2020 Annual Energy Report

A summary of progress made toward the goals of Vermont's Comprehensive Energy Plan

Prepared by the Vermont Department of Public Service

January 15, 2020

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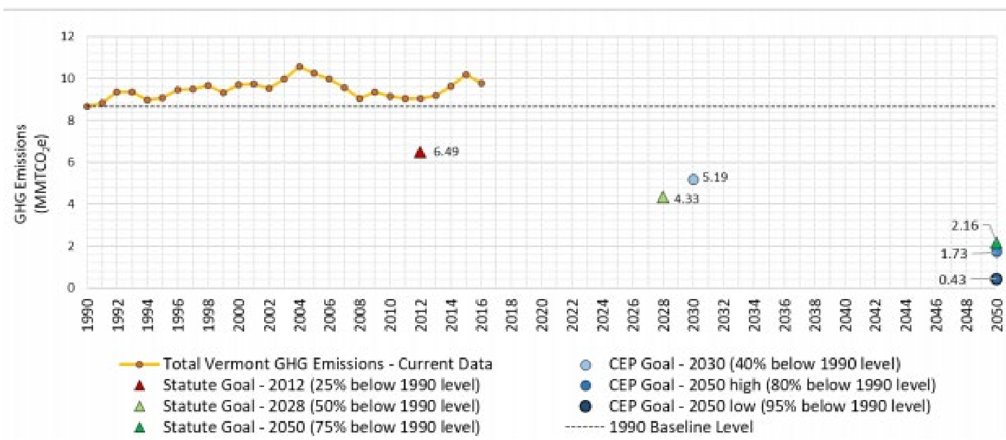
I. Executive Summary

The 2016 Comprehensive Energy Plan (CEP) sets a goal of 90% renewable by 2050, with several sector-specific interim goals for 2025. At a high level, the CEP goals are being surpassed in the electric sector, there is moderate progress in the heating sector, and relatively small movement in the transportation sector. The Renewable Energy Standard (RES) in the electric sector has led to approximately 63% renewability. The heating and transportation sectors are approximately 27% and 5.5% renewable, respectively.

Greenhouse Gas Emissions

With respect to the greenhouse gas (GHG) goals contained in the CEP, the most recent data indicates that Vermont is continuing to struggle to reduce carbon emissions, with 2016 emissions 13% above the 1990 baseline. GHG emissions did decline from 2015 to 2016; however, this was partly due to warmer weather, and emissions in the transportation sector actually increased during that time period. Based on forecasted emissions data for 2017 and 2018, GHG emissions are expected to increase further over the next two years.

Vermont GHG Emissions Compared to 1990 Baseline[1]



The majority of GHG emissions in Vermont continues to be from the transportation and heating sectors; based on estimates of 2018 data, these two sectors make up approximately 77% of the GHG emissions for the State. Emissions from the electric sector for the same year constitute 2% of the total GHG emissions for Vermont.

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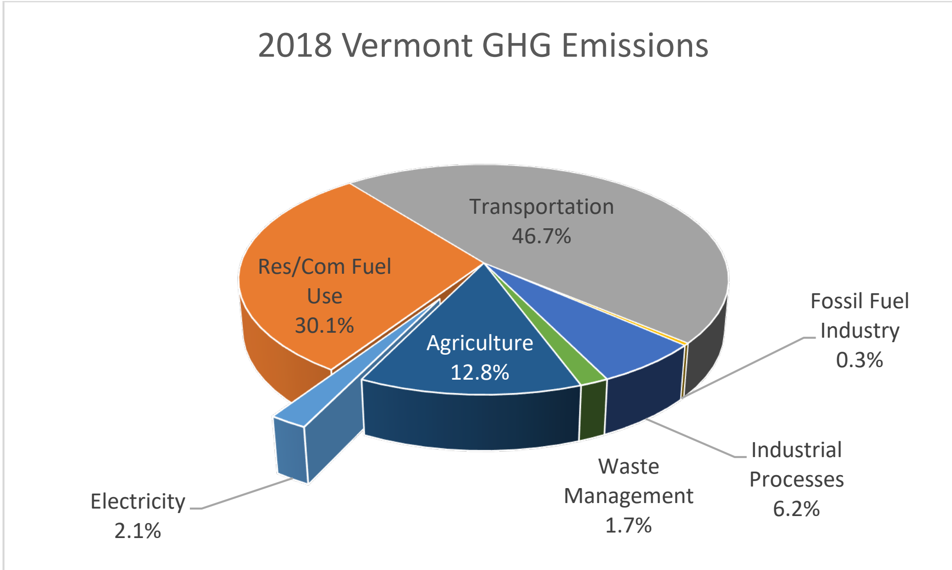
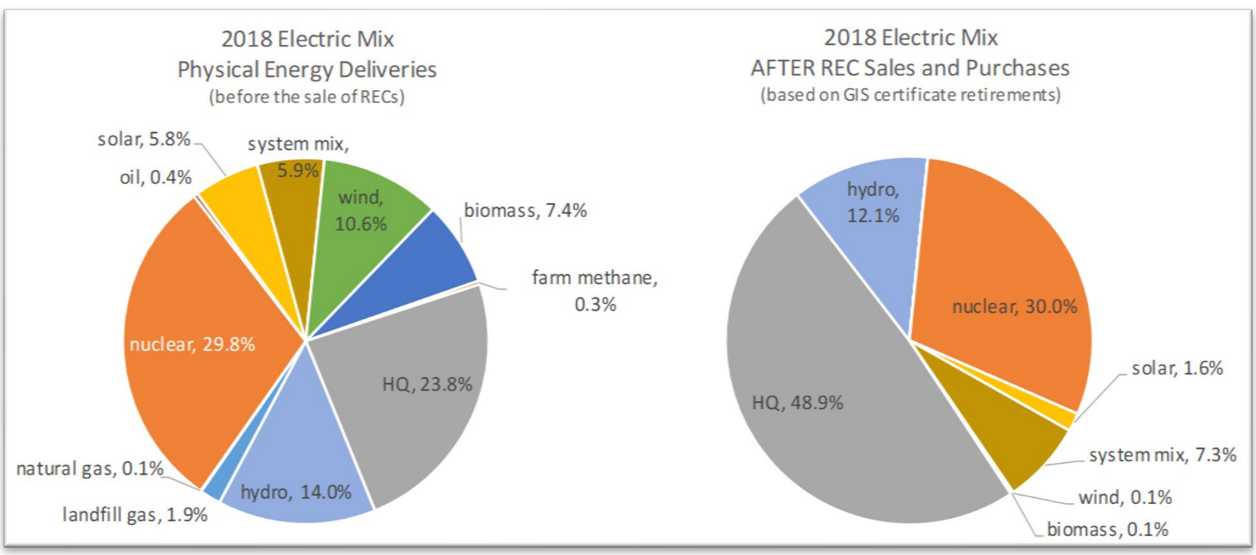
[1] Vermont Air Quality and Climate Division, Department of Environmental Conservation, VERMONT GREENHOUSE GAS EMISSIONS INVENTORY AND FORECAST: BRIEF 1990 – 2016. (January 2020). Available at: https://dec.vermont.gov/air-quality/climate-change.

Estimated 2018 GHG Emissions[2]



Vermont's Electric Power Supply

Much of the electricity provided to Vermonters is from renewable resources. This is true with respect to the resources that are procured by Vermont's electric utilities to provide power to their customers, and also with respect to Vermont's renewable requirements and the associated retirement of renewable energy credits.

