FINAL REPORT:

City of Montpelier Net Zero Energy Action Plan

Submitted: August 13th, 2021

City of Montpelier

Montpelier is the smallest state capital in the United States with a population of just under 8,000 people. The city provides municipal services for its residents and businesses. These services include local law enforcement, firefighting, street and road maintenance, and provision for potable drinking water and wastewater.

The City of Montpelier is a national leader in the use of renewable energy and has already embarked on the road to meeting its goal of net zero energy by the year 2030. Major reductions in the use of fossil fuels have come from executed projects like the district heating system, solar PV installations, pellet heating of a senior center, installation of heat pumps, and the recent biogas project at the waste-water treatment facility. For further information, visit the City's website at – **https://www.montpelier-vt.org/**

Montpelier Energy Advisory Committee

The Montpelier Energy Advisory Committee was founded in 2010 to act in an advisory capacity to the City Council on energy issues. MEAC identifies and nurtures energy saving projects and opportunities; informs and engages city residents on energy issues; and partners with other statewide groups to foster projects that reduce Montpelier's energy use or help to meet its energy needs from renewables. Further information can be found at the MEAC website at - **https://www.netzeromontpelier.org/**

VEIC

As a non-profit sustainable energy organization, VEIC works with organizations across the energy landscape to create immediate and lasting change. Since 1986, we've served as an objective partner for our clients as they navigate complex energy challenges. With expertise in energy efficiency, building and transportation electrification, and new approaches for a clean and flexible grid, we bring solutions to the market that meet our clients' goals. We have assisted municipalities, transit agencies, states, utilities, and businesses in designing and executing strategies to reduce energy use and greenhouse gas emissions through policy planning, analysis, and implementation support. For further information on VEIC, please visit our website – **www.veic.org**

Disclaimer

The information, analysis, and recommendations made in this report are those of the authors, consistent with the commissioning of this work as an independent study. The analysis is intended to provide a level of detail necessary to develop high-level strategies and take action over time toward achieving the City of Montpelier's energy related goals. This study and its findings are not based on detailed design engineering.

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Executive Summary

The City of Montpelier has set an ambitious goal to eliminate fossil fuels from City owned buildings, operations, and vehicle/transportation fleet by the year 2030. This action plan examines the current energy uses and energy sources, forecasts a business-as-usual scenario, and explores the optimal pathway to reach the goal, by using efficiency, renewable energy, and electrification solutions.

This action plan was developed for the City of Montpelier in close collaboration with several City departments, the School District, and the Montpelier Energy Advisory Committee (MEAC). The purpose of the action plan is to lay out a realistic pathway to achieving the goal of net zero energy by the year 2030 without being overly prescriptive. This action plan provides helpful information that can be used to develop the necessary strategies to dramatically reduce and eventually eliminate fossil fuel use.

Baseline or historic energy consumption in Fiscal Year 2020 totaled 37,801 GJ, of which 36% is renewable. This includes energy from electricity use and fuel use of City-owned and managed buildings, as well as fleet vehicles, including school buses. Overall, 43% of the energy currently used in buildings is renewable, and only 3% of vehicle fuel is considered renewable (based on the ethanol mixed into gasoline).

Baseline data indicate the largest category of continued fossil fuel use is for thermal energy in buildings. Fossil fuel use is highest at the High School, the Water Resource Recovery Facility, the Middle School, and Public Works Buildings. However, with the recent completion of Phase 1 Biogas project, the fossil heating fuels previously used at the Water Resource Recovery Facility have already been eliminated.

If the City of Montpelier does not take any further action, it can expect that 55% of its energy use in 2030 will be from renewables. This scenario is driven largely by the recent completion of its Waste Resource Recovery Facility project and discontinued burning oil for summer domestic hot water to feed the district heat system. Lastly, this scenario assumes that electricity will be 100% renewable if Green Mountain Power reaches its goal.

Based on the analysis, the City of Montpelier can cost-effectively reach 88% renewable energy by 2030 by taking actions outlined in the Action Plan. Vehicles and some building energy will still likely use some fossil fuels.

Table 1 - Projected Energy Consumption 2030 with Net Zero Action Plan

Energy Sector	Annual Energy Use (GJ)	Percent Renewable	Metric Tons CO_2e
Buildings	30,875	95%	110
Vehicles	4,305	28%	271
Total	**35,181**	**88%**	**382**

The ability to meet 100% fossil fuel-free energy usage in City operations is limited largely by vehicle replacement costs and availability and small amounts of remaining usage for space heating, domestic hot water, and cooking in select buildings. High annual mileage light-duty vehicles are currently the best use-case for cost-effective electrification. Vehicles with a medium range, and medium- and heavy-duty vehicles have been shown to be less cost effective in this analysis within the 2030 timeframe or lack EV replacement options currently.

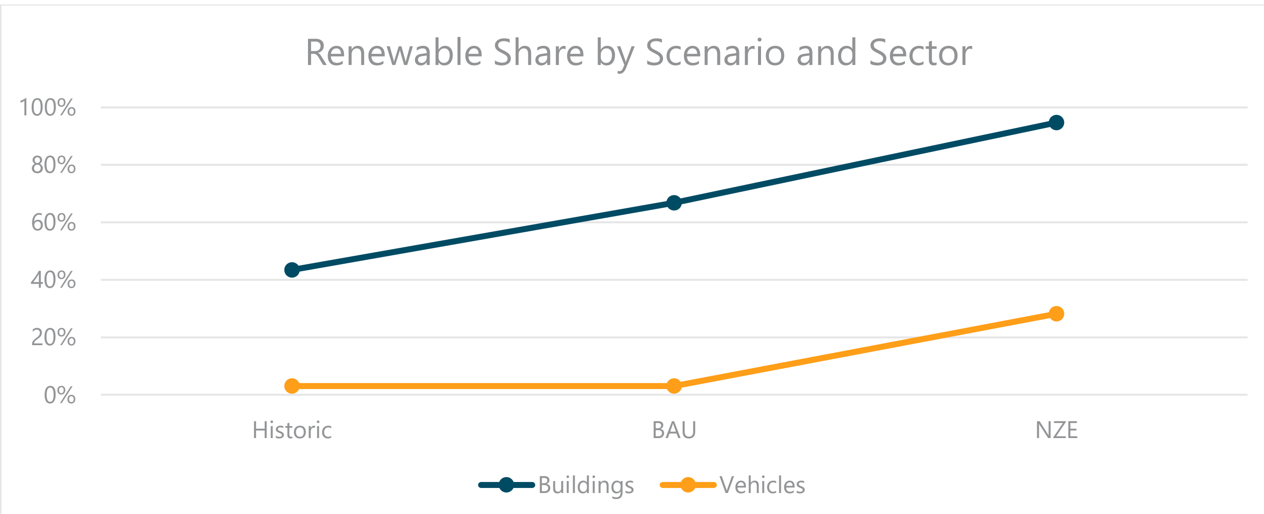

Figure 1- Graph depicting the percentages of renewable energy broken out between buildings and vehicles for Baseline, 2030 Business-as-Usual, and 2030 Net Zero.

The Net Zero Action plan identifies actions that the City can take to viably transition its energy away from fossil fuels by 2030. These actions were reviewed to meet a simple payback requirement and prioritized based on timeframe for implementation.

The City has three options to address the remaining 12% fossil energy:

1. Purchase carbon credits to offset emissions from continued fossil fuel usage,
2. Aggressively pursue supplemental grant funding to effectively lower capital costs and improve cost-effectiveness.
3. Change the cost-effectiveness requirements to allow investments with longer or no paybacks, or

If supplemental grants cannot be secured and the cost-effectiveness criteria cannot be altered, purchasing offsets to make up the remaining 12% will be the bridge to full realization of the 100% goal.

1.0 Introduction

1.1 Background

In 2014, the City of Montpelier adopted the goal of achieving Net Zero by the year 2030. In 2018, this goal was further defined in a City Council Resolution:

> *Montpelier is committed to becoming the first capital city to eliminate fossil fuel use by converting to 100% renewable energy. By 2030, 100% of the energy used for municipal government operations (thermal, electrical, and transportation) will be renewable or offset. By 2050, fossil fuel use will be eliminated entirely and 100% of energy needs (municipal, residential, and commercial) will be met renewably.*

One of the specific actions called for in this resolution was to:

> *"RECOMMEND THAT CITY STAFF DEVELOP A 10-YEAR PLAN TO ACHIEVE THE CITY'S NET ZERO GOAL. This will include identification of specific actions to reduce municipal energy use and emissions, metrics for cost effective decisions, a public communications plan, and efforts to ensure that targets are achieved in a socially equitable manner."*

In 2021, the City of Montpelier engaged VEIC to support the development of an Action Plan to support the City's net-zero fossil fuels goal by 2030. The process and methodology for the development of the Action Plan are below.

Defining "Net Zero" Energy

The term "net zero" energy can mean different things to different people. The "net zero" goal set by the City of Montpelier is to eliminate the use of fossil fuels. Therefore, the goal is not necessarily to achieve 100% local generation of the City's needed energy nor to achieve neutral (or net zero) carbon emissions. Within this plan and the associated analysis, fossil fuels include propane, heating oil, gasoline, and diesel. To achieve "net zero" in this context, the City will aim to reduce as much use of fossil fuels as possible and find ways to offset any negative environmental impacts of continued fossil fuel use.

This action plan identifies measures and methods to reduce and eventually eliminate the use of fossil fuels in the City buildings and operations by the year 2030. This action plan does not factor or address the fossil energy use of the private residents, organizations, agencies, or businesses located in the City of Montpelier. While the School District is a separate entity from the City, school buildings and operations were included in the scope.

To achieve this goal, the Action Plan considers measures focused on energy efficiency (e.g., weatherization, or equipment upgrades), renewable energy generation, efficient vehicles, fuel switching, and the purchase of

The Action Plan provides the City of Montpelier with potential pathways and a list of recommended actions to achieve its net zero fossil fuel goal by 2030. This document assesses different measures to support municipal electricity, thermal, and transportation use, with the main focus being on the latter two sectors. The Action Plan provides an assessment of greenhouse gas impacts, and economic viability (in the form of simple payback).

UNITS OF ENERGY USED WITHIN THE ANALYSIS

Energy is measured in different ways and with different units of measure. For example, electricity is commonly measured in kilowatt-hours (kWh). In the United State, thermal energy is sometimes measured in British thermal units (Btu), and the amount of energy used in vehicles is frequently reported in gallons of the fuel used.

In order to report total energy use across electric, thermal, and transportation, we needed as single common framework. While all energy can be reported in millions of Btu or kilowatt-hours, we chose to report energy values in Gigajoules (GJ) because of it ease for reporting large values and its common use nationally and internationally for energy action plans and GHG reporting.

1 GJ = 278 kWh or 0.95 million Btu or 7.6 gallons of gasoline

1.2 Methods

The following section outlines the key methods and steps used to evaluate and identify potential actions the City of Montpelier could take to achieve its ambitious goal.

1.2.1 Energy Use Data

For the analysis underlying this plan, VEIC leaned heavily on MEAC's data of existing energy consumption in municipal operations. This includes energy consumption by building or department, by fiscal year, and by fuel for electricity, fuel oil, propane, pellets, biogas, district heat, diesel, and gasoline. VEIC requested and received additional details on fuel use by vehicle, and on energy used in the leased school bus fleet.

1.2.2 Baseline Energy Use

VEIC used the data obtained in the previous step and used a 3-year average as baseline where available. Where fewer years of data were available, or significant changes happened in a building or vehicles energy in the past 3 years, a shorter period was used as the baseline. VEIC also included fuel use data for the leased school buses in the baseline. This detailed baseline was used to inform the actions and measures needed to eliminate fossil fuel use.

1.2.3 Business-as-Usual (BAU) Energy Use Projection

The Business-as-Usual (BAU) scenario is the basis of comparison for the Action Plan. It identifies expected energy use by sector and fuel should the City not take further steps to reduce or eliminate fossil fuels. This projection assumes the following:

- The existing project at the WWRF is completed and all thermal energy needs are met with biogas and the annual amount of energy used remains the same as the baseline (i.e. increased demand from a biosolids drier are not factored);
- The district heat utility no longer burns fuel oil in the City hall basement (as it had previously to provide domestic hot water in summer to customers when the State's steam plant was not running);
- Green Mountain Power achieves its 100% renewable energy by 2030 goal; [1]
- This analysis uses a straight-line interpolation between the 2020 renewable energy share (64%) and 2030 goal. [2] GMP does not include nuclear in their renewable percentage; but it does include it in its carbon free number, which stood at 95% in 2020;
- This increasingly renewable utility electricity was used for the roughly 40% of electricity the City does not get from its own solar arrays. There is no difference in electricity supply between the Business as Usual and Net Zero scenarios;
- No further efficiency or renewables efforts are made (besides those recently completed or those already underway);
- There will be no additional City-owned buildings connected to the district heat system;
- There are no changes to the number and types of vehicles in the City's fleet;
- Vehicles are assumed to be replaced at end-of-life with equivalent vehicles of the same fuel type (gasoline or diesel) and similar fuel economy;
- Industry-standard maintenance and operating costs by vehicle type; and
- Future energy costs are based on the Energy Information Administration's (EIA's) Annual Energy Outlook 2021.[3]

1.2.4 Analyzing Actions to Reduce Fossil Fuel Use

VEIC identified and assessed a wide range of efficiency and fuel-switching actions or measures that Montpelier could take to replace as much of the current fossil fuel consumption as possible.

