
Year 2	10,000	$5,400.00	$3,822.00
Year 3	10,000	$5,400.00	$3,822.00
Totals		$16,200.00	$13,865.00

Appendix E

Operating Costs – 2002 Chevy Malibu vs. i-MiEV Lease

Table E1 - Vehicle and Fuel Information		
	2002 Chevy Malibu	**i-MiEV**
Fuel Costs		
January 2013	$3.584 per gallon of gasoline	0.17 per kWh
January 2014	$3.603 per gallon of gasoline	0.17 per kWh
January 2015	$2.646 per gallon of gasoline	0.17 per kWh
Average Fuel Economy	21	

Table E2 – Fuel Costs Calculations			
Year	Miles	2002 Chevy Malibu	i-MiEV
2013	5,000	$853.33	$280.50
2014	5,000	$857.86	$280.50
2015	5,000	$630.00	$280.50
Total		$2,341.19	$841.50

Appendix F

Operating Costs – 2016 Chevy Malibu Lease vs. i-MiEV Lease

Table F1 - Vehicle and Fuel Information		
	2016 Chevy Malibu	**i-MiEV**
Fuel Costs	$2.76 per gallon of gasoline	0.17 per kWh
Down Payment	$1,897	$0
Monthly Lease Payment	$199	$110
Average MPG	29	

Table F2 – Fuel Costs Calculations			
Year	**Mileage**	**Chevy Malibu**	**i-MiEV**
Year 1	5,000	$475.86	$195.00
Year 2	5,000	$475.86	$195.00
Year 3	5,000	$475.86	$195.00
Totals		$1,427.59	$585.00

Table F3 – Total Operating Costs		
	Chevy Malibu	**i-MiEV**
Down payment	$1,897.00	$0.00
Year 1	$4,025.86	$2,606.00
Year 2	$4,095.86	$2,606.00
Year 3	$4,095.86	$2,606.00
Total	$14,114.59	$7,818.00

Appendix G

Operating Costs – 2016 F-150 vs. i-MiEV

Table G1 - Vehicle and Fuel Information		
	F-150	**i-MiEV**
Fuel Costs		
January 2013	$3.584 per gallon of gasoline	0.17 per kWh
January 2014	$3.603 per gallon of gasoline	0.17 per kWh
January 2015	$2.646 per gallon of gasoline	0.17 per kWh
Average Fuel Economy	22.5	

Table G2 – Fuel Costs Calculations			
Year	**Mileage**	**F-150**	**i-MiEV**
Year 1	1,200	$191.15	$67.32
Year 2	1,200	$192.16	$67.32
Year 3	1,200	$141.12	$67.32
Totals	3,600	$524.43	$201.96