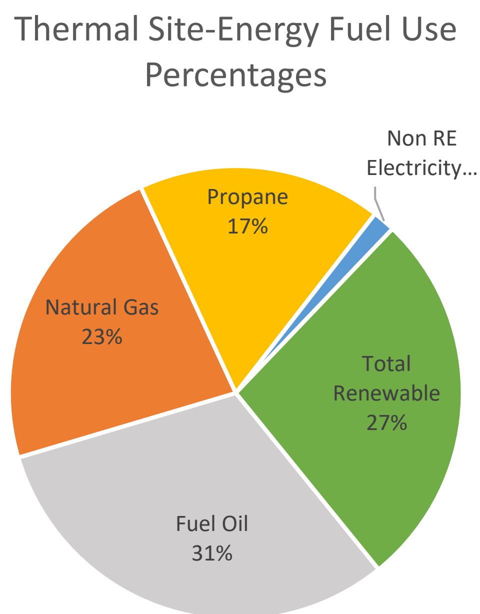


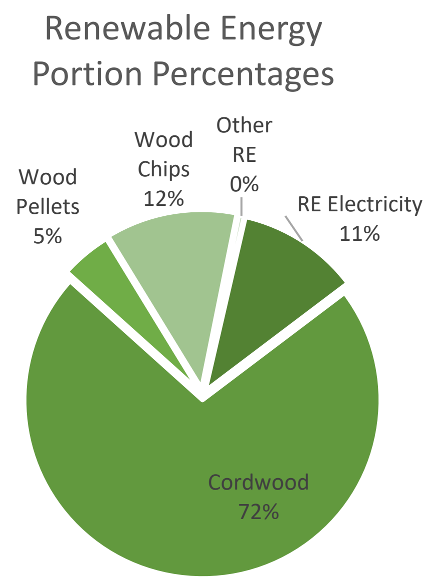
Vermont's Thermal Sector

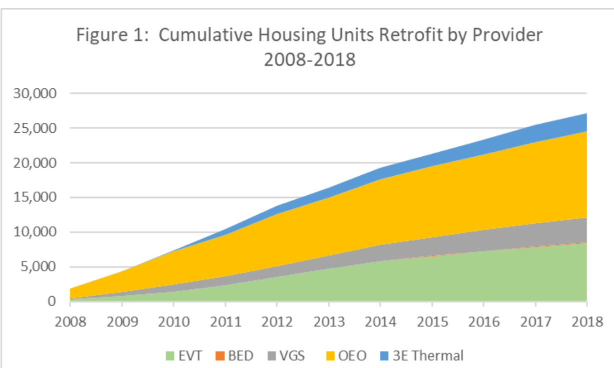
Although the numbers appear to indicate that Vermont's thermal sector is well on its way to meeting the 2025 goal of 30% renewable energy, the change in renewable supply in the sector has been slow.

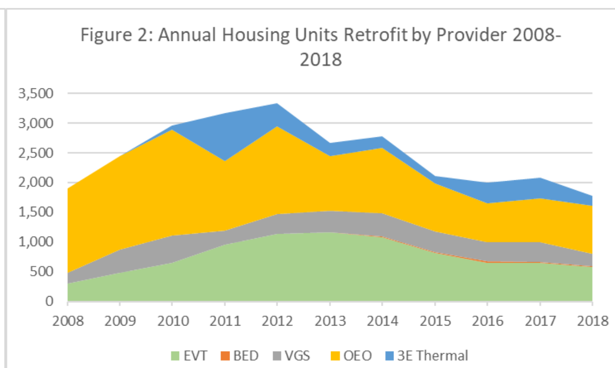
[2] Vermont Air Quality and Climate Division, Department of Environmental Conservation, VERMONT GREENHOUSE GAS EMISSIONS INVENTORY AND FORECAST: BRIEF 1990 – 2016. (January 2020). Available at: https://dec.vermont.gov/air-quality/climate-change.

27% of the energy used for heating is considered renewable but consists primarily of cordwood, with relatively small gains in the percentage of new renewable resources in the sector. Additionally, while there have been efforts to increase weatherization efforts, Vermont is failing to meet the building efficiency goals set forth in statute.



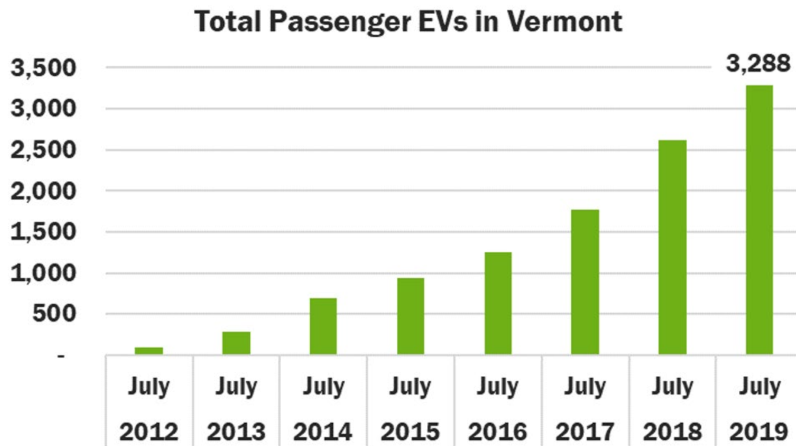




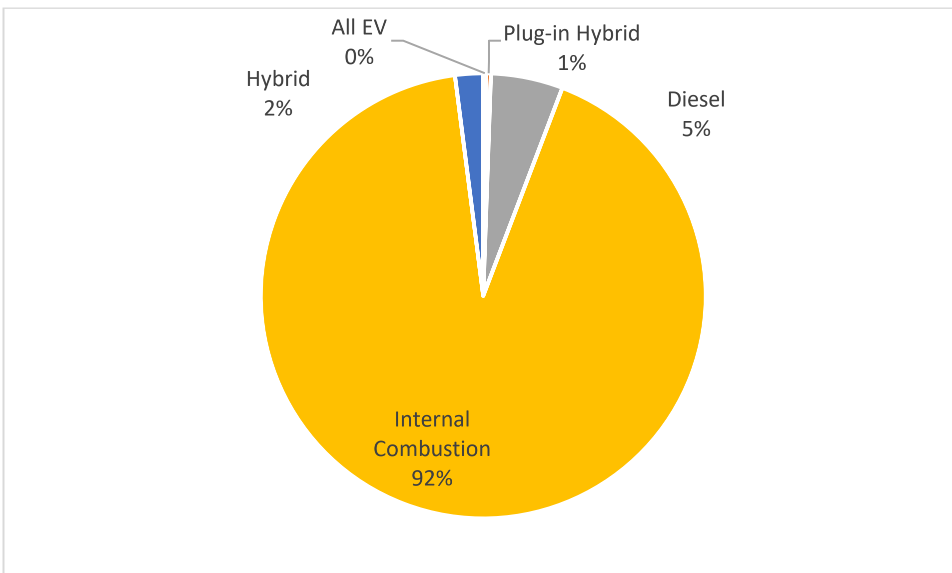


Transportation Sector

The transportation sector continues to be the primary contributor to GHG emissions in Vermont and has proven to be the most difficult sector to transform. Electric vehicle registrations are growing steadily and Vermont has the fifth highest rate of electric vehicle registrations on a per capita basis; however, Vermont will need to see significant progress in this area.



Vermont Vehicle Registrations



As the data in this report shows, from a climate perspective, most of Vermont's focus should be on the transportation and heating sectors. Much of the change necessary in those sectors will be a result of individuals making decisions regarding their vehicle and heating options, and therefore education regarding options is important. In addition, the degree to which heat pumps and electric vehicles reduce GHG emissions is dependent on the amount of renewable energy provided by the electric utilities. Vermonters are more likely to move away from fossil fuels and to electric vehicles and heat pumps when it is economical to do so, and the cost of fuel is an important consideration. Accordingly, it is essential that meeting renewable goals for the electric sector is accomplish at the lowest feasible cost.

II. Introduction

Vermont's energy policy, as articulated in statute, is:

> To assure, to the greatest extent practicable, that Vermont can meet its energy service needs in a manner that is adequate, reliable, secure, and sustainable; that assures affordability and encourages the State's economic vitality, the efficient use of energy resources, and cost-effective demand-side management; and that is environmentally sound.[3]

The three goals – reliability, affordability, and sustainability – can at times be in competition. Any policy actions should acknowledge this and should also be informed by objective data as to Vermont's existing energy usage and policies. This Annual Energy Report[4] is designed to provide that objective data and also provide transparency regarding how this data informs the policies pursued by the Public Service Department (PSD or the Department).

Overview of the 2016 Comprehensive Energy Plan

Vermont's CEP, which is published every six years by the Department of Public Service, is designed to "implement the State energy policy set forth in section 202a" and be consistent with the relevant land use planning goals contained in 24 V.S.A. § 4302. The 2016 CEP contains an overarching goal of meeting 90% of the state's energy needs with renewable energy across the electric, thermal, and transportation sectors by 2050.[5] In addition to the 90% by 2050 goal, the CEP contains many sector-specific goals, as summarized below.

Figure 1: 2016 Comprehensive Energy Plan Goals

Sector	Goal
Total Energy	90% by 2050
	40% by 2035
	25% by 2025
	Reduce consumption per capita by 15% by 2025 and by more than 33% by 2050
Electricity	67% Renewable by 2025
Thermal	30% Renewable by 2025
Transportation	10% Renewable by 2025
Greenhouse Gases	40% below 1990 levels by 2030
	80-95% below 1990 levels by 2050

A significant component of reaching the goals set forth in the CEP is the reduction in energy use across all sectors. The scale of reduction would not be consistent across all sectors – Vermont's electric sector has had great success reducing consumption through energy efficiency, but will

[3] 30 V.S.A. § 202a.
[4] 30 V.S.A. § 202b(e).
[5] The 2016 Comprehensive Energy Plan is available at: https://publicservice.vermont.gov/publications-resources/publications/energy_plan.

not be able to reduce per-capita electric usage by a third, particularly with the necessary shift to electric vehicles and heat pumps. Instead most of the total energy reduction will come from the transportation and heating sectors through efforts to move away from inherently inefficient combustion technologies and toward electric vehicles and cold climate heat pumps.