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[1] **https://greenmountainpower.com/gmp-launches-vision-to-have-100-renewable-energy-by-2030/**

[2] With an Integrated Resource Plan (IRP) forthcoming, but modeling and forecasting not yet available, GMP's Director of Power Supply, Doug Smith, suggested a straight-line forecast is appropriate. Personal communications, email to Damon Lane, VEIC, May 5, 2021.

[3] EIA, AEO2021 National Energy Modeling System, Reference case: ref2021.d113020a

VEIC reviewed energy audit reports, interviewed City and School District staff on their buildings, vehicle fleets, and operations, and developed and reviewed draft measure lists with MEAC and Department Heads to seek further feedback. At this stage, applicability and functionality were the primary considerations.

1.2.5 Simple Payback Analysis

To assess the financial viability of the various investments identified, VEIC used simple payback analysis. Simple payback evaluates how long it will take for the annual financial savings from the measures to exceed the initial capital invested. Measures that generate enough savings to exceed the investment cost within the measure's expected lifetime were deemed viable options – others were excluded.

VEIC developed and applied capital cost estimates and operating costs for each technology specific to the given size and load of each building or use of vehicles. Industry averages for heating system sizing were used as precursor to developing capital cost estimates. Capital costs estimates were derived from reported actual costs for comparable projects across the region for facility improvements. It is important to note that capital cost estimates and analysis for this action plan were not based on detailed engineering-grade assessments. For vehicles, estimated pricing for gasoline or diesel-fueled models and equivalent electric vehicle models by vehicle type were taken from the *Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET)* Tool[4], focusing on the difference between them (incremental cost) to determine EV capital costs for each category of vehicle with a known or expected EV equivalent by 2030. Industry standard defaults for charging station purchase and installation costs were included in capital cost calculations (though note installations costs are highly variable based on existing infrastructure at each facility, which were not examined as part of this study).

Operating costs were derived from the Vermont Department of Public Service's Fuel Price Reports[5] for current energy costs to use in the simple payback analysis. This covered traditional fossil fuels, but for dry wood chips and wood pellets regional suppliers were surveyed. For biodiesel blends and renewable diesel national price data[6] was compared to reported prices from regional suppliers.

1.2.6 Developing Recommended Actions

For each building and vehicle, VEIC reviewed the payback analysis and operational considerations and identified the most promising action to reduce fossil fuel use. It is important to note that the recommended actions were not based on design engineering level assessment – rather portfolio level analysis using averaged input values. For some, like heavy duty vehicles, there is not currently

[4] **https://greet.es.anl.gov/afleet_tool**
[5] **https://publicservice.vermont.gov/content/retail-prices-heating-fuels**
[6] DOE AFDC data (**https://afdc.energy.gov/fuels/prices.html**)

a viable path to go further than B20 biodiesel. When economics limit further action, VEIC included a calculation of the additional funding necessary. For example, in vehicle replacement, if an electric version is available, but would not pay back within the vehicle's lifetime, VEIC would provide a calculation of the upfront incentive needed to reduce the payback to the vehicle's lifetime.

2.0 Results

2.1 Baseline Energy Use: 2020

2.1.1 Electricity

MEAC provided electricity data for 66 consumption meters and eight generation meters from 2011 to 2020, grouped by building or department. Based on the most recent year's data, the waste-water plant consumed 36% of total electricity, and the water plant used 16%. The schools used about 1/3 as much electricity as the City. The High School uses about as much electricity as the Middle School and Elementary School combined. The last 3 years of electricity use was 14% lower than the first 3 years, though the change over time varies by account.

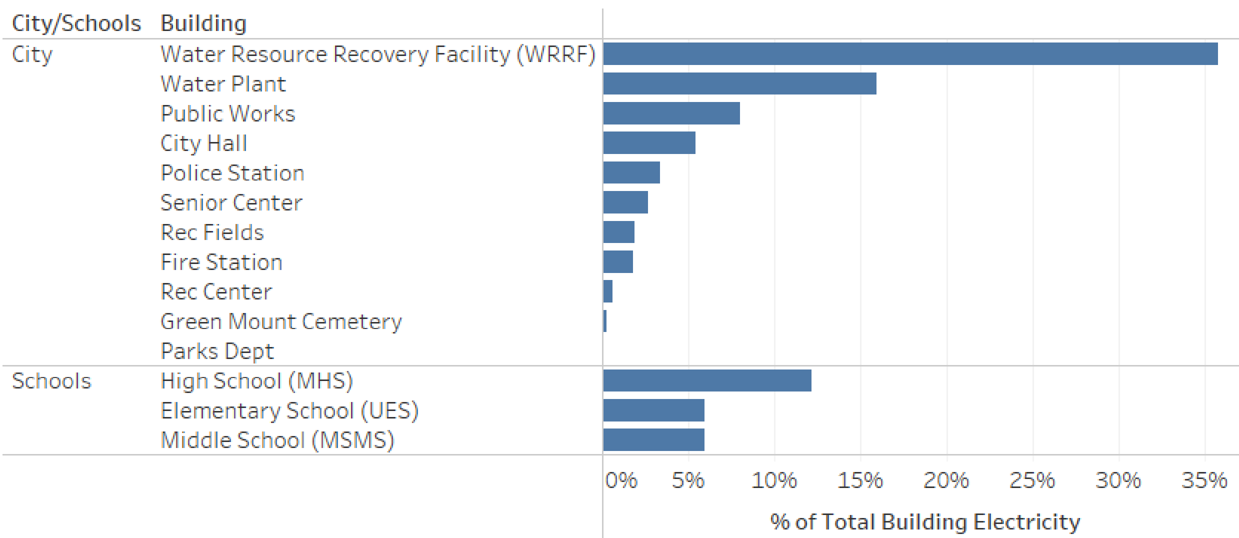


Figure 2 - Share of total electricity by Building/Department in Fiscal Year 2020.

The electric account data indicate that 62.4 kW of solar PV have been installed and operating at the waste-water plant since 2011. An additional small solar PV array was installed in 2013 at the Department of Public Works garage. In 2017, the City and the school district entered into a power-purchase agreement for the energy generated from two additional privately-owned PV arrays located in Montpelier and Sharon. Today, electric generation from solar PV accounts for nearly 60% of the electricity used by the City. The School district has separate solar systems that provide 60% of their electricity on an annual basis.

Today, electric generation from solar PV accounts for nearly 60% of the electricity used by the City.

Over the same time-period, between 2011 and 2020, Green Mountain Power's (GMP's) share of renewable energy supply grew from 5% to 64%,[7] cleaning the electricity Montpelier buys dramatically. Green Mountain Power sources nuclear power for most of the rest of their supply, and they count that as carbon free, but do not include it in their renewable percentage.

In 2020, the on-site solar and GMP's supply combine to provide Montpelier with electricity that is about 88% renewable.

Besides the electricity generated by the City owned PV arrays and what is purchased from the electrical grid, there is a small amount of diesel fuel burned in emergency power gensets at the police station and at the water treatment plant. While these units are not needed for typical day-to-day operations, they provide critical back-up and need to be run periodically for testing and maintenance.

2.1.2 Thermal

Across the various departments including the school district, the City of Montpelier has 24 heated buildings totaling approximately 350,000 square feet. Buildings range from 15 to over 100 years in age – with sizes from 1,300 square feet to 90,000 square feet. These buildings also range widely in use and condition. A majority of the City's buildings provide heat using boilers and modern hot water (hydronic) heat distribution systems, while a handful of buildings use furnaces feeding warm air ducted systems or direct-fired units. The recreation center has a steam heat system that should be replaced with hydronics as soon as possible. VEIC worked with the City of Montpelier staff and MEAC members to review heating fuel use data[8] to examine thermal energy uses:

- Space heating loads
- DHW loads
- Cooking fuel use

In 2014, the City completed the district heating project that provides hot water to a total of 22 buildings in downtown Montpelier including four City owned buildings (City hall, the fire station, police station, and Union Elementary School). Steam from the State of Vermont's woodchip heating system is converted to hot water and the City operates the district heating system as a hot water supply utility[9]. At the time, these four buildings were the priority for connection to the district heating loop and the remaining City owned buildings were not connected due to the distance and cost to connect them. These buildings, not connected to the district heating system,

[7] Based on the 2019 and 2020 renewable electricity percentage shown on **https://greenmountainpower.com/energy-mix/** during May 2021 and historic emissions by year provided via personal communications by Graham Turk, Innovation Strategist at GMP to Damon Lane on May 5, 2021.

[8] Data were examined to assess energy use intensity (Btu per square foot per year) in each building, but the usefulness of the EUI was skewed by high EUI values – especially a few buildings that have diesel generators tied to heating oil tanks and no fuel use metering.

[9] **https://www.montpelier-vt.org/375/District-Heat-Montpelier**

mostly produce their own space heating and hot water using oil and propane boilers and heaters. There is one exception; the Senior Center on Barre Street uses a pellet boiler and a solar hot water system. Over the past several years, cold-climate heat pumps that provide supplemental heating and cooling have been installed in several buildings. Additionally, heat pump hot water heaters have been installed in select City buildings to provide summer-time domestic hot water when the district heating plant is off-line.

For a more detailed list of City owned buildings, please see **Appendix A – Inventory of Buildings.**

2.1.3 Transportation

The City has 76 vehicles operated by five City departments: Fire & Ambulance, Police, Public Works, Cemeteries, Community Services. Forty-one of these vehicles are in the Department of Public Works (DPW). Across Departments, there are a range of vehicle models ranging from light-duty sedans, SUVs, pick-up trucks and vans to medium- and heavy-duty fire engines, dump trucks, and specialized municipal equipment such as plows and streetsweepers. The City's vehicle fleet also includes off-road heavy construction and excavation equipment: wheel loaders, road grader, pavers and asphalt recyclers, backhoes/excavators, sidewalk plows, rollers and a lawn tractor. The majority of the City's on-road vehicles operate on diesel with unleaded gasoline being the other primary source of fuel.

School buses are included in this report for energy use tracking but are owned and operated by a third-party school transportation contractor. In addition, tools such as fuel-burning landscaping equipment, mobile fuel tanks, mobile generators, and vehicle accessories were not included in the transportation analysis, though their fuel use is captured by the City's overall fossil fuel tracking system.

Only three percent of the fuel used by the City's fleet is renewable, which is from to the ethanol content in gasoline. In 2020 the Police Department deployed a hybrid electric police interceptor SUV, and the schools deployed a battery electric Chevrolet Bolt for driver's education classes, and hybrid-electric minivan for school activities, all with good success. There are currently no modern city-owned EV charging stations to support the fleet other than the charging station associated with the Bolt EV at the high school.

In 2019 MEAC and the Department of Public Works investigated the viability of biodiesel and renewable diesel as alternative fuels, particularly for heavy-duty equipment and vehicles that are unlikely candidates for electrification in the near to mid-term. There is interest in a pilot project to test these fuels in smaller dump trucks and there is also interest in electric work trucks and vans that are beginning to emerge on the market. However, the City has identified challenges with the supply of biodiesel blends and renewable diesel as well as vehicle makes and models that can serve DPW's operational needs.

2.1.4 Combined Energy

In total, the City of Montpelier uses 37,801 GJ of energy annually, with roughly 82% from building energy use (electric and thermal) and the remaining 18% from vehicles.

Table 3 below provides a comprehensive overview of the current energy use by department from both fossil and renewable energy based on a three-year average. The "buildings" row represents both the electrical and thermal energy consumption.

Table 2- Baseline Annual Energy Consumption Table

Building/Department	Use	Energy (GJ)	Renewable Share (%)	Metric tons of CO_2
City Hall	Total	2,370	95%	4
	Buildings	2,370	95%	4
	Vehicles	-	-	-
Fire Station	Total	739	25%	41
	Buildings	200	88%	0
	Vehicles	539	1%	41
Green Mount Cemetery	Total	212	13%	12
	Buildings	135	21%	6
	Vehicles	77	0%	6
Parks Dept	Total	108	11%	7
	Buildings	23	17%	1
	Vehicles	85	9%	6
Police Station	Total	2,127	59%	62
	Buildings	1,264	93%	4
	Vehicles	862	10%	58
Public Works	Total	6,919	12%	441
	Buildings	3,161	24%	156
	Vehicles	3,757	1%	285
Rec Center	Total	977	7%	63
	Buildings	863	7%	55
	Vehicles	113	7%	8
Rec Fields	Total	395	47%	13
	Buildings	339	53%	10
	Vehicles	56	10%	4
Senior Center	Total	369	71%	5
	Buildings	350	74%	4
	Vehicles	19	10%	1
Water Plant	Total	2,973	52%	77
	Buildings	2,879	53%	70
	Vehicles	95	10%	6
Water Resource Recovery Facility (WRRF)	Total	8,177	42%	301
	Buildings	8,147	42%	299
	Vehicles	30	9%	2
Elementary School (UES)	Total	2,478	75%	38
	Buildings	2,478	75%	38
	Vehicles	-	0%	-
Middle School (MSMS)	Total	2,990	19%	164
	Buildings	2,990	19%	164
	Vehicles	-	-	-
High School (MHS)	Total	6,041	19%	328
	Buildings	5,761	20%	310
	Vehicles	280	10%	19
School Bus Contractor	Total	927	0%	72
	Buildings	-	-	-
	Vehicles	927	0%	72
Total	Total	37,801	36%	1,628
	Buildings	30,960	43%	1,120
	Vehicles	6,841	3%	508

The baseline data reported in this document was not taken from a single year – especially because 2020 was such an outlier due to the pandemic. Two to three years of data were used depending on when efficiency projects were done or operational changes that affect the baseline were made.

It is important to note that in 2019 there was considerably more fossil fuel use in vehicles and equipment than in 2020, so the two-year average used for vehicles may prove low if use returns to previous levels. In Fiscal Year 2019 the City's fleet used 35,324 gallons of diesel and 19,403 gallons of gasoline and was responsible for 57% of the City's GHG emissions. **In Fiscal Year 2020, reported diesel use dropped 31% and gasoline dropped 12%.**

The City of Montpelier baseline energy use is 37,801 GJ per year, with slightly over 24,000 GJ from fossil energy sources.

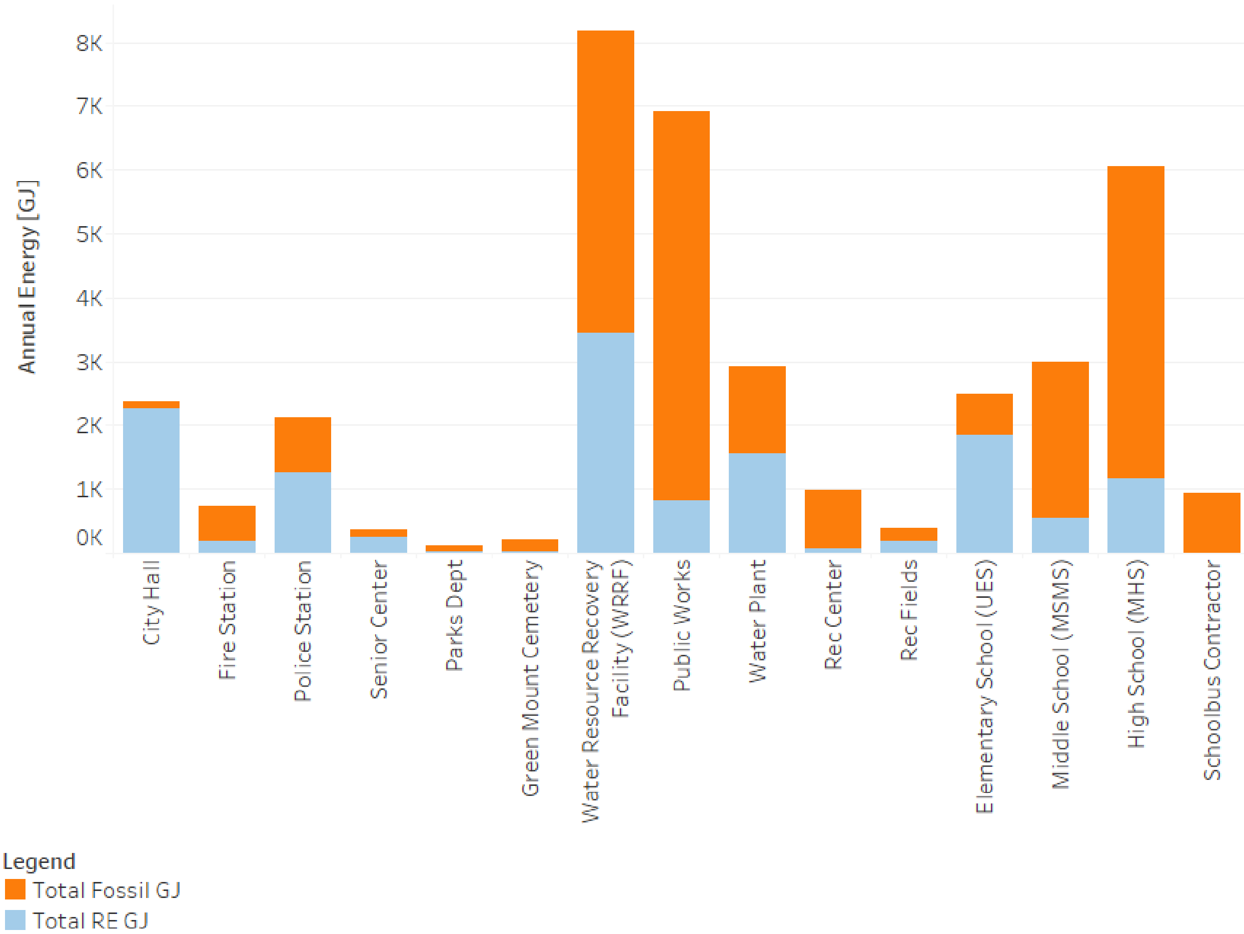


Figure 3. FY2020 historic energy use (baseline) by department by fossil fuel vs renewable (GJ)

While the baseline fossil energy used for the Water Resource Recovery Facility looks high in the graph above, it is important to note that the Phase 1 Biogas project, completed in 2021, nearly eliminates all the thermal energy sources from fossil fuels. This change is reflected in the business-as-usual section below. Similarly, a large portion of the fossil energy attributed to Public Works is due to heating oil burned in the City Hall boilers to provide thermal energy for the district heat utility. This boiler has provided summer-time domestic hot water and shoulder-season heating to district heat utility customers. This practice was recently discontinued in 2020.

2.2 Business as Usual (BAU) Scenario: 2030

The City already gets 60% of its electricity from its own solar PV arrays and the remaining 40% is sourced from the electric utility that is continually increasing its percentage of energy sourced from renewables and is expected to reach 100% renewable by 2030. Therefore, there is no difference in electricity supply between the Business as Usual and Net Zero scenarios.

2.2.1 Combined Energy

Due to the minimal change between 2021 and 2030 (besides the first-year changes to account for the completion of phase 1 biogas project and the elimination of oil fueled district heat for summer-time domestic hot water), Figure 4 below shows the energy consumption across departments in the end year of 2030.

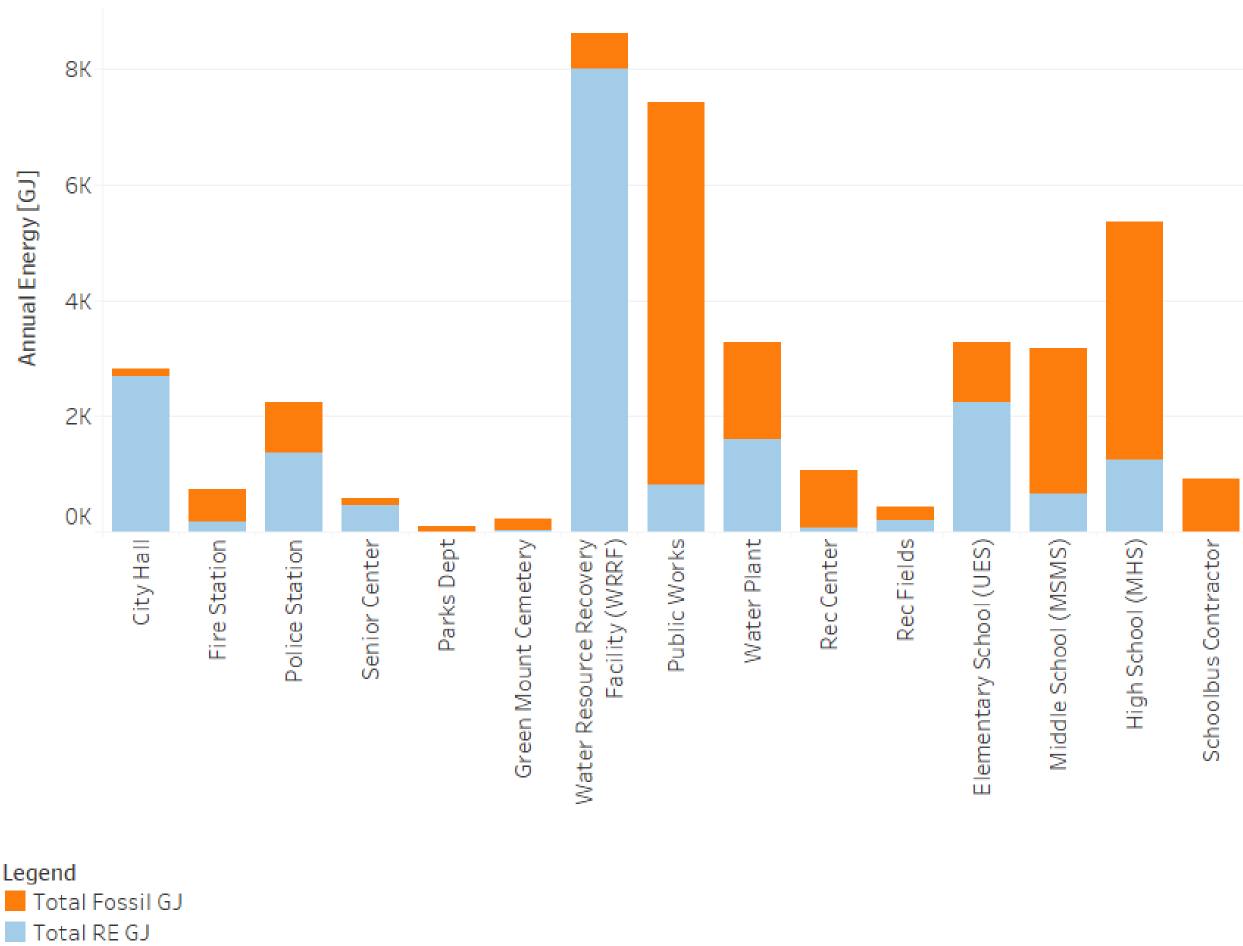


Figure 4. BAU energy in 2030 by fossil vs renewable (GJ)

Without additional action, the City would reach only 55% renewables and fall far short of its fossil fuel reduction goal. The fossil fuel usage by 2030 would be approximately 45% of total energy. To meet its goal under the Business-as-Usual scenario, the City could purchase carbon credits to offset the emissions generated from its continued fossil fuel usage. **The Business-as-Usual scenario is projected to have 1,209 metric tons of CO_2e that would need to be offset annually at a cost estimated to be between $4,000 and $18,000 each year.** For more information on carbon offsets, see Appendix D – Discussion of Carbon Offsets.