The 2016 CEP also contains illustrative pathways that could be taken in order to reach the goals outlined above. For example, one such pathway is the installation of 35,000 cold-climate heat pumps by 2025. These pathways, while helpful to understand the rate and scope of change needed to reach our goals, should not be interpreted as the intended or only possible pathways to reach those goals. Planning documents must recognize that technological changes, markets, and other forces will impact how we proceed into the future and which path we take to reach our goals. Dictating specific technologies now can limit more cost-effective options in the future. Conversely, waiting for the best possible technological shift or market change can result in the goals never being met. Good planning requires an eye towards what the future may bring while simultaneously striving to meet goals within the present context. Planning goals should inform and drive policy choices and not simply be a soundbite that is used to promote a particular narrative.

Moving Forward to Meet the 2016 CEP Goals

As described in detail in this report, Vermont is surpassing the 2016 CEP goals for the electric sector; however, achieving significant transformation of the transportation and heating sectors continues to pose challenges.

The success in the electric sector is in large part due to the structure of the electric industry. To the extent that mandates are imposed upon the electric utilities, the utilities, as monopolies, are able to recover from electric customers the reasonable costs of meeting these mandates. This dynamic creates cost pressure on electric rates which has the effect of making it more difficult to decarbonize the transportation and heating sectors, which account for approximately 68% of the greenhouse gas emissions in Vermont in 2016. The 2016 CEP goals for the transportation and heating sectors are heavily dependent on electrification technologies – such as moving from inefficient internal combustion engines to electric vehicles. However, this move to electrification technologies is not a government mandate and is dependent on customers choosing electric vehicles over traditional cars and/or choosing to install cold climate heat pumps or advanced wood heating to reduce the use of heating oil and propane. For most customers, these choices are informed not only by environmental considerations but also by economics.

Customers are more likely to adopt electric vehicles and heat pumps when the fuel costs – in this case electricity – are reasonable compared to the alternative fossil fuel costs. Progressive rate designs can be developed to provide lower rates for certain end-use technologies; however, these rates must still be set to ensure just and reasonable rates. To the extent that policies center on the electric sector and power supply costs, there will be further rate pressures that risk undermining progress in those sectors that contribute the lion's share of GHG emissions.

In addition, there are a multitude of existing programs related to either decreasing energy consumption or increasing the amount of renewable energy used in Vermont. Appendix A provides a summary of programs and services offered in Vermont to meet these goals.

III. Greenhouse Gas Emissions

In addition to statutory goals, the CEP sets forth specific goals for reducing GHG emissions in all sectors. As with the CEP generally, GHG reductions can be achieved through reduced energy usage and switching to renewable sources for the remainder of the necessary energy.

This section of the report provides an overview of: (1) the GHG reduction goals in statute and in the 2016 CEP; (2) the progress on meeting the GHG goals; and (3) the results of a recent modeling exercise conducted by the Department to determine the relative cost-effectiveness of different policy measures toward carbon reductions.

Greenhouse Gas Reduction Goals

In 2005, the Vermont legislature established goals to reduce greenhouse gas emissions "from within the geographical boundaries of the State and those emissions outside the boundaries of the State that are caused by the use of energy in Vermont"[6] from a 1990 baseline by:

(1) 25 percent by January 1, 2012;
(2) 50 percent by January 1, 2028;
(3) If practicable using reasonable efforts, 75% percent by January 1, 2050

Recognizing the nexus between energy generation and greenhouse gas emissions, Vermont's 2016 CEP sets two supplemental goals for reduction in emissions specifically from Vermont's energy use, both of which are consistent with the plan's other goals for energy use reduction and renewability. The first is a 40 percent reduction below 1990 levels by 2030, and the next is a reduction of 80-95 percent below 1990 levels by 2050.[7]

Progress on Meeting GHG Goals

Vermont's Agency of Natural Resources, through its Air Quality and Climate Division, provides annual estimates on the amount of greenhouse gas emissions (GHG) by sector. The Vermont Greenhouse Gas Emissions Inventory and Forecast: Brief 1990 – 2016 provides very useful data that should be incorporated into any discussion regarding energy policy.

Generally, Vermont's GHG emissions have declined from 2015 to 2016, but are still well above 1990 levels. In addition, Vermont's per capita emissions are below the per capita emissions in the U.S., but higher than any other state in the Northeast.

[6] 10 V.S.A. § 578.
[7] 2016 CEP at 4.

Figure 2: Per Capita GHG Emissions U.S. and Vermont[8]

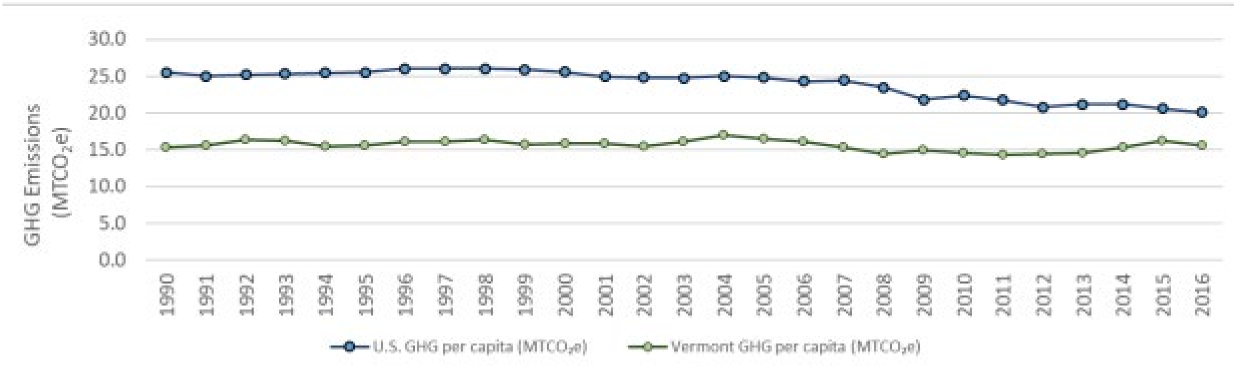
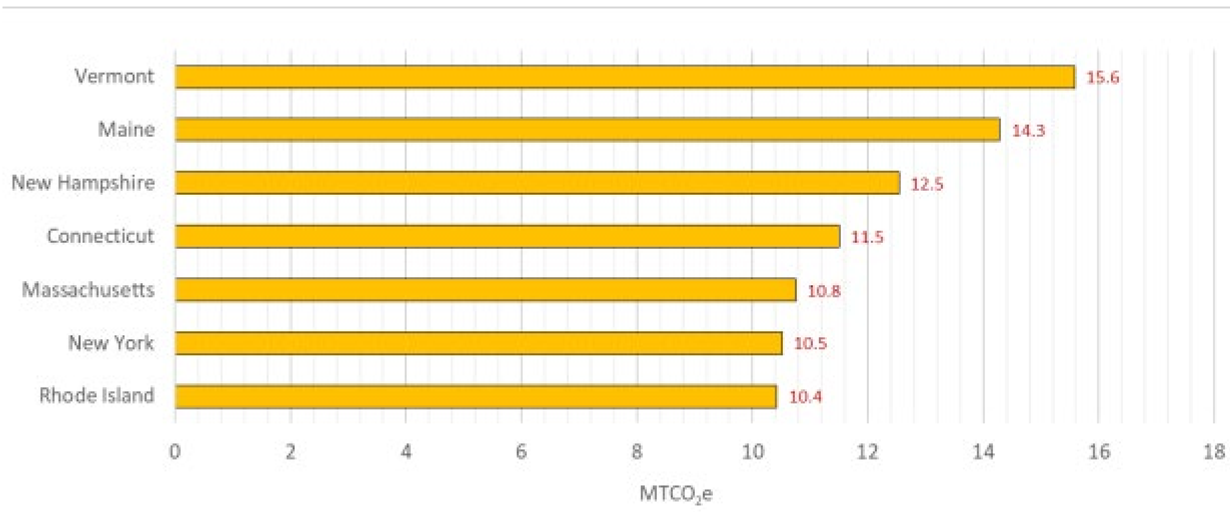


Figure 3: Comparison of GHG Emissions Among Northeastern States[9]



The transportation and heating sectors continue to be the highest sources of GHG emissions in Vermont at 44.5% and 23.1% respectively. The electric sector is fourth, behind the agricultural sector, at 8.3%. Additionally, the Air Quality and Climate Division provides additional GHG emission values for 2017 and 2018, estimating some data and providing actual data in other cases. Data for the electric sector shows a decline of 77% in actual GHG emissions from 2016 to 2018, primarily as a result of the RES and energy purchases from nuclear units. For the heating and industrial fuel use sector, emissions from 2016 to 2018 are estimated to increase by 1.5%. In

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[8] Vermont Air Quality and Climate Division, Department of Environmental Conservation, VERMONT GREENHOUSE GAS EMISSIONS INVENTORY AND FORECAST: BRIEF 1990 – 2016, at 9. (January 2020). Available at: https://dec.vermont.gov/air-quality/climate-change.