Table 3- Business-as-Usual Projected Annual Energy Consumption Table

Building/Department	Use	Energy (GJ)	Renewable Share (%)	Metric tons of CO_2
City Hall	Total	2,825	98%	3
	Buildings	2,825	98%	3
	Vehicles	-	0%	-
Fire Station	Total	731	27%	41
	Buildings	192	100%	-
	Vehicles	539	1%	41
Green Mount Cemetery	Total	221	16%	12
	Buildings	144	24%	7
	Vehicles	77	0%	6
Parks Dept	Total	99	13%	6
	Buildings	15	34%	1
	Vehicles	85	9%	6
Police Station	Total	2,229	65%	59
	Buildings	1,367	99%	1
	Vehicles	862	10%	58
Public Works	Total	5,315	18%	328
	Buildings	1,558	57%	43
	Vehicles	3,757	1%	285
Rec Center	Total	1,066	8%	69
	Buildings	953	8%	61
	Vehicles	113	7%	8
Rec Fields	Total	420	57%	13
	Buildings	364	64%	9
	Vehicles	56	10%	4
Senior Center	Total	572	85%	5
	Buildings	553	88%	4
	Vehicles	19	10%	1
Water Plant	Total	3,319	55%	90
	Buildings	3,224	57%	84
	Vehicles	95	10%	6
Water Resource Recovery Facility (WRRF)	Total	8,611	100%	3
	Buildings	8,581	100%	1
	Vehicles	30	9%	2
Elementary School (UES)	Total	3,276	71%	66
	Buildings	3,276	71%	66
	Vehicles	-	0%	-
Middle School (MSMS)	Total	3,174	24%	167
	Buildings	3,174	24%	167
	Vehicles	-	0%	-
High School (MHS)	Total	5,358	27%	273
	Buildings	5,078	28%	255
	Vehicles	280	10%	19
School Bus Contractor	Total	927	0%	72
	Buildings	-	-	-
	Vehicles	927	0%	72
Total	Total	38,144	55%	1,209
	Buildings	31,304	67%	700
	Vehicles	6,841	3%	508

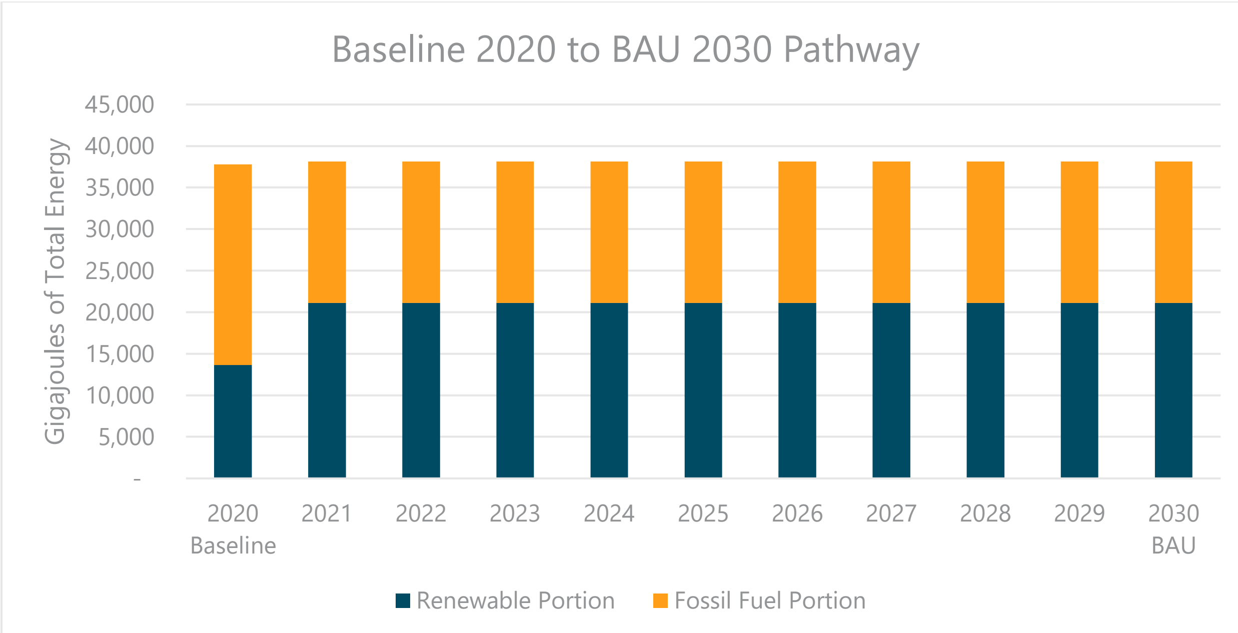


Figure 5 – Illustrative pathway for getting from 2020 to 2030 under the BAU scenario

Figure 5 depicts the relative straight line over the next nine years for the business-as-usual projection that illustrates how much fossil fuel will still be used if no action is taken.

2.3 Net Zero Scenario: 2030

The following possible actions have been identified to support eliminating fossil fuel usage by the City of Montpelier. Fuel-switching and electrification are essential for reducing fossil fuel usage by the City in the long-term. Each action includes a description, anticipated financial cost, fossil fuel reduction to be achieved, emissions reduction to be achieved, and which City Department is responsible for implementing the project. Table 2 below provides a short summary of the categories of measures broken out between primary strategies and secondary strategies. Renewable fuels like B100 and the use of purchased offsets were deemed secondary strategies because they do not necessarily provide durable infrastructure that ensures long-term fossil fuel replacement.

Table 4 – Summary List of Building and Vehicle Measures Assessed

Category of Measure	Measure Assessed
Primary Building Measures	Weatherization and efficiency
	Ground-source heat pumps
	Cold-climate air-source heat pumps
	Dry wood chip boiler systems[10]
	Wood pellet boiler systems
Secondary Building Measures	B100 heating oil
	Carbon offsets
Primary Vehicle Measures (includes charging stations)	Plug-in electric vehicles (all-electric & plug-in hybrid)
	Medium and heavy-duty electric vehicles
	Electric heavy equipment as possible
Secondary Vehicle Measures	Biodiesel blends
	Renewable diesel
	Carbon offsets

For a more detailed list of measures considered, please refer to Appendix C.

[10] Dry woodchip fuel and boiler systems differ from traditional woodchip fuel and systems. Dry woodchips contain nearly half the amount of moisture than traditional woodchips and therefore have greater energy density and fuel can be stored in an outdoor metal silo like wood pellets. Dry woodchip boiler systems are typically smaller and can be fitted into tighter boiler rooms than traditional woodchip systems – thereby lowering the overall project capital costs. For further information - **http://biomassmagazine.com/articles/15964/critical-mass**

Table 5- 2030 Net Zero Energy Annual Energy Consumption Table

Building/Department	Use	Energy (GJ)	Renewable Share (%)	Metric tons of CO_2
City Hall	Total	2,825	98%	3
	Buildings	2,825	98%	3
	Vehicles	-	0%	-
Fire Station	Total	678	44%	42
	Buildings	192	100%	-
	Vehicles	485	2%	42
Green Mount Cemetery	Total	261	21%	16
	Buildings	144	24%	7
	Vehicles	117	3%	10
Parks Dept	Total	141	72%	3
	Buildings	93	88%	1
	Vehicles	48	43%	2
Police Station	Total	1,707	97%	4
	Buildings	1,367	99%	1
	Vehicles	340	89%	3
Public Works	Total	4,757	58%	214
	Buildings	2,025	96%	5
	Vehicles	2,733	13%	209
Rec Center	Total	821	100%	-
	Buildings	821	100%	-
	Vehicles	-	0%	-
Rec Fields	Total	364	64%	9
	Buildings	364	64%	9
	Vehicles	-	0%	-
Senior Center	Total	411	99%	0
	Buildings	411	99%	0
	Vehicles	-	0%	-
Water Plant	Total	3,016	100%	-
	Buildings	2,983	100%	-
	Vehicles	33	100%	-
Water Resource Recovery Facility (WRRF)	Total	8,591	100%	1
	Buildings	8,581	100%	1
	Vehicles	10	100%	-
Elementary School (UES)	Total	3,314	70%	68
	Buildings	3,276	71%	66
	Vehicles	38	10%	3
Middle School (MSMS)	Total	3,126	96%	9
	Buildings	3,110	96%	8
	Vehicles	15	10%	1
High School (MHS)	Total	4,833	97%	11
	Buildings	4,683	97%	11
	Vehicles	150	100%	-
School Bus Contractor	Total	336	95%	1
	Buildings	-	-	-
	Vehicles	336	95%	1
Total	Total	35,181	88%	382
	Buildings	30,875	95%	110
	Vehicles	4,305	28%	271

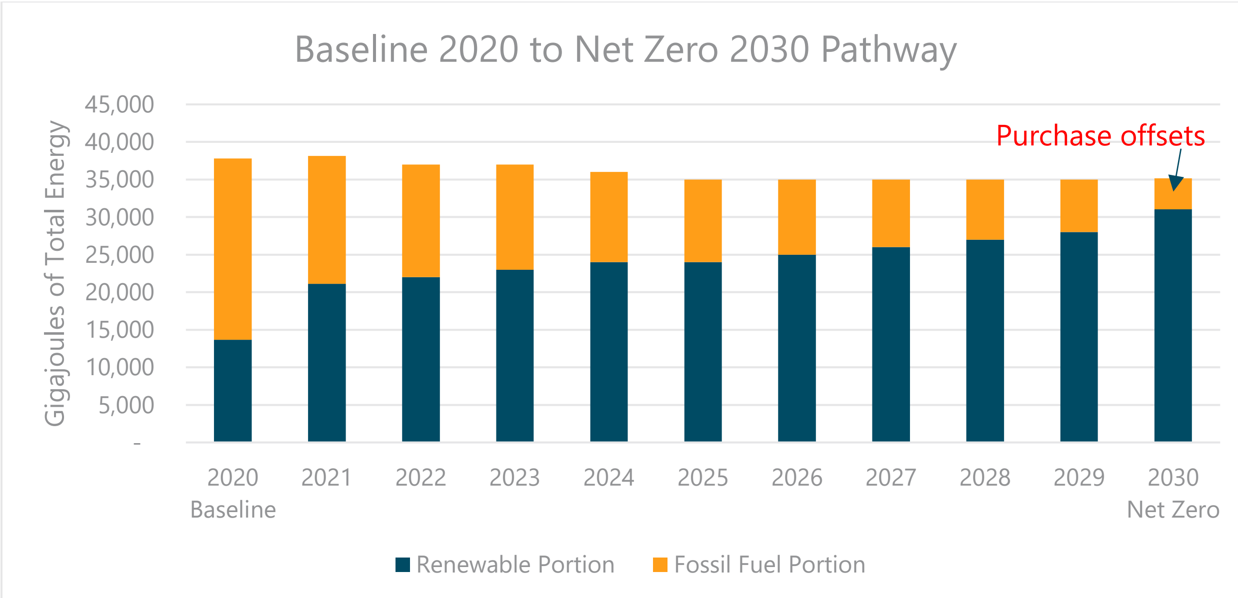


Figure 6 - Illustrative pathway of getting from baseline 2020 to Net Zero by 2030

2.3.1 Economic Analysis

2.3.1.1 Capital Costs

Electric

Due to the current amount of electricity that comes from renewable energy and the projections supporting 100% renewables by 2030, no capital investments were deemed necessary for the City.

Thermal

Using the baseline energy use data and integrating anecdotal information gathered with city staff, system capacity ratings were estimated for each building to serve both the space heating and domestic hot water loads. Recent installed system cost data were used to develop average capital costs per unit of system capacity. The system output capacities and the averaged system costs were used to develop capital cost estimates specific to each building for each technology option considered. For the 24 buildings this included the following measures:

- Ground-source Heat Pumps (GSHP) have relatively high-capital costs per unit of system output capacity ($700-800k per million Btu of hourly output capacity).
- Cold-climate Air-source heat pumps (ccASHP) have moderate capital costs per unit of system output capacity ($400-450k per million Btu of hourly output capacity).
- Dry woodchip boilers have moderate capital costs per unit of system output capacity ($250-275k per million Btu of hourly output capacity).

- Bulk wood pellet boilers have low to moderate capital costs per unit of system output capacity ($200-225k per million Btu of hourly output capacity).

Fleet Vehicles

Using the City's vehicle inventory, estimated pricing for gasoline or diesel fueled models and equivalent EV models by vehicle type were taken from the AFLEET tool, focusing on the difference between them (incremental cost) to determine capital costs for each category of vehicle with a known or expected EV equivalent by 2030. Batteries are the most expensive component of EVs. Medium- and heavy-duty EVs require larger batteries to produce sufficient power and range to meet operational demands, which is why they are considerably more expensive to purchase than gas or diesel vehicles.

1. Light-duty EVs, including All-Electric Vehicles (AEVs) and Plug-in Hybrid Electric Vehicles (PHEVs), currently cost more than their fossil fuel counterparts, with a typical price premium of around $7,000 for an AEV or PHEV sedan and $10,000 for an AEV or PHEV SUV, before any available incentives. Mid-sized electric trucks have a higher premium of approximately $16,000 to $23,000 more depending on the size of the truck.
2. Medium and heavy-duty EVs such as school buses, trucks, dump trucks, and bucket trucks have more significant price premiums and can be as much as 2-4 times the cost of a diesel equivalent.

Electric Vehicle Supply Equipment (Charging Stations)

Our analysis identified recommendations for EV charging station types (Level 1, Level 2 standard or high powered, DC fast charging) by vehicle-type. Industry standard costs for charging station purchase and installation were included in capital cost calculations. Costs for purchase and installation of Level 2 chargers range from $2,300 for non-networked chargers to $5,700 for high-end networked chargers. Higher powered Level 2 chargers (19 kW) are likely to cost around $15,500. High powered DC fast chargers (50 kW) are the most expensive at approximately $45,000-50,000. It is important to note that installation costs are highly variable based on available electrical infrastructure at each facility, which was not examined as part of this study.

Biofuels

Biofuels are recommended as an alternative for vehicles that are not expected to have viable EV equivalents by 2030.

1. B20 blends can serve as a drop-in replacement for conventional diesel with a revised fuel management protocol, including potentially dropping down to a lower blend level (B10) in the winter months to avoid gelling in fuel lines. Switching the entire fleet to B20 is feasible with adequate planning and preparation and would utilize either the City's

existing diesel underground tank or an updated version if/when that tank is replaced. Thus, no capital costs are required for use of B20 fleetwide.

2. B100 requires vehicle fuel tank and engine control module aftermarket modification to run year-round without gelling. Modifications from the leading 3rd-party upfitter (Optimus Technologies) cost approximately $15,000 per vehicle. Additionally, we assumed that not all vehicles and equipment would be converted to B100, and so Montpelier would need to maintain fueling capacity for both diesel and B100. The most cost-effective way to do this would be to replace the existing underground diesel tank at end of life with a segmented tank capable of storing 2 fuel types, and then add a second pump to dispense the B100. Estimated capital costs for this additional pump were included in B100 capital cost estimates.
3. Renewable Diesel is a drop-in replacement for conventional diesel and would not require any new fuel management protocols or capital equipment upgrades. Therefore, we assumed Montpelier would switch to 100% Renewable Diesel for their entire fleet when a cost-effective source is available, rather than incrementally, and would utilize either their existing diesel underground tank or an updated version if/when that tank is replaced. Thus, no capital costs are required for use of renewable diesel fleetwide.

2.3.1.2 Incentives to lower Capital Costs

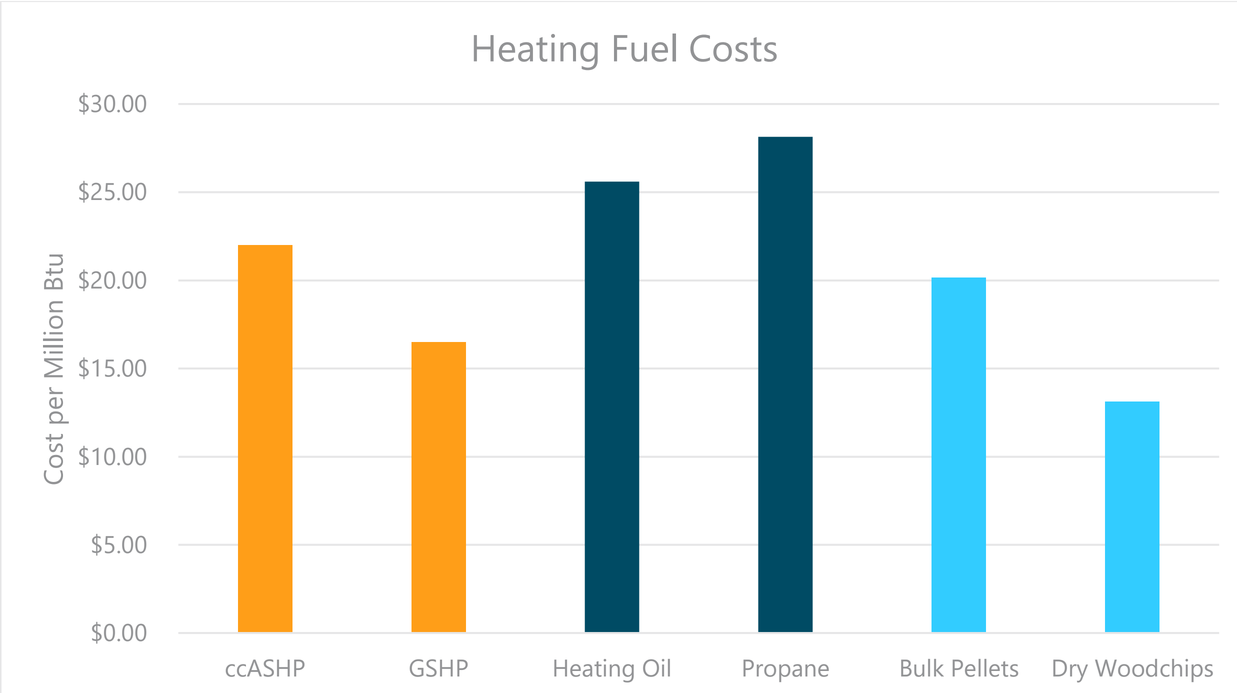
In many cases, energy efficiency and renewable energy projects can secure supplemental funding to lower the upfront project cost. While some incentives are available through sources like Efficiency Vermont, and Tier 3 programs run by the regulated electric distribution utilities, for large municipal-scale projects these are usually offered as "custom" incentives and the actual amount of funds available are not easily predicted. Other incentive sources, like federal income tax credits or investment tax rebates for ground-source heat pumps, wood heating equipment and electric vehicles, are challenging for municipalities to access. Rather than make speculative estimates on incentive availability, analysis was performed using the full capital costs without incentives. For further information on discussion of potential incentives please see Appendix F.

2.3.1.3 Operating Costs

Capital costs are important but understanding the annual costs of fueling and operating various technologies is critical to assessing the overall cost-effectiveness and whether lower annual operating costs can be achieved to drive a return on the investment.

Thermal Energy

Figure 7 – Illustrative graph depicting the cost of heating fuels used in this analysis



The bar graph above illustrates the comparative fuel costs of delivered heat for ccASP, GSHP, Bulk wood pellets, and dry woodchips against oil and propane. While both GSHP and ccASHP use electricity, GSHP consistently operate at higher efficiency whereas ccASHP efficiency fluctuates widely depending on outdoor air temperatures. Despite the greater energy density of pellets, woodchips are a lower cost boiler fuel. All four options offer energy savings when compared against current market prices for heating oil and propane. Note that oil and propane prices can swing widely and the prices depicted in the graph above are based on the prices detailed in the table below.

Figure 8 – Chart detailing the input assumptions that yield a cost per mmBtu for each technology/fuel type.

Fuel Type	Unit	Cost per Unit	Net mmBtu per Unit	Average Efficiency or COP	Cost per mmBtu After Combustion
ccASHP	kWh	$0.18	0.003	2.5	$21.98
GSHP	kWh	$0.18	0.003	3.6	$16.49
Heating Oil	Gallon	$2.65	0.138	89%	$25.60
Propane	Gallon	$2.20	0.092	91%	$28.13
Bulk Pellets	Ton	$250	15.510	85%	$20.15
Dry Woodchips	Ton	$130	12.375	83%	$13.13

In addition to the fuel costs presented above, operating and maintenance cost were also factored in the economic analysis performed.

Vehicles

Electrification

All classes of EVs will generate operational savings from lower maintenance and fuel costs. Electricity is roughly twice as expensive per unit of energy than gasoline or diesel, but EVs are roughly 3-4 times more efficient so their net energy costs are lower. In Vermont, costs to charge an EV are estimated to be the equivalent of $1.50 per gallon of gas, and costs can be lower if users are able to access off-peak rates for EV charging provided by Green Mountain Power and other electric utilities.

EVs have significantly lower maintenance needs and costs relative to conventional gasoline vehicles. This results in an estimated $0.09/mile cost for maintenance of light duty EVs compared to $0.15-$0.23/mile for gasoline or diesel vehicles. On average Consumer Reports has found light-duty electric vehicles can save $4,600 in maintenance costs over the life of the vehicle[11]. For medium to heavy duty EVs maintenance savings are estimated at $0.07-$0.08 per miles with some models netting higher benefits.

PHEVs achieve slightly smaller fuel cost savings than AEVs and lower maintenance savings, as they contain both electric and conventional powertrains which require maintenance.

Operating costs for charging stations vary on service packages and whether the chargers are networked. Basic, non-networked charging stations require minimal maintenance and no annual fees, whereas networked charging stations typically require significant annual fees to operate.

Biofuels

Biodiesel: In Vermont, B20 and B100 prices are generally equal to or lower than diesel – anywhere from $0.00 to $0.49 lower per gallon, according to the most recent AFDC alternative fuels price report.[12]

Renewable diesel: Renewable diesel is not currently available in Vermont. Availability is limited to California, where it is lower cost than diesel fuel due to the state's low-carbon fuel standard. For the purposes of this study, it is assumed renewable diesel will be available in Vermont by 2025, at a price premium of $0.50 over conventional diesel. This is based on high-level market research

[11] https://www.consumerreports.org/hybrids-evs/evs-offer-big-savings-over-traditional-gas-powered-cars/

[12] https://afdc.energy.gov/files/u/publication/alternative_fuel_price_report_january_2021.pdf

and predicted outcomes of the Transportation Climate Initiative (TCI) for Northeast and Mid-Atlantic States.[13]

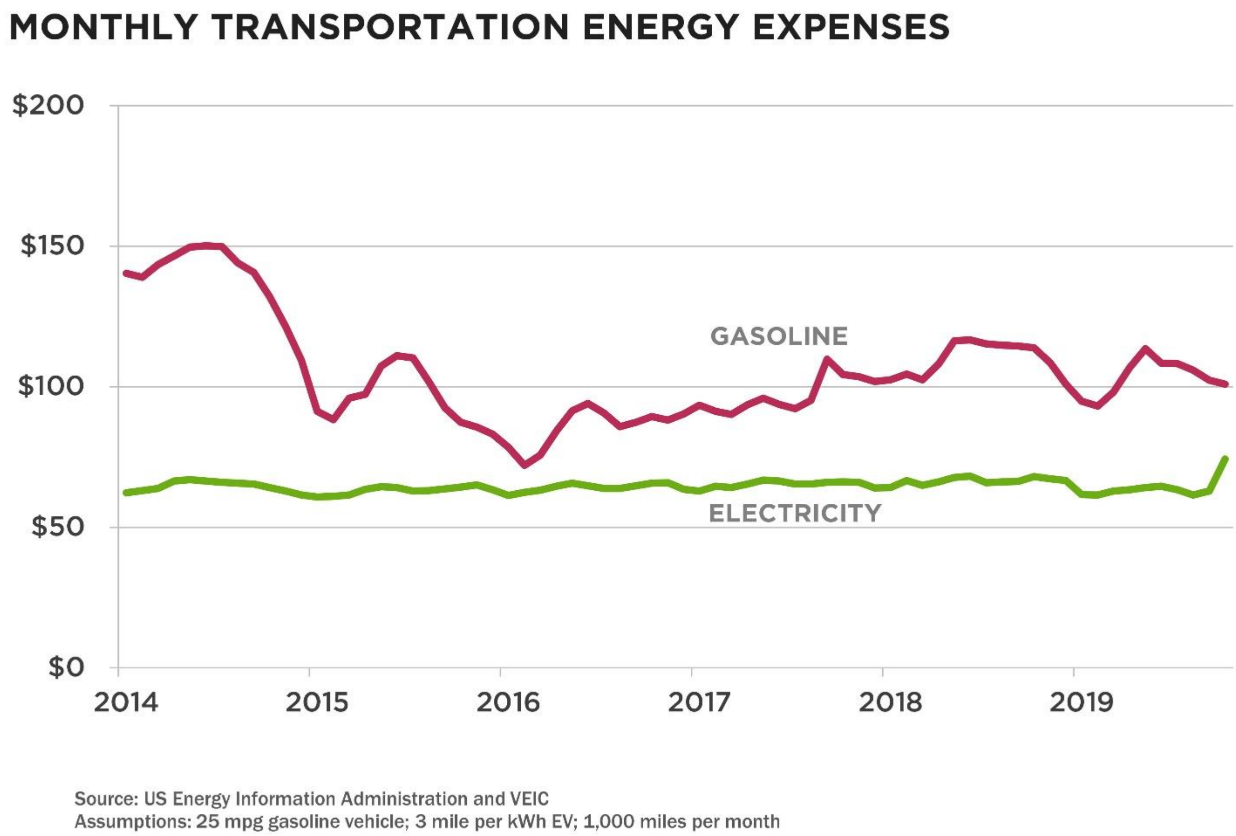


Figure 9 - Comparison of the cost of operating a gasoline car and an EV from Drive Electric Vermont.

Table 6 - Chart detailing the input assumptions that yield a cost per mmBtu for each technology/fuel type.

Fuel Type	Unit	Cost per Unit	Net mmBtu per Unit
Electricity	kWh	$0.18	0.003
Gasoline	Gallon	$2.16	0.115
Diesel	Gallon	$2.36	0.128
B20	Gallon	$2.01	0.127
B100	Gallon	$2.21	0.119
Renewable Diesel	Gallon	$2.86	0.121

[13] https://www.transportationandclimate.org/TCIP-FAQ

2.3.1.4 Results for Thermal Energy

For each building and possible measure, simple payback analysis was performed for GSHP, ccASHP, chip and pellet fueled boilers.

Table 7 below presents the results of best matched technology with the shortest payback period. Table 7 does not include buildings that do not require further measures to eliminate fossil fuel use (i.e., the buildings that are already connected to the biogas fueled boiler system at the WRRF or the district heating system).

Table 7 – Economic analysis results for Building thermal energy

Department	Building name	Viable Measure	Estimated CapEx[14]	Annual Savings	Simple Payback (years)	Breakeven Subsidy Needed
Recreation	Recreation Center	Pellet Boiler	$45k	$2,900	15	None
Senior Center	Senior Activity Center	Pellet Boiler	$31k	$345	90	$25k
DPW	DPW Garage and Office	Pellet Boiler	$85k	$2,000	41	$22k
	DPW R/M Shop	ccASHP	$165k	$300	555	$160k
	DPW R/M Shop #2	ccASHP	$85k	$300	285	$80k
School District	Montpelier High School	Dry chip boiler	$585k	$32,000	18	None
	Main Street Middle School	Dry chip boiler	$370k	$23,000	16	None
Parks	Hubbard Park Caretaker's House	ccASHP	$15k	$240	None	$12k
	Hubbard Park office	ccASHP	$16k	$14	None	$16k
Water	Water Treatment Plant	Pellet Boiler	$72k	$4,500	16	None

Some heating systems have high capital costs and lower operating costs while other measures have lower capital costs and higher operating costs. For an economic perspective (not factoring site-logistics), the best option depends on the size of the energy load. Big buildings with more energy demand (and realized savings) can often carry the extra capital costs, whereas smaller buildings often cannot generate enough annual savings to justify the higher capital cost options.