[9] Vermont Air Quality and Climate Division, Department of Environmental Conservation, VERMONT GREENHOUSE GAS EMISSIONS INVENTORY AND FORECAST: BRIEF 1990 – 2016, at 10. (January 2020). Available at: https://dec.vermont.gov/air-quality/climate-change.

the transportation sector, there is an estimated decline of 3% in GHG emissions from 2016 to 2018.

Figure 4: 2016 Vermont GHG Emissions by Sector[10]

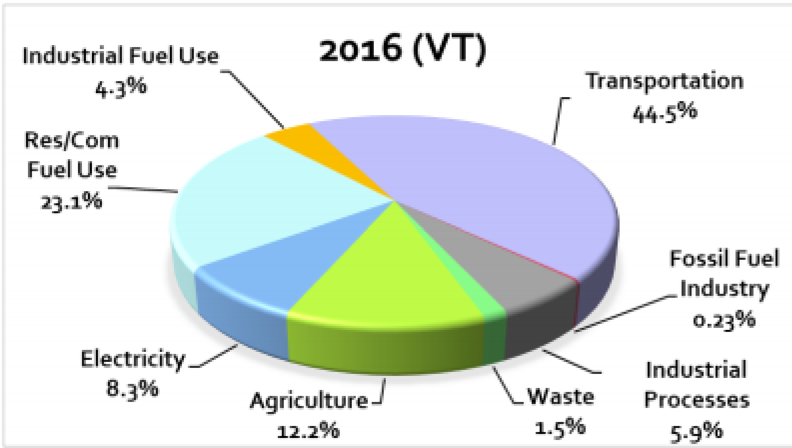
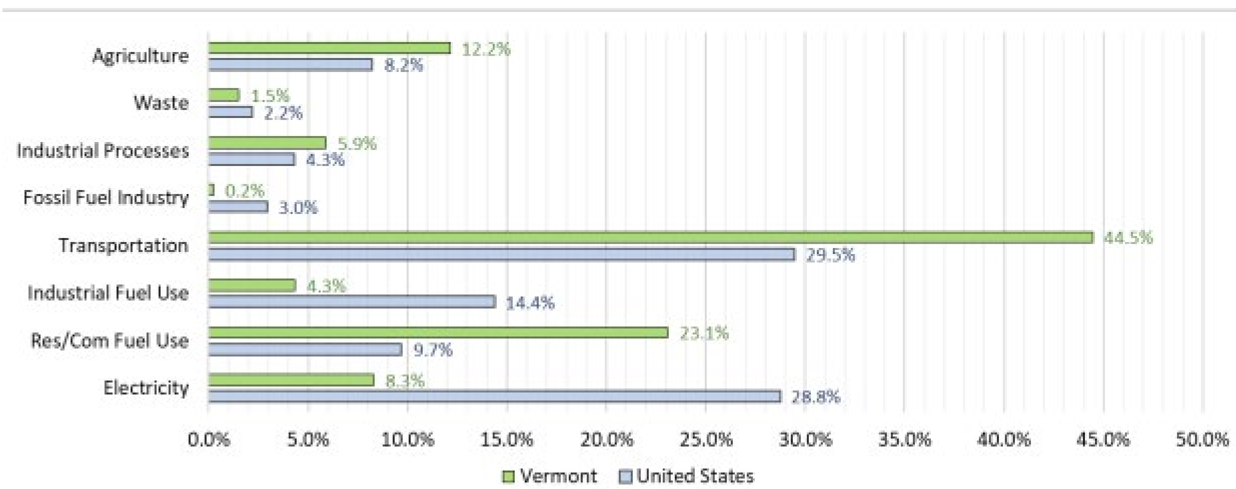


Figure 5: GHG Emissions by Sector Vermont and U.S.[11]



Variability of GHG Emissions

An important consideration in reviewing the progress toward GHG reduction goals is the impact of weather on GHG emissions. Emissions from the heating sector are directly tied to cold

[10] Vermont Air Quality and Climate Division, Department of Environmental Conservation, VERMONT GREENHOUSE GAS EMISSIONS INVENTORY AND FORECAST: BRIEF 1990 – 2016, at 6. (January 2020). Available at: https://dec.vermont.gov/air-quality/climate-change.

[11] Vermont Air Quality and Climate Division, Department of Environmental Conservation, VERMONT GREENHOUSE GAS EMISSIONS INVENTORY AND FORECAST: BRIEF 1990 – 2016, at 10. (January 2020). Available at: https://dec.vermont.gov/air-quality/climate-change.

weather, but even the electric sector sees an increase in emissions during cold periods, as less efficient resources are called upon to generate when natural gas is heavily utilized for heating, and unavailable for generation, and the significant amounts of solar resources are constrained by the longer nights and occasional snow and ice cover. Consequently, it is important to review trends over time rather than point to data from unusually cold or mild winters and claiming failure or success.

Relative Costs of Carbon Reduction

There are many state programs that support Vermont's efforts to reduce GHG emissions across the different sectors, including renewable power supply requirements, energy efficiency, weatherization, advanced wood heating, and incentives for electric vehicles and cold climate heat pumps. These programs use a mix of public and private investment to effectively lower emissions. The Department created a tool to better understand how particular actions ("measures") reduce carbon emissions relative to the costs and benefits of each action. This spreadsheet model compares efficiency, transportation, and renewable energy measures by estimating the amount of carbon savings per public dollar invested. The measures analyzed may provide additional benefits besides carbon reduction, including economic development, and increased safety and health in weatherized homes. The model does not attempt to capture these additional benefits.

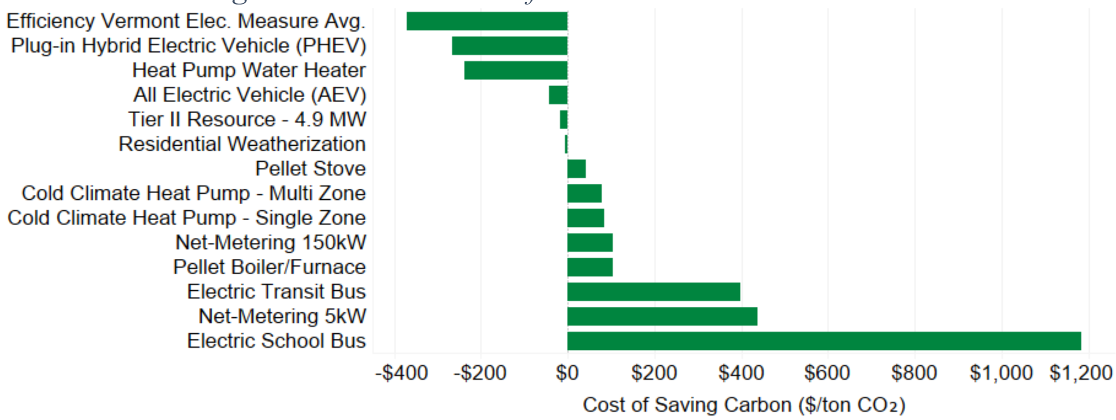
The model is not an argument to expand or eliminate certain programs, but instead intended to compare the carbon impacts of existing clean energy measures. The Department supports continuing a diverse approach to mitigating carbon emissions; such a portfolio approach provides customers with choices and ensures lower cost strategies are accessible as technologies improve and prices fall.

The tool uses readily available data and estimates, meaning that only select measures are included, and includes data and assumptions developed during the summer and fall of 2019. Other important emissions reduction policies, such as improving bicycle and pedestrian infrastructure and supporting public transit, are not included given the difficulty of estimating emissions reductions on a per-measure basis.

Findings

The chart below depicts the measures analyzed, ranked occurring to the cost per ton of carbon avoided. A negative cost means that benefits outweigh costs; in other words, the measures save money over their lifetime. A positive cost means that the financial costs of the carbon-reducing measure outweigh the financial benefits. The summary does not differentiate who bears the cost and includes incremental expenditures and savings whether these are borne by individuals (e.g., buying equipment) or Vermonters at large (e.g., lower electricity costs).

Figure 6: Relative Cost of Carbon Reduction Policies



Generally, efficiency measures such as electric efficiency and weatherization programs are more cost-effective than measures that require significant up-front expenditures. Some of the measures analyzed require significant up-front costs and are not widely deployed. For such measures, it is important to remember that it is useful to trial new technologies, particularly in the areas of transportation and heating where electrifications efforts are relatively nascent, and that technology costs will likely continue to decline.