While ground-source heat pumps were assessed for each building in the payback analysis, the annual savings generated were insufficient to yield a simple payback on any of the City buildings. Given the size and nature of City-owned buildings, ccASHP, pellet boilers, or wood chip boilers are the optimal options for dramatically reducing the amount of oil and propane currently used for space heating.

[14] Capital cost estimates are based on averaged installed costs per unit of system heat output capacity and may not reflect the full capital costs of associated site, building and mechanical system upgrade costs.

2.3.1.5 Results for Transportation Energy

VEIC calculated the simple payback for each vehicle/piece of equipment and potential measure combination. We evaluated gasoline-powered vehicles and equipment for replacement with equivalent electric vehicles and associated charging stations. Additionally, for diesel-powered vehicles/equipment, simple payback analysis was performed for 20% (B20) and 100% (B100) biodiesel blends and renewable diesel.

Vehicles that log the most miles per year typically consume the most fuel, and therefore have the greatest opportunity for energy and maintenance costs savings through replacement with an electric vehicle. Electric vehicles have higher capital costs due to the cost of batteries, which are their most expensive components. Because medium and heavy-duty EVs require larger batteries to produce sufficient power and range to meet operational demands, they are considerably more expensive to purchase than gas or diesel counterparts. Medium and heavy-duty vehicles also typically require larger, more expensive charging stations which may have considerably higher installation costs.

As a result, high annual mileage light-duty vehicles are currently the best use-case for cost-effective electrification. There are 10 high-mileage sedans, SUVs or pickups that meet these criteria, show a positive lifetime payback, and are recommended for electrification when the next replacement vehicle is procured. An additional 24 vehicles with mid-range annual mileage are not currently cost-effective to replace with EVs, but with expected reductions in battery prices and additional incentive programs, these vehicles are expected to show a positive payback if they are replaced by 2030.

Medium and heavy-duty electric vehicles which require higher powered chargers are not likely to provide a payback by 2030 unless the City's utilization of these vehicles increases dramatically or if incentives become available to reduce capital costs. Therefore, all remaining diesel-powered trucks and buses that won't likely have cost effective (or any) EV options by 2030 are recommended to switch to B20 now and transition to renewable diesel as supply becomes available in Vermont and costs come down.

B100 per-vehicle capital costs and logistical challenges (requiring new segmented underground fueling and new fuel pump) are greater than either B20 or renewable diesel options. They are also expected to remain a relatively niche product, whereas EV options are likely to become more mainstream and cost effective (though they are currently more expensive than B100 retrofit options for medium and heavy-duty vehicles in most cases).

Offsets are recommended for a handful of very low mileage vehicles. Depending on operational needs the City could also consider eliminating very low mileage vehicles that are not performing a specialized service.

With the number of mid- to low-mileage vehicles in the City's fleet it is important to note that aside from fuel switching, reducing fleet size (and increasing the mileage of remaining vehicles to make them better candidates for electrification) and/or using vehicles less fleetwide to reduce fossil fuel use are two other strategies to reduce vehicle-related fossil fuel consumption.

3.0 Action Plan

How to Use this Action Plan

The actions outlined within this analysis represent the best options for meeting the City of Montpelier's fossil fuel reduction goals based on current technologies, stakeholder feedback, and current economic and energy analyses as outlined above. This is not meant to serve as a prescriptive action plan, but rather a tool to support the City's decision-making and strategy.

The following section presents more details on the possible actions that could be taken by the City of Montpelier to achieve 88% renewable energy use by 2030 as outlined in the Net Zero scenario above. While the goal is 100% fossil fuel displacement, given the difficulties of cost-effectively eliminating fossil fuel use in vehicles and heavy equipment, some of which don't have non-fossil options yet, aiming for 88% may be a more realistic target. MEAC and the City should monitor the sustainable options for equipment like dump trucks, street sweepers, which are evolving quickly.[15] Purchasing offsets to make up the remaining 12% and/or waiving the "cost-effective" requirement will be the bridge to full realization of the 100% goal.

Table 8 – Comparison of the energy used and emissions in 2030 between the BAU and Net Zero Energy Scenarios

Energy Sector	Annual Energy Use (GJ)		Percent Renewable		Metric Tons CO_2e	
	BAU	Net Zero	BAU	Net Zero	BAU	Net Zero
Buildings	31,304	30,875	67%	95%	700	110
Vehicles	6,841	4,305	3%	28%	508	271
Total	**38,144**	**35,181**	**55%**	**88%**	**1,209**	**382**

Table 8 above illustrates the gap that needs to be bridged via these actions items to meet the goal.

3.1 Electric Energy

Although this action plan does not focus on electricity, as vehicles and buildings electrify, Montpelier should consider control strategies that avoid increased demand charges. This is particularly important for vehicle chargers which often draw much more than buildings.

[15] The Mayors of Copenhagen, Oslo, and Stockholm announced a focus on zero carbon construction equipment at C40 in 2019. E,g,: "In Oslo, all city-owned machinery and municipally or owned construction sites will operate with zero emissions by 2025." **https://www.c40.org/press_releases/mayors-of-copenhagen-oslo-and-stockholm-commit-to-clean-construction**
Oslo has demonstrated an all-electric construction site. **https://www.bbc.com/future/article/20210622-the-scandinavian-way-to-zero-carbon-construction**

With the increased electricity consumption, additional solar may be a good investment that provides savings that can be utilized to fund other strategies to reduce fossil fuel. At the time of writing, the GMP Solar Map[16] shows in Montpelier a mix of circuits with plenty of solar capacity and ones that may be difficult to site more solar.

Consider replacing the backup generators with battery systems. Prior to pandemic supply chain interruptions, the price of battery storage had become very competitive and the Statehouse installed a large backup system that may provide an example.[17]

Additional efficiency actions like LED lighting should happen at time of replacement.

3.2 Thermal Energy for Buildings

The following section breaks down the list of possible measures into prioritized categories based on the size of the fossil fuel displacement opportunity and the more favorable simple payback periods.

General note for thermal investments:

- Pursue heating loads as first priority. For either dry chip or pellet boiler systems connect boilers to also cover domestic hot water loads.
- Install slightly under-sized systems with a little back up fossil fuel needed. Use savings to help fund further air-sealing and insulation work to eliminate the back-up fossil fuel use.

3.2.1 Priority one action items (recommended action for 2021 -2024)

1. Montpelier High School. Pursue installation of a dry wood chip boiler at High School. MHS consumes over 30,000 gallons of oil annually and is the single largest use of fossil fuels. A recommended next step is to commission a detailed engineering study for Montpelier High School to assess the design considerations for installing a dry woodchip boiler given the tight space restrictions they have. This assessment should also consider the alternative option of a vertical loop GSHP system if capital costs can be effectively lowered to a reasonable level.[18]

[16] Green Mountain Power, "GMP Solar Mao 2.0," accessed July 13, 2021. **https://www.arcgis.com/apps/webappviewer/index.html?id=4eaec2b58c4c4820b24c408a95ee8956**

[17] Vermont Digger, "Vermont Statehouse is first in nation to install batteries for backup power," January 8, 2021. **https://vtdigger.org/2021/01/08/vermont-statehouse-is-first-in-nation-to-install-batteries-for-backup-power/**

[18] Note: both Montpelier High School and Middle School are part of the School District that is a separate entity from the City and decision making and budgeting will follow a separate path than other measures enacted by the City.

2. Montpelier Middle School. Pursue installing a dry chip boiler at the Middle school. The middle school consumes over 20,000 gallons of oil annually and is the second largest single use of fossil fuel in the City. A recommended next step is to commission detailed engineering study for Montpelier Middle School to assess the design considerations for installing a dry woodchip boiler given the extremely tight space restrictions they have. This assessment should also consider the alternative option of a vertical loop GSHP system if capital costs can be effectively lowered to a reasonable level.
3. Montpelier Water Plant. Pursue installing a pellet boiler at the Water Plant. The water plant consumes over 12,000 gallons of propane annually and is the third greatest single use of fossil fuel.

3.2.2 Priority two action items (recommended actions for 2025 – 2027)

1. Montpelier Recreation Center. The recreation center uses over 5,000 gallons of heating oil annually and has the highest energy use per square foot of any City building. Significant weatherization improvements should be made. The existing steam heating system will need to be removed and a hydronic system paired to a pellet boiler should be installed.
2. DPW Garage. Install a pellet boiler to provide 100% of space heating and domestic hot water needs. Fan-coil units can be used to transfer hydronic heat to overhead blowers in the garage space.
3. DPW Maintenance Shops. Install ccASHPs at both shops to displace the oil and propane consumed by the existing wall units.

3.2.3 Priority three action items (recommended action for 2028 – 2030)

1. Pursue heating system replacements using heat pumps at the other small buildings with lower thermal loads.
2. Go back through the inventory of larger buildings to address any remaining fossil fuel use for peaking/back-up or domestic hot water loads. Install Heat Pump water heaters to cover domestic hot water demands.
3. Buy carbon offsets to make up the difference of any remaining fossil fuel use. For further discussion of carbon offsets see Appendix D.

3.3 Transportation and Heavy Equipment

The following section breaks down the list of possible measures into prioritized categories based on the size of the fossil fuel displacement opportunity and the more favorable simple payback periods. Due to the relatively short life of vehicles and the existing capital replacement plans and schedules in place, we recommend sequencing of transportation fleet and equipment at regular end-life replacement schedule.

3.3.1 Priority one action items (recommended action for 2021-2027*)

1. Electrify 10 relatively high annual mileage gasoline-powered vehicles at their next vehicle replacement. These vehicles show a positive payback over their lifetime. Some of the best candidates for replacement include Police Department SUVs and some DPW pickup trucks.
    a. Police SUVs could be replaced with Tesla Model 3 or Model Y sedans. Many police departments across the country have made this switch and reported positive experiences with performance and cost savings. Ford's Police Interceptor SUV Hybrid (non-plug in) is an option for replacement until all-electric police SUVs are available on the market.
    b. DPW's half-ton pickups can be replaced with Ford electric F-150s starting as soon as 2022.
    c. DPW should also consider whether the Ford electric F-150 will also be capable of meeting DPW's needs for their higher annual mileage (10,000 miles/year) ¾ ton pickups, as replacing them with electric F-150s will generate lifetime savings due to the lower capital cost of an electric F-150 ($42,000) compared to estimated costs for forthcoming ¾ and 1-ton electric pickups ($60,000).
2. Install 10 standard-power networked Level 2 charging stations to support these vehicles. Networked chargers are recommended to implement managed charging plans to charge when electricity demand is lowest, and stagger charging so that no more than one vehicle is charging at the same time.
3. When facilities that host fleet vehicles are being renovated or constructed, prepare the site to support easy installation of future EV chargers.
4. Initiate a relationship with Green Mountain Power to support plans to electrify fleet vehicles. Seek their support to analyze the City's current rate structure, to determine current and future electricity demand and costs at individual facilities where EVs are being considered, identify off-peak charging strategies, and coordinate installation of EV chargers.

    a. Consider prioritizing EV deployment and overnight vehicle charging at facilities that have: off-peak overnight hours; and/or higher electricity demand during the day.

5. DPW staff connect to peer fleet managers who have switched to B20 for their operations to discuss best practices and recommendations and develop a plan for deployment.

3.3.2 Priority two action items (recommended action by 2025-2028)

1. Monitor EV market and incentives for all vehicle classes and accelerate EV procurements as battery prices continue to drop and model availability and sales volume increase. Light-duty vehicles are likely to be the most cost effective in the near future as they are closer to price parity with existing internal combustion engine counterparts.
    a. Based on peer learnings and deployment best practices, switch to B20 for all diesel operations, and buy carbon offsets for the diesel portion of the fuel starting in 2030.
    b. Monitor the renewable diesel market and begin to make the switch when it makes economic and operational sense. It is anticipated to happen before 2030.
2. Consider a pilot to test deployment of lightly used all-electric vehicles. Used vehicles offer the opportunity to expand the number of light duty vehicles in Montpelier's fleet that are cost-effective replacements. For example, due to advances in AEV range over the last few years, earlier AEV models with shorter standard ranges (80-110 miles, such as the Nissan Leaf, Volkswagen e-Golf or Kia Soul) can be found on the used market at prices 50% or lower than original MSRP. These vehicles are commonly 3-5 years old (often just off lease) with low odometer miles (<20,000mi or less) and transferrable powertrain warranties. Because their standard range is lower than current vehicles on the market, they may be less desirable to consumers, but can be an excellent fit for fleet applications where daily maximum range needs are low and predictable. Local inventory of these vehicles may be limited, but auto dealers are often able to search national inventories and have vehicles brought in for purchase.

3.3.3 Priority Three Recommendations (2028 – 2030 and beyond)

1. By 2030, expect to electrify an additional 24 gasoline and diesel-powered vehicles with relatively mid-range annual VMT. While these vehicles are not cost-effective to replace with EVs currently at their current annual VMTs, they are expected to be by 2030 due to a combination of anticipated decreasing battery costs, increasing sales volume for those specific vehicle types (and in the case of the Type C school buses, additional financial incentives and financing options).

2. For all other vehicles buy fueling offsets by or before 2030.

Managed Charging Considerations

EVs (and especially AEVs) can draw enough power while charging to increase monthly electricity demand charges for the facility where they are charged. This is most likely to occur at small facilities that are not eligible for off-peak nighttime charging rates, or large facilities where multiple EVs are charged during the day. Depending on Montpelier's electricity rate structure and existing demand at various facilities, demand charges could add potentially hundreds of dollars in annual electricity costs per EV if not properly managed. These demand charges were not included in the annual cost estimates in this analysis.

Appendices

Appendix A – Inventory of Buildings

Building Name	Building size (square feet)	Heat Distribution Type	Primary Heat Source
Recreation Center	8,596	Steam	#2 Heating Oil
Senior Activity Center	10,892	Hydronic	Wood pellets
DPW Garage and Office	16,404	Commercial wall units	#2 Heating Oil
DPW R/M Shop	15,000	Commercial wall units	#2 Heating Oil
DPW R/M Shop #2	7,704	Hydronic	Propane
WRRF Office	3,244	Hydronic	Phase 1 - biogas project
WRRF Utility Building #1	1,320	Commercial wall unit	Phase 1 - biogas project
WRRF Utility Building #2	1,932	Commercial wall unit	Phase 1 - biogas project
WRRF Utility Building #3	1,254	Commercial wall unit	Phase 1 - biogas project
WRRF Utility Building #4	400	Commercial wall unit	Phase 1 - biogas project
WRRF Digester Building	1,980	Commercial wall unit	Phase 1 - biogas project
WRRF Garage	1,705	Commercial wall unit	Phase 1 - biogas project
Montpelier High School	89,847	Hydronic	#2 Heating Oil
Main Street Middle School	56,625	Hydronic	#2 Heating Oil
City Hall	28,622	Hydronic	District Heat
Fire Station	8,340	Hydronic	District Heat
Union Elementary School	60,804	Hydronic	District Heat
Hubbard Park Caretaker's House	1,840	Hydronic	#2 Heating Oil
Hubbard Park office	2,000	None	#2 Heating Oil & Propane
Green Mount Cemetery	2,296	None	N/A
Police Station	6,504	Hydronic	District Heat
Recreation Field Lodge	4,820	None	None
Cummings St Pump Station	1,404	None	None
Water Treatment Plant	14,000	Hydronic	Propane

Appendix B – List of Vehicles by Department

Department	Equip #	Year	Make	Model	Vehicle type	Night time parking location	Fuel Type
AMB	AMB 1	2016	FORD	F450	Ambulance	61 Main St	Diesel
AMB	AMB 2	2010	INT'L	2010 INT'L	Ambulance	61 Main St	Diesel
DPW	027	2016	CHEVROLET	SILVERADO	1 Ton Pickup Truck	811 Dog River Road	Diesel
DPW	037	2015	CHEVROLET	SILVERADO	1/2 Ton Pickup Truck	811 Dog River Road	Unleaded
DPW	024	2014	FORD	F-150	1/2 Ton Pickup Truck	811 Dog River Road	Unleaded
DPW	043	2018	FORD	F150 2WD	1/2 Ton Pickup Truck	811 Dog River Road	Unleaded
DPW	030	2014	CHEVROLET	SILVERADO	1/2 Ton Pickup Truck	811 Dog River Road,	Unleaded
DPW	023	2019	FORD	F250	3/4 Ton Pickup Truck	811 Dog River Road,	Unleaded
DPW	026	2011	FORD	F250	3/4 Ton Pickup Truck	811 Dog River Road,	Unleaded
DPW	016	2014	INTERNATIONAL	7400	Dump Truck	811 Dog River Road,	Diesel
DPW	004	2017	INTERNATIONAL	7400	Dump Truck	811 Dog River Road,	Diesel
DPW	017	2016	INTL	7400	Dump Truck	811 Dog River Road,	Diesel
DPW	006	2015	INTERNATIONAL	7400	Dump Truck	811 Dog River Road,	Diesel
DPW	010	2006	INTL	4300	Dump Truck	811 Dog River Road,	Diesel
DPW	009	2018	INTERNATIONAL	7400	Dump Truck	811 Dog River Road,	Diesel
DPW	008	2016	INTL	7400	Dump Truck	811 Dog River Road,	Diesel
DPW	047	2013	INTL	4300 DUMP	Dump Truck	811 Dog River Road,	Diesel
DPW	042	2017	CHEVROLET	EXPRESS VAN	Full-sized Van	811 Dog River Road,	Unleaded
DPW	029	2017	CASE	590SN	Heavy Equipment - backhoe	811 Dog River Road,	Diesel
DPW	088	2019	CRAFTCO	KM T2 C1M2	Heavy Equipment – asphalt recycler	811 Dog River Road,	Diesel
DPW	034	2017	CASE	621G	Heavy Equipment – bucket loader	811 Dog River Road,	Diesel
DPW	035	2017	CASE	621G	Heavy Equipment – bucket loader	811 Dog River Road,	Diesel
DPW	036	2013	CASE	621F	Heavy Equipment – bucket loader	811 Dog River Road,	Diesel
DPW	031	2009	CATERPILLAR	CAT 120M	Heavy Equipment - grader	811 Dog River Road,	Diesel
DPW	059		SALSCO	TP44	Heavy Equipment – track paver	811 Dog River Road,	Diesel
DPW	057		WACKER	RD12A-90	Heavy Equipment - roller	811 Dog River Road,	Unleaded
DPW	079		KUBOTA	GR2100-54	Lawn Tractor	811 Dog River Road,	Diesel
DPW	033	2008	SERIAL DUO70095	SST37NE	MD Bucket Truck	811 Dog River Road,	Diesel
DPW	001	2019	FORD	F550	MD Truck	811 Dog River Road,	Diesel
DPW	003	2017	FORD	F550	MD Truck	811 Dog River Road,	Diesel
DPW	007	2017	FORD	F550	MD Truck	811 Dog River Road,	Diesel
DPW	025	2019	FORD	F550	MD Truck	811 Dog River Road,	Diesel
DPW	021	2016	FORD	F550	MD dump truck	811 Dog River Road,	Diesel
DPW	PARK	2013	FORD	F550	MD Truck	811 Dog River Road,	Diesel
DPW	018	2007	CATERPILLER	303C CR	Mini Excavator	811 Dog River Road,	Diesel
DPW	044	2013	FORD	INTERCEPTOR	Police Car	811 Dog River Road,	Unleaded
DPW	028	2012	CHEVROLET	IMPALA	Police Car	811 Dog River Road,	Unleaded
DPW	015	2015	TRACKLESS	MT-6	Sidewalk Plow	811 Dog River Road,	Diesel
DPW	011	2014	TRACKLESS	MT-6	Sidewalk Plow	811 Dog River Road,	Diesel
DPW	012	2014	TRACKLESS	MT-6	Sidewalk Plow	811 Dog River Road,	Diesel
DPW	032	2014	JOHNSTON	RT655	Street Sweeper	811 Dog River Road,	Diesel
DPW	022	2004	JOHNSTON	4000	Street Sweeper	811 Dog River Road,	Diesel
DPW	013	2019	WACKER NEUSON	RL30	Wheel Loader	811 Dog River Road,	Diesel

Department	Equip #	Year	Make	Model	Vehicle type	Night time parking location	Fuel Type
GMC	CEM TRK	2012	FORD	F550	MD Truck	250 State St,	Diesel
HP	PARK	2019	FORD	F250	3/4 Ton Pickup Truck	401 Parkway Street	Unleaded
HP	PARK VAN	2002	DODGE	3500	Full-sized Van	401 Parkway Street	Unleaded
MFD	TRK 5	2009	FORD	F-150	1/2 Ton Pickup Truck	61 Main St,	Unleaded
MFD	RESCUE 1	2006	FORD	F250	3/4 Ton Pickup Truck	61 Main St,	Unleaded
MFD	ENG 2	2013	E-ONE	TYPHOON	Fire Engine	61 Main St,	Diesel
MFD	ENG 1		INTERNATIONAL	4800 4X4	Fire Engine - pumper	61 Main St,	Diesel
MFD	TOWER 1		SUTPEN	MINNY TOWER	Fire Engine	61 Main St,	Diesel
MFD	CHIEF CAR	2013	FORD	INTERCEPTOR	Police Car	61 Main St,	Unleaded
MPD	275	2016	CHEVROLET	IMPALA	Police Car	1 Pitkin Ct,	Unleaded
MPD	277	2012	CHEVROLET	IMPALA	Police Car	1 Pitkin Ct,	Unleaded
MPD	272	2018	CHEVROLET	MALIBU	Police Car	1 Pitkin Ct,	Unleaded
MPD	274	2017	FORD	INTERCEPTOR	SUV	1 Pitkin Ct,	
MPD	276	2017	FORD	INTERCEPTOR	SUV	1 Pitkin Ct,	
MPD	273	2016	FORD	INTERCEPTOR	SUV	1 Pitkin Ct,	Unleaded
MPD	271	2020	FORD	INTERCEPTOR	SUV (Hybrid)	1 Pitkin Ct,	Unleaded
REC	REC	2019	FORD	F150	1/2 Ton Pickup Truck	55 Barre St,	Unleaded
REC	REC		FORD	F550	MD Truck	55 Barre St,	Unleaded
SCHOOL	MHS	2017	CHEVROLET	SILVERADO	3/4 Ton Pickup Truck	5 High School Dr,	Unleaded
SCHOOL	FOOD VAN	2017	FORD	TRANSIT C VAN	Full-sized Van	5 High School Dr,	Unleaded
SCHOOL	CBL VAN	2019	FORD	TRANSIT C VAN	Full-sized Van	5 High School Dr,	Unleaded
SCHOOL	SP ED VAN	2016	DODGE	CARAVAN	Minivan	5 High School Dr,	Unleaded
SCHOOL	ACT VAN	2020	TOYOTA	SIENNA LE	Minivan (Hybrid)	5 High School Dr,	Unleaded
School Contractor	Bus 6	Unknown	Unknown	Unknown	Type C School Bus	185 Ferno Road, Williamstown	Diesel
School Contractor	Bus 7	Unknown	Unknown	Unknown	Type C School Bus	185 Ferno Road, Williamstown	Diesel
School Contractor	Bus 1	Unknown	Unknown	Unknown	Type C School Bus	185 Ferno Road, Williamstown	Diesel
School Contractor	Bus 2	Unknown	Unknown	Unknown	Type C School Bus	185 Ferno Road, Williamstown	Diesel
School Contractor	Bus 3	Unknown	Unknown	Unknown	Type C School Bus	185 Ferno Road, Williamstown	Diesel
School Contractor	Bus 4	Unknown	Unknown	Unknown	Type C School Bus	185 Ferno Road, Williamstown	Diesel
School Contractor	Bus 5	Unknown	Unknown	Unknown	Type C School Bus	185 Ferno Road, Williamstown	Diesel
SENIOR CENTER	SENIOR VAN	Unknown	FORD	E450	Full-sized Van	58 Barre St,	Unleaded
WTP	048	2015	CHEVROLET	SILVERADO	3/4 Ton Pickup Truck	1480 Paine Turnpike N, Berlin	Unleaded
WWTP	045	Unknown	CHEVROLET	SILVERADO	1/2 Ton Pickup Truck	784 Dog River Road,	Unleaded