IV. Electric Sector

Overview

Vermont has had remarkable success in meeting the goals and requirements established for the electric sector. In 2018, Vermont utilities were required to retire renewable energy credits (RECs) for 55% of the kWh sales to customers; the utilities surpassed that requirement and provided sufficient RECs to meet 63% of sales. In addition, even though nuclear power is not considered renewable, it is considered to be carbon free; for 2018, power from nuclear energy constituted 30% of the retail sales to customers.

In 2018, the electric sector contributed approximately 2% to Vermont's GHG emissions, compared to approximately 77% in the thermal and transportation sectors. The major challenge facing the electric sector is ensuring that renewable requirements are met in as cost-effective a manner as possible. This helps protect the economically vulnerable, who pay a greater share of income toward basic needs such as electricity. Lowering cost in the electric sector is also important to meet climate goals in the heating and transportation sectors – the cost of "fueling" electric vehicles and heat pumps is an important consideration for individuals in deciding whether to move to these technologies.

2016 Comprehensive Energy Plan Goals

The 2016 CEP sets a goal of having 67% of electricity provided in the electric sector met through renewable generation by 2025. As the CEP makes clear, this goal is linked to the requirements of the Renewable Energy Standard and further states: "Power supply questions now revolve around the most cost-effective way to meet the RES requirements, not around how much renewable energy to acquire."[12]

The CEP goals for the heating and transportation sectors are also linked to the electric sector goals. Moving away from fossil fuels in these sectors will require moving towards electric vehicles and heat pumps. These uses will likely add significantly to the amount of electricity used by Vermonters and one of the more significant challenges will be managing this new load to minimize impacts on the electric system.

Renewable Electric Supply

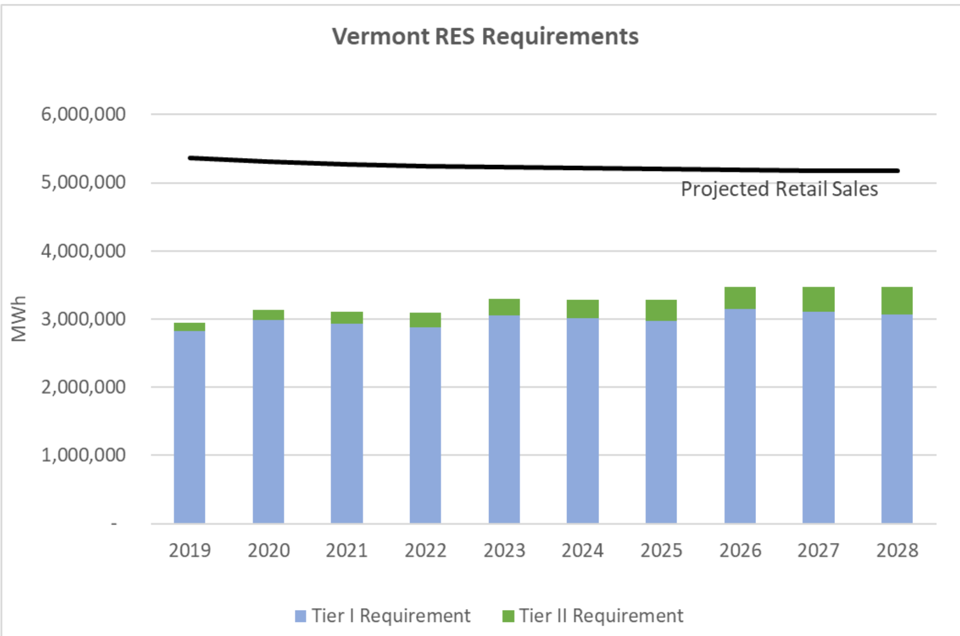
For the electric sector, a utility demonstrates that it is supplying its electric customers with renewable energy through the retirement of RECs. Vermont's RES requires that Vermont's utilities retire sufficient number of RECs to cover an increasing percentage of retail sales. Tier I requires distribution utilities (DUs) to retire qualified RECs or attributes from any renewable resource capable of delivering energy into New England to cover at least 55% of their annual retail electric sales starting in 2017. This amount increases by 4% every third January 1 thereafter, up to 75% in 2032. Tier II requires DUs to retire qualified RECs equivalent to 1% of their annual retail sales starting in 2017, increasing by three-fifths of a percent each year, up to 10% in 2032. RECs associated with the net metering and standard offer programs are eligible for Tier II of RES. Appendix E of this report includes the Department's 2020 ANNUAL REPORT ON

[12] 2016 CEP at 277.

THE RENEWABLE ENERGY STANDARD, as required by 30 V.S.A. § 8005b, and contains additional data.

Tier I resources include any renewable generator in ISO New England (ISO-NE) and imports from neighboring control areas (e.g., Hydro Quebec, New York Power Authority hydro). Tier II of the RES is a carveout of Tier I and defines eligible resources as renewable generators with a nameplate capacity of less than 5 MW, commissioned after June 30, 2015, and connected to a Vermont distribution or subtransmission line.

Figure 7: Vermont RES Requirements



Of the 5,415,719 MWhs that were sold in Vermont during 2018, approximately 63%, or 3,405,435 MWhs, are considered to be renewable as demonstrated by the associated retired RECs produced by renewable generation facilities. An additional 30% of the MWhs sold were supplied by nuclear units; which are not renewable but are considered to be non-carbon emitting resources that help meet Vermont's GHG reduction goals.

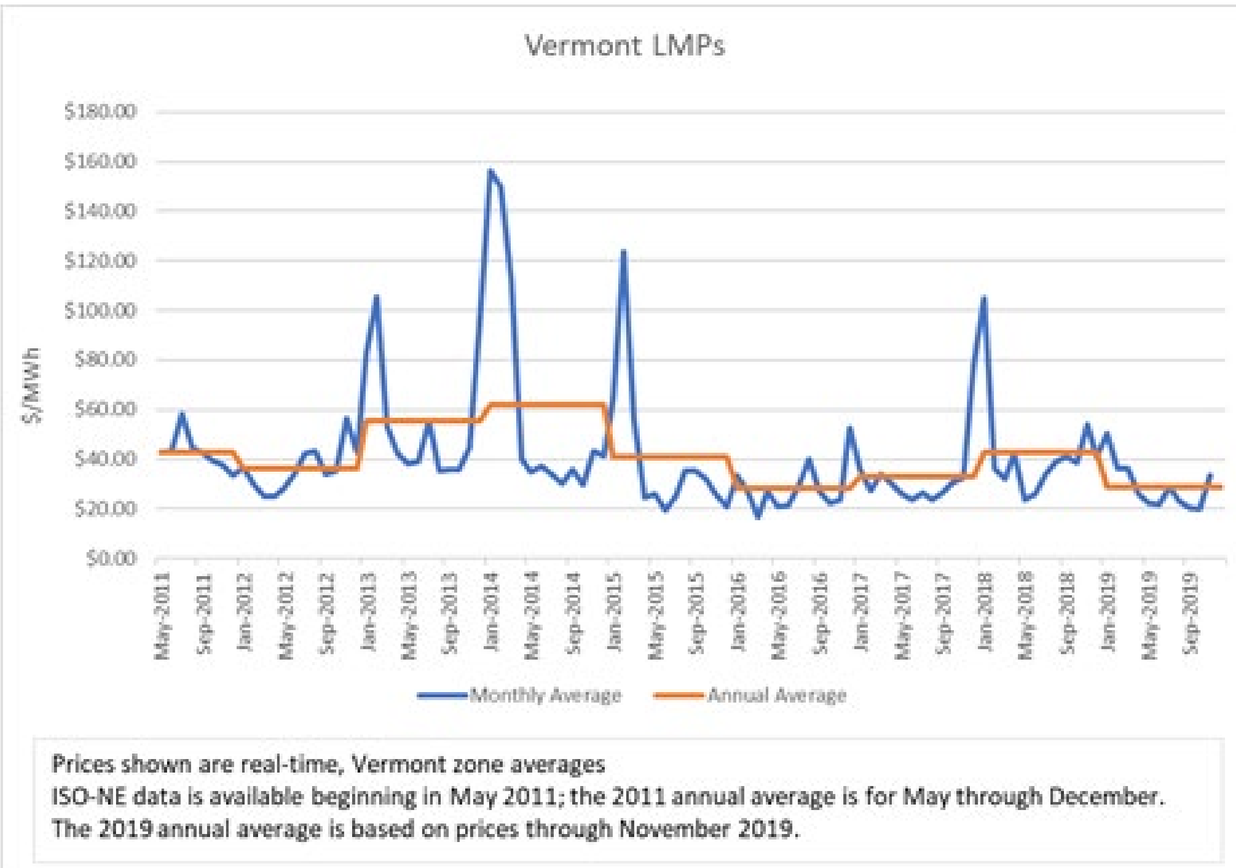
Electricity Prices

There are three prices that are relevant to supplying electric energy to Vermont's electric customers: (1) the wholesale price represents the avoided cost of energy; (2) RECs represent the cost of meeting RES compliance; and (3) retail prices reflect the costs of power supply and other necessary utility services (such as transmission and capacity costs, explained below).

Wholesale Energy Prices

The average 2018 wholesale energy price in New England was $43.54/MWh ($0.04354/kWh); higher than the past two years, but still among the lowest prices since the introduction of the wholesale markets in 2003.[13] New England wholesale energy prices have been trending down as the price of natural gas has fallen. Natural-gas-fired units are typically the marginal units[14] in the region and therefore set the price – natural gas prices and wholesale energy prices correlate extremely well. Given constraints on the gas pipelines in the winter (due to natural gas being prioritized for heating in the winter) this means that annual average energy prices have become primarily dependent on winter temperatures. For example, the average wholesale energy price for the month of January 2018 was $107.54/MWh, while the price in May was $23.89/MWh. This seasonal variation impacts the relative value of different intermittent resources as well, with resources that generally produce more energy in the winter having significantly more value than resources that produce in the spring and summer.

Figure 8: Wholesale Energy Prices for Vermont



The wholesale prices are indicative of what Vermont's utilities could be paying for power supply if they procured all energy needs through the ISO-NE market. However, there is statutory policy

[13] ISO New England Pres Release, New England's Wholesale Electricity Prices Up in 2018. March, 2019. Available at: https://www.iso-ne.com/static-assets/documents/2019/03/20190312_pr_2018-price-release.pdf
[14] ISO-NE dispatches generation based on the price of the generation unit. A wind facility has not fuel costs and is therefore less expensive to dispatch than a natural gas-fired unit, which in turn in less expensive than an oil-fired resource. A marginal unit is the last resource needed to meet load in a particular period of time. Typically, as load increases, more expensive units are needed to provide power to the system, and this more expensive unit than becomes the marginal unit.

that Vermont utilities should pursue stably priced long-term contracts with renewable resources. Consistent with this policy, Vermont electric utilities are significantly hedged against wholesale market prices (either through long-term contracts or utility-owned generation resources),[15] and therefore the benefits of these current and historically low wholesale prices are muted for Vermont ratepayers. Conversely, Vermont ratepayers are not fully bearing the significant price increases that occur when cold weather drives up wholesale prices.

Wholesale prices also have an important role in the Department's and Public Utility Commission's (PUC's) review of additions to an electric utility's power supply portfolio as well. The cost of any new resource is compared against wholesale market prices – to the extent that there are significantly lower wholesale prices, it becomes more difficult for a utility to demonstrate that a particular resource provides an economic benefit to Vermonters. A similar approach is also applied to energy efficiency – low wholesale energy costs means that there are likely to be less energy efficiency measures that are economically justifiable.

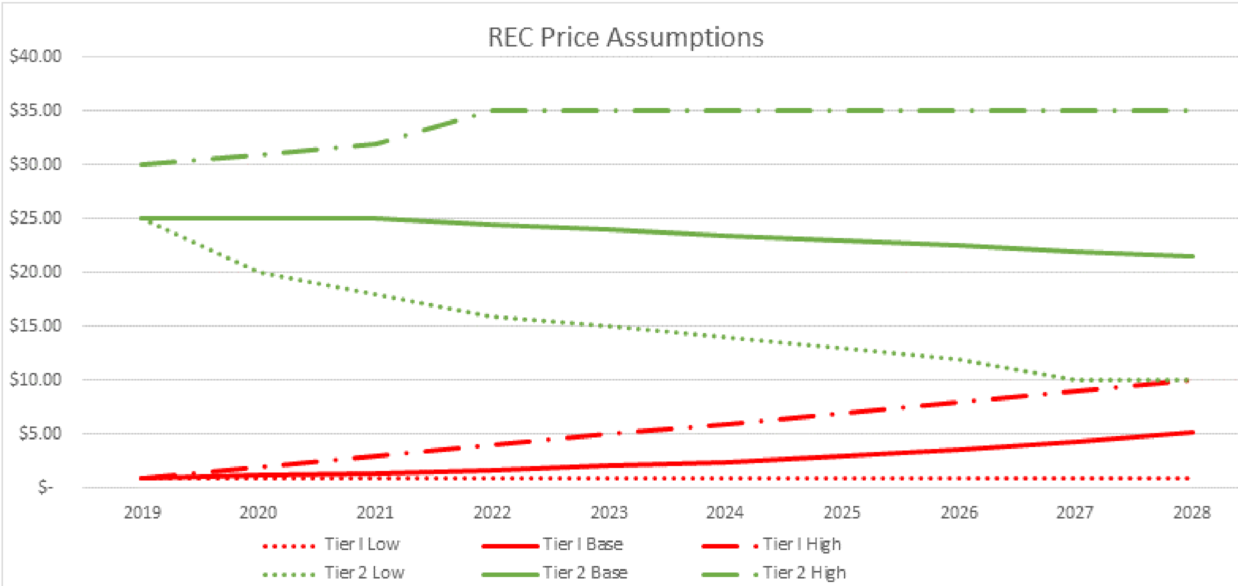
Renewable Energy Credit Prices

RECs represent the renewable attributes of energy. REC prices can vary considerably over time and are largely driven by state renewable energy requirements within the region. In order to understand Vermont REC price forecasts, it is important to first understand the relationships among the different regional REC markets. Vermont Tier I RECs are generally equivalent to Class II or existing resource, RECs in neighboring states, with the exception that imports from HydroQuebec (HQ) and New York Power Supply Authority (NYPA) are considered renewable in Vermont but not in other states. It follows that Vermont Tier I prices tend to be very similar to Class II prices in neighboring states. Currently, Tier I prices are low given the relatively low demand in the region for these RECs and the ability of Vermont utilities to use HQ and NYPA attributes to satisfy the Tier I requirement. However, other states have recently shown an interest in expanding their requirements related to existing renewable resources, which would drive up Tier I prices.

Vermont Tier II resources are a small subset of Class I or premium resources in other states, so when there is sufficient Tier II supply in Vermont, excess RECs will be sold as Class I to neighboring states, which results in Tier II prices that are very similar to Class I prices. However, if a shortage of Vermont Tier II resources develops, for example, resulting from constraints on the electric distribution system, then prices will diverge with Tier II prices approaching the Alternative Compliance Payment[16] while Class I prices trade at a different market price.

[15] Vermont's renewable energy policy encourages Vermont utilities "to enter into affordable, long-term, stably priced renewable energy contracts that mitigate market price fluctuations for Vermonters." 30 V.S.A. § 8001(a)(3).
[16] The Alternative Compliance Payment acts as an upper bound on the price that a DU must pay to comply with RES. If REC prices are higher than the ACP, the utility may pay the ACP instead of retiring a REC.

Figure 9: REC Price Assumptions



Tier I RECs are generally satisfied with RECs from existing, utility-owned resources or purchases of unbundled RECs from existing renewable resources physically located in New England or imported into the region. Tier II RECs are generally satisfied with RECs from utility-owned resources as well as resources from Vermont's net metering and standard offer programs. Vermont statute requires electric utilities to retire RECs from net metered systems; these RECs can be counted toward Tier II of RES. However, the compensation paid to net metering systems currently exceeds the wholesale energy price and REC prices combined, and therefore results in a higher cost of compliance for meeting the RES and serving Vermont customers with electricity than would alternative resources.

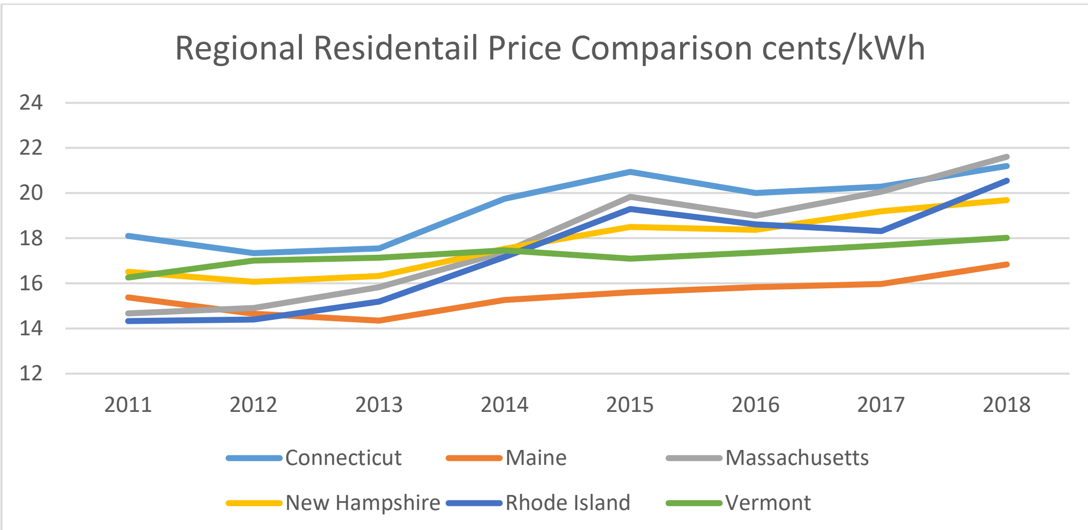
Retail Prices

Retail rates are what are paid by end-use customers. These rates reflect not just the power supply portfolio but also other regional costs to secure and deliver wholesale electricity (e.g. ISO-NE capacity and transmission), the costs of maintaining the distribution system (e.g. tree trimming, upgrading lines and transformers, etc.), and administrative costs (e.g. billing, customer service, etc.). The power supply component, along with regional capacity and transmission costs, generally accounts for 50-60% of retail rates.

It is also important to consider that different customer classes pay different rates. The Department has been advocating for separate rates for electric vehicles that reflect the fact these significant new sources of load impose different costs and therefore could be charged lower rates. Recognizing that prices matter when it comes to customer choice, it is important to move to end use rates for significant new technologies such as electric vehicles and heat pumps.

Vermont's retail prices tend to be relatively stable compared to retail prices in other states. This is due in part to the fact that Vermont remains the only state in the Northeast with vertically integrated electric utilities[17] and also due to the statutory policy regarding stably priced contracts and the resulting hedging strategy employed by Vermont's utilities. The retail rates of Vermont's utilities vary considerably, and are dependent on a number of factors, including power supply commitments and whether the utility's service territory is urban or rural. The figure below provides a comparison of electric prices among the New England states.

Figure 10: Residential Electric Price Comparison[18]



Reducing Electric Energy Demand

One strategy for meeting renewable requirements is to reduce the number of kWh sold, which reduces the amount of fossil-fuel-fired and renewable generation required. Efficiency Vermont (EVT) implements electric efficiency services in every electric utility service territory except the City of Burlington Electric Department (BED), which provides its own electric efficiency services.

Vermont statute requires that the PUC establish a budget to achieve all reasonably available cost-effective energy efficiency savings, while also accounting for rate impacts. The budget amount is set through the Demand Resource Plan (DRP) proceeding, which is used to establish a three-year budget, as well as Minimum Performance Requirements (MPR) and Quantifiable Performance Indicators (QPI). Collectively, the QPI and MPR are intended to strike a balance of risk/reward to encourage the implementer to achieve high performance while ensuring economic and geographic equity across ratepayers.

The approved EVT program budgets for the past ten years are depicted in the chart below, increasing significantly before leveling off in recent years. The BED budget has a very similar shape but is an order of magnitude lower than EVT's budget.

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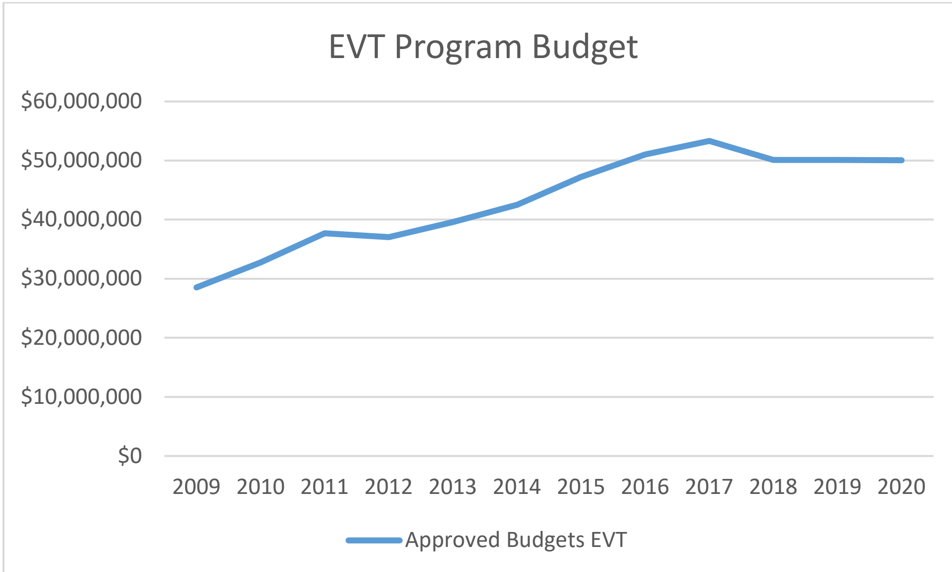
[17] A vertically integrated utility is able to own generation resources or enter into long-term contracts with merchant generators. In other states, absent specific statutory mandates to the contrary, regulated utilities are not able to own generation or enter into contracts for periods of longer than five years.
[18] Source: Energy Information Agency.

Figure 11: Approved Efficiency Vermont Program Budgets



In 2018, EVT reported savings of 140,001 first year MWh, while spending $43,562,755, not including earned performance awards.[19] For the 2015-2017 performance period, EVT achieved savings of 390,373 MWh and reduced summer peak demand by 45 MW and winter peak demand by 70 MW. The cost per kWh saved was $0.044 for 2017; this value averages the savings costs for all of EVT's programs. With respect to energy efficiency, annual savings are not always the best indicator as the programs are developed and implemented on a three-year cycle, to match the three-year budget and QPI cycle. Thus, Energy Efficiency Utilities are measured both on first year and lifetime savings metrics.

As a result of significant changes to the lighting sector, potential energy efficiency savings are expected to decline going forward. This declining potential will impact the ability of EVT to continue to achieve significant savings.

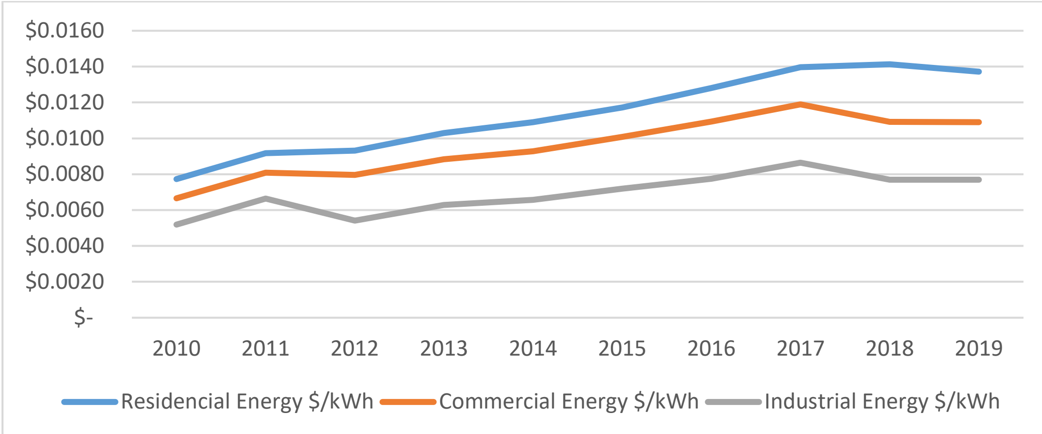
Prices

The energy efficiency charge (EEC) is used to fund the services of Efficiency Vermont and BED's efficiency programs. Figure 12 shows the history of the EEC for Efficiency Vermont.[20]

[19] Efficiency Vermont 2018 Annual Report at 2. Available at: https://www.efficiencyvermont.com/Media/Default/docs/plans-reports-highlights/2018/Efficiency-Vermont-2018-Annual-Report.pdf.

[20] Rates for customers with demand charges, not shown here, have both a kWh and kW component. These rates follow a similar trajectory.

Figure 12: Energy Efficiency Charge Rates



System Operations

Vermont is part of the larger New England grid, with the transmission system and wholesale markets operated by ISO-NE, with Vermont Electric Power Company (VELCO) owning the majority of the transmission infrastructure within Vermont. The New England grid is operated as a balancing area, where generation is matched in real time with load to ensure that federal reliability standards are met. On a day-to-day basis, load generally follows a similar pattern, with most variations being due to the time of day and ambient temperature. The load patterns can be seen on a daily, seasonal, and annual basis. An additional and increasingly important factor for ISO-NE's ability to ensure sufficient resources to meet region-wide load is the presence of "behind-the-meter" resources such as net metered solar. Generation resources smaller than 5 MW do not need to participate in ISO-NE wholesale electricity markets and therefore ISO-NE does not "see" the generation from these resources but instead a reduction in the amount of load that must be delivered to a DU. Through December of 2018, there were 2,884 MW of distributed solar in New England, with almost half of this amount considered behind-the-meter.[21] The amount of distributed solar is forecasted to grow to 6,744 MW by 2028, with 4,150 MW considered behind-the-meter.

In addition, generation resources have their own "supply curves" that demonstrate when they produce power. For renewable resources such as solar and wind, these curves demonstrate when the "fuel" is available. Solar has fairly well described, and intuitive pattern where maximum generation occurs during mid-afternoon and during the summer. Wind generally produces more during the winter months.

Regional coordination of the grid dates back decades and provides the benefit of ensuring a diversity of resource types and a larger area over which to balance load, system diversity, and economic dispatch of generation. Similar to an ecological system, the larger an area and the more diverse the resources, the more reliable and resilient the system is likely to be. The ISO-NE grid

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[21] ISO-NE, *Final 2019 PV Forecast.* Available at: https://www.iso-ne.com/static-assets/documents/2019/04/final-2019-pv-forecast.pdf.

allows Vermont utilities to purchase energy from any source in New England, thereby providing a diverse power supply portfolio and more hedging opportunities throughout the year.

A significant issue facing Vermont's transmission grid is the emergence of the Sheffield Highgate Export Interface (SHEI), an area designated by ISO-NE where the amount of generation exceeds the load in the area and the ability of the transmission infrastructure to export the excess energy.[22] New generation in the area will result in curtailment of existing renewable generation.[23]

Vermont remains a winter-peaking system, while the New England System continues to peak in the summer. Electrification of the transportation and heating sectors will increase winter peaks and is expected, in the long term, to move New England to a winter peaking system.[24] It is also important to note that the amount of in-state solar generation has shifted Vermont's summer peak into the evening hours and is expected to do the same for New England generally.

Federal reliability standards ensure that the New England transmission system is robust. Almost all customer outages are a result of issues on the distribution system rather than the transmission system. The primary concern on the regional level is ensuring that there is sufficient energy during winter months, when the natural gas system is being primarily utilized for heating and old, inefficient oil-fired units are required to provide energy.

On the local level, there have been significant changes to the electric system within the past ten years with the explosive growth of distributed generation. Distributed generation in Vermont is now more likely to raise system constraints rather than solve them, although the ability to choreograph new load from electric vehicles and heat pumps has the potential to reduce such constraints.

Battery storage also has the potential to improve the efficiency of the electric grid, but to date has mostly been used to lower monthly and regional peak loads and therefore reduce costs for customers. In addition, battery storage has been used by customers to provide back-up power for themselves in the event of electric system outages. This use case benefits those customers with the installed storage, although it does not provide benefits to other customers; similar to the way that Vermonters have relied on woodstoves and fossil-fuel-fired emergency generators to ride through electrical outages. In order for battery storage to provide increased reliability for other customers the battery storage must be integrated into the electric system in a configuration such as a microgrid. To date, there has not been a microgrid in Vermont that has provided reliability benefits to customers during an electrical outage, although the Department expects that it is only

[22] *See,* Department of Public Service, IDENTIFYING AND ADDRESSING ELECTRIC GENERATION CONSTRAINTS IN VERMONT: A REPORT SUBMITTED PURSUANT TO ACT 139 OF 2018 (January 2019) at 17.
[23] *See*, Case No. 17-1247-NMP, *Application of Derby GLC Solar,* Order of 1/24/19 at 2.
[24] *See,* Electric Power Research Institute, *Grid Transformation – Trends and Technologies,* at slide 13. Available at: https://www.iso-ne.com/static-assets/documents/2019/05/a2_grid_transformation_solving_technical_challenges_tuohy_epri.pdf.

a matter of time before this use case becomes a reality. For additional information regarding battery storage, please see the Public Service Department's Battery Storage Report from 2017.[25]

Prices

ISO-NE operates the regional Forward Capacity Market (FCM). This market ensures that there are sufficient resources available to meet the future peak demand for electricity. ISO-NE holds an annual auction three years before the period of time to which the resources are committing to be available. Resources bid into the auction to obtain a commitment to supply generation capacity (termed a "capacity supply obligation"). Successful resources will be paid the market-based capacity price for performance. A utility's capacity costs are a function of its share of the total system-wide load in New England during the peak hour of energy usage during the year. Capacity prices peaked for the period of June 1, 2018 to May 31, 2019; however, prices will decline over the next three years. Appendix C contains a chart of capacity prices.

Regional Network Service (RNS) charges can be thought of as the local utility's share of the overall cost to maintain and upgrade the bulk transmission facilities relied on by all wholesale market participants in the region. The costs of reliability projects are socialized across the region, with each state paying based on its proportion of peak demand. Vermont accounts for about 4% of regional peak demand. Vermont utilities pay for the use of the regional transmission grid based on each utility's demand during state coincident monthly peak loads (the electric use at the peak hour of energy use each month). Because there is a fixed cost associated with maintaining the transmission system, by reducing monthly coincident peaks, utilities can reduce their own transmission charges, but will essentially be shifting those charges to other utilities and ratepayers in New England.

The RNS rate from June 30, 2018 to July 1, 2019 was about $100/kW-year. The total regional transmission costs paid by Vermonters in 2018 was $166 million. In addition to the regional transmission costs, there are also local bulk and sub-transmission costs as well. These are costs associated with transmission infrastructure needed to maintain Vermont, as opposed to New England-wide, reliability. For 2018, local transmission costs totaled approximately $30 million.[26] Appendix C includes a graph with historic and forecast RNS rates.

Recommended Policies

The inception of the RES in 2017 was the single most significant action taken to date in the electric sector to move toward the 90% by 2050 contained in the CEP. The Department does not recommend any legislative changes with respect to the electric sector. To the extent that the legislature makes changes to the RES, it should be mindful of the potential impacts on affordability; both with respect to the impact on Vermont's economically vulnerable that already

[25] Vermont Public Service Department, *Energy Storage Report,* 2017. Available at: https://publicservice.vermont.gov/sites/dps/files/documents/Pubs_Plans_Reports/Energy_Storage_Report/Storage_Report_Final.pdf.

[26] A few Vermont utilities have Open Access Transmission Tariffs as well. An OATT is a regulatory mechanism that ensures consistent pricing for all resources that utilize the transmission network by establishing transparent terms and conditions that apply to all resources.

disproportionately bear the costs of energy mandates, and the impact on the economics of transitioning to a lower carbon economy.

Instead, the most significant improvements that can be made to the electric sector involve improving the economics of technologies such as electric vehicles and heat pumps; actions that can best be accomplished through developing new rate designs, controls, and incentives that remove barriers to beneficial electrification efforts. The Department is continuing discussions with stakeholders regarding the development of such rate designs.

Act 62 of 2019 required the PUC to review whether to expand the scope of the EEUs to include electrification activities and also the potential use of EEC funds for weatherization services.[27] The Department has recommended in that proceeding that any expansion of the use of EEC funds for services other than passive efficiency should be strictly constrained. Discussion of the Department's Act 62 recommendations is included in the relevant portions of the Thermal and Transportation portions of this report. At a high level, the Department has recommended that with respect to electrification efforts, EVT should play a supporting role to the DUs that have clear responsibility for these efforts as a result of Tier III of RES. Additionally, the Department has put forward the following principles to guide decisions regarding energy service delivery issues:

- Emphasize sustainable pathways for market intervention, such as supply chain development over one-time interventions such as incentives;
- Energy services, and any collection of funds to support those services, should seek to lower the energy burden of all Vermonters, especially the low-income;
- Minimize cross-subsidies across fuel types and ratepayer classes;
- Ensure efficient rules and regulations that facilitate efficient coordination across service providers including energy efficiency utilities ("EEUs") and distribution utilities ("DUs") while keeping a single entity as the decision-maker to direct the course of service activity and ensure maximum statewide impact; and
- Foster inclusion and the establishment of private market actors that drive the economic proposition for efficiency.

The Department also continues to work with stakeholders to address the SHEI constraints. There are utility efforts to mitigate the issue; however, the cost of fully resolving the issue has continued to be prohibitively expensive to implement. In addition, the Vermont System Planning Committee is continuing to discuss potential solutions to generation-constrained areas on the distribution system. Particular focus has been on the ability to choreograph beneficial load such as electric vehicle charging and intermittent generation to minimize constraints caused by excess distributed solar. This group will continue to meet through 2020.

[27] See PUC Case No. 19-2956-INV.

V. Heating Sector

Overview

In 2016, the heating sector accounted for 27% of the greenhouse gas emissions. The total amount of GHG emissions will vary significantly depending on weather, with increased emissions during cold weather. Generally