Appendix C – List of Measures Assessed

Category	Measure	Description	Measure life (years)	Capital Cost Ranges
Energy Efficiency	Weatherization	Air-sealing and adding insulation. Typically results in 5-25% reduction in heating fuel needs.	Custom	Custom
	HVAC Controls	Greater efficiency and precision in the timing and delivery of heat when heat is needed. Typically results in 5-10% reduction in heating fuel needs.	15	Custom
Electrification Measures	Cold-climate air-source heat pumps (ducted and ductless)	High-efficiency HVAC system that provides heating and cooling by concentrating outdoor energy for conditioned indoor space. Considered air to air units for smaller buildings and air-to-water units for larger buildings. Provides heating and cooling only. Typically covers 50% to 90% of space heating load.	15	$400 - $450k per mmBtu/hr
	Ground source heat pumps	High-efficiency HVAC system that provides heating and cooling by concentrating energy extracted from belowground into conditioned indoor space. Can provide heating, cooling and domestic hot water. Typically designed to cover 100% of space heating, DHW, and cooling loads.	20	$700- $800k per mmBtu/hr
	Heat pump hot water heaters	High-efficiency unit that concentrates heat from indoor conditioned space into hot water supply.	15	$2 - $5k
	Induction stoves	High-efficiency electric range and oven units. For use at buildings confirmed to have propane ovens and ranges.	15	$4k -$9k
	Electric cars	Electric versions of light duty vehicles are increasingly available and cost effective. They are generally about 3-4 times more efficient than their fossil powered counterparts.	5-12	$5-$25k (incremental, including charging infrastructure)
	Electric trucks	Electric medium and heavy-duty trucks and other specialized large vehicles are currently limited in availability, and significantly more expensive than fossil fuel counterparts due to their need for very large battery packs, but both are expected to improve in the future. They are generally about 3-4 times more efficient than their fossil powered counterparts and offer dramatic local air quality improvements.	8-15	$35-$260k (incremental, including charging infrastructure)
	Electric heavy equipment	Currently very few electric options on the market (mostly small to medium-sized equipment) but options are expected to improve in the future. They are generally	8-15	$6-$30K (incremental, including

		about 3-4 times more efficient than their fossil powered counterparts, and offer dramatic local air quality improvements		charging infrastructure)
Advanced wood heating	Dry chip boiler	Modern solid fuel boiler fueled with pre-dried woodchips. Smaller and more efficient than traditional "green" wood chip boilers". Provides 100% of space heating and domestic hot water.	30	$250 - $275k per mmBtu/hr
	Wood pellet boiler	Modern solid fuel boiler fueled with loose, bulk wood pellets. Provides 100% of space heating and domestic hot water.	30	$200 - $250k per mmBtu/hr
Biofuels	B20	Used for heating, vehicles and heavy equipment. Locally available.	N/A	No upgrade typically needed
	B100	Used for heating, vehicles and heavy equipment. Not locally available yet.	N/A	$15k/vehicle to enable year-round use
	Renewable diesel	Used for heating, vehicles and heavy equipment. Not locally available yet.	N/A	No upgrade needed
Carbon Offsets	Offset Purchases	Can be used to offset emissions from continued fossil fuel usage. Further discussion of offsets can be found in Appendix D.		Annual purchase as operating expense

Appendix D – Discussion of Carbon Offsets

Description: While carbon emissions are not the main focus of this work, this analysis did include consideration for emissions reductions that would occur as a result of reducing fossil fuel use. Carbon offsets are a tool to help entities meet short term emissions targets while working towards long-term emissions reduction or fuel switching goals. A carbon offset is simply a credit that represents one metric ton of carbon dioxide (CO_2) or carbon dioxide equivalent (CO_2e) that has been reduced or stored as the result of a specific project. Once purchased, credits are retired and credited towards the purchaser's greenhouse gas inventory.

Carbon offsets provide flexibility by allowing organizations to bridge gaps they may face towards meeting specific emissions targets. For the City of Montpelier, carbon offsets represent a way to offset the emissions from continued fossil fuel use. There are several key decisions that should be made when purchasing offsets:

Decision Points	Description
Purchasing Mechanism	There are a variety of pathways to purchase carbon offsets, including: • Retailers: Usually this is the simplest option. Retailers provide a registry of carbon offset projects and support purchases. • Project Developers: Purchasing entities can invest in future projects, enter into purchasing agreements, or purchase unsold carbon offsets directly from a project developer. • Brokers: often used to facilitate large transactions and portfolio of projects.[19]
Project Verification	There are a number of organizations that certify carbon offset projects. Certifications help verify that the projects are real, and offsets can be reasonably claimed. In North America, the most common certifications are from Verra (verified carbon units), Climate Action Reserve (climate reserve tonnes), American Carbon Registry (verified emissions reductions), and Gold Standard (Certified and Verified Emissions Reductions).[20]
Additionality	In order to claim emissions reductions, projects need to prove that they go beyond business as usual, and reductions occur in addition, to what would have happened under normal circumstances; and would not have occurred without the carbon market mechanism. Cheaper offsets often are found to have weaker claims of additionality.[21]
Geography	Purchasing entities may be interested in supporting projects on a local, national, or international basis.
Project Type	Offsets can be claimed from a variety of types of projects. The most common projects in North America are waste disposal, forestry, chemical processing/industrial manufacturing, and renewable energy.[22]
Vintage Year	Vintage year refers to the year in which the emissions reduction occurs.
Cost	Costs for carbon offsets can vary based on all of the factors noted above.

[19] Carbon Offset Guide. 2021. Stockholm Environment Institute. Greenhouse Gas Management Institute.
[20] Donofrio, Maguire, Myers. 2021. Ecosystem Marketplace Insights Brief: Buyers of Voluntary Carbon Offsets, A Regional Analysis. **https://app.hubspot.com/documents/3298623/view/125182374?accessId=a759f9**
[21] Carbon Offset Guide. 2021. Stockholm Environment Institute. Greenhouse Gas Management Institute.
[22] Donofrio, Maguire, Myers. 2021. Ecosystem Marketplace Insights Brief: Buyers of Voluntary Carbon Offsets, A Regional Analysis. **https://app.hubspot.com/documents/3298623/view/125182374?accessId=a759f9**

The factors above largely impact the cost of the resulting credits, and the City will need to identify what is the best option based on its priorities.

Anticipated Fossil Fuel Reduction: Carbon offset purchases will not reduce fossil fuels used by the City of Montpelier.

Anticipated Emissions Reduction: As the City works toward its 2030 goal, it may want to use offsets to fill the gap for fossil fuels currently used. It may ramp up the purchase of offsets to phase the practice in or may wait until the 2030 and only cover any remaining fossil fuels. The cost and impact vary with the amount the City chooses to cover. For example, if the City covered all of its FY2020 emissions, it would purchase 1,628 credits (representing 1628 tonnes of CO2e). As more work is done to replace and reduce fossil fuel usage, the number of carbon offsets needed is expected to reduce over time.

Anticipated Costs: Carbon offset costs vary largely based on the factors noted above. In 2019, on average, carbon offsets purchased by entities in North America, were $3.29/tonne.[23] However, prices can vary drastically and high-quality offsets have been known to cost more than $10/tonne. Project type, quality, procurement mechanism, location, certification, and vintage all factor into overall price.

Resources:

1. Native Energy, Inc. located in Burlington works as a carbon offset retailer and project developer.
2. Vermont Land Trust published a study focused on Vermont's opportunity for creating forest carbon projects.[24]
3. Stockholm Environment Institute and Greenhouse Gas Management Institute have an in-depth guide on carbon offset purchasing and best practices.[25]

A Note About Carbon Offsets:

Carbon offsets are a tool used to claim greenhouse gas emissions reductions. These credits can be purchased to support claims on emissions reductions and bridge any gaps in emissions reduction goals. While these credits do not keep fossil fuels from being used, they can help counter the emissions that are caused by the usage of fossil fuels and other emitting sources. In the context of the City of Montpelier, carbon offsets are a potential tool to help reduce the impact from fossil fuels as they are phased out.

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[23] Ibid.
[24] 2018. Vermont Forest Carbon: A Market Opportunity for Forestland Owners. Vermont Land Trust, Spatial Informatics Group, The Carbon Lab. https://vlt.org/wp-content/uploads/2018/07/Vermont_Forest_Carbon.pdf
[25] Carbon Offset Guide. 2021. Stockholm Environment Institute. Greenhouse Gas Management Institute.

Appendix E – Action Plan Summary Table

Table 9 Summary Table of Net Zero Building Actions

Department	Action Item	Priority Ranking	Timeframe	Simple payback	Notes
School District	Install dry wood chip boiler at MHS	1	2022 - 2024	18 years	Tight space - further assessment need
	Install dry woodchip boiler at MMS	1	2022 - 2024	16 years	Tighter space
	Efficiency measures	2	On-going		
DPW	Install pellet boiler at office and garage	2	2025-2027	19 years	
	Install ccASHP at maintenance shops	2	2025-2027	10-26 years	
Recreation	Weatherization of Recreation Center	2	2025-2027		
	Install hydronic system and pellet boiler at Recreation Center	2	2025-2027	15 years	
Water Plant	Install pellet boiler	1	2021-2024	16 years	
General	Install heat pumps at small buildings	3	2028-2030	20+	Focus on smaller buildings with lower thermal loads
	Install heat pump water heaters for domestic hot water demands	3	2028-2030		
	Purchase carbon offsets	3	2030		

Department	Action Item	Priority Ranking	Timeframe
DPW	Electrify DPW high-annual mileage half-ton pick-up trucks	1	2022-2027
	Install standard-power networked Level 2 charging stations to support vehicles	1	2022-2027
	Connect with peer fleet managers about transition to B20, and develop plan for deployment	1	2021-2027
Police	Electrify high-annual mileage gasoline-powered vehicles (SUVs)	1	2021-2027
	Install standard-power networked Level 2 charging stations to support vehicles	1	2021-2027
General	During renovation or construction, make sites EV-ready	1	2021-2027
	Coordinate with GMP on rate structures and electrification and charging plans	1	2021-2027
	Monitor EV market and incentives for light-duty replacement	2	2025-2028
	Switch to B20 in all diesel operations	2	2025-2028
	Switch to renewable diesel when it becomes economically viable	2	2025-2028
	Create a light duty all-electric vehicle pilot program	2	2025-2028
	Electrify 24 mid-range gasoline or diesel vehicles	3	2028-2030
	Purchase carbon offsets for any continued fossil fuel usage	3	2030

Appendix F – Discussion of Incentives

Thermal Energy Incentives:

Green Mountain Power and Efficiency Vermont have modest incentive programs aimed at lowering the upfront costs of installing heat pumps. Incentive levels vary depending on the type and size of the heat pump systems. Further information can be found at - **https://www.efficiencyvermont.com/rebates/list?cat=Heating%2C+Cooling+%26+Ventilation&hvacfilter=Heat+Pumps&type=**

While ground source heat pumps are currently eligible for federal income and investment tax credits, these would not be applicable to Municipal projects.

For advanced wood heating systems fueled with either bulk wood pellets or chips, Efficiency Vermont offers custom incentives on qualifying technologies. Due to thermal budget constraints, the incentive level offered was lowered considerably in 2020. City representatives should contact Efficiency Vermont to learn more.

In addition, the State of Vermont's Clean Energy Development Fund (CEDF) has historically offered incentives and grant aimed at lowering the capital costs of installing advance wood heating systems. While CEDF does not currently offer incentives for municipal buildings, new offerings could be available in the future. Further details can be found at -

https://publicservice.vermont.gov/content/funding-opportunities-projects

Electric Vehicle Incentives and Funding Programs:

There is significant policy activity as the state and federal level that could increase the availability of incentives or other funding for electric vehicles and charging equipment. It is recommended that Montpelier monitor legislation and take advantage of new programs as they become available. The following is information on existing programs. Federal – the federal tax credits won't apply for a municipal fleet purchase but leasing options may incorporate the credits. The Climate Mayors EV Purchasing Collaborative has leasing programs that factor in the federal tax credit and provide other resources to municipalities (**https://driveevfleets.org/**). There is discussion of changing the federal incentive to allow it to be claimed at the point of sale which might streamline availability for municipalities and non-profits, but it is hard to predict if or when that might happen.

1. State – the State of Vermont incentives are only currently available to individual purchasers. There will be one exception to allow non-profit car sharing services to get a State incentive coming out of the just-passed state transportation bill. There was some

talk of allowing municipal fleets to access incentives in the Legislature this year, but no action was taken. It is possible this could change in the future, but it is not expected in the next year.

   a. The State Department of Buildings and General Services has a State contract for EV charging equipment that Montpelier can access. The City could avoid engaging in a procurement process by participating in this program. **https://bgs.vermont.gov/content/electric-vehicle-ev-charging-stations**

2. Utility – as long as the municipality is a utility customer, they can access utility incentives. Green Mountain Power offers the following incentives: $1,500 for an all-electric vehicle and $1,000 for a plug-in hybrid electric vehicle **https://greenmountainpower.com/rebates-programs/business-innovation/electric-vehicles/**

At this point, there are no state or federal incentives for medium or heavy-duty vehicles. However, the state's Volkswagen Settlement program can be used to replace medium and heavy-duty diesel-powered vehicles. This program is administered by the Agency of Natural Resources and the City should watch for project solicitations. In addition, GMP can offer customized incentives through their Tier III program to support procurement of these vehicles and associated charging infrastructure. **https://greenmountainpower.com/rebates-programs/business-innovation/electric-vehicles/**

GMP also has incentives for public and workplace charging, including a low interest financing option through the State Infrastructure Bank (VEDA) that might be of interest: **https://greenmountainpower.com/rebates-programs/business-innovation/electric-vehicles/workplace-charging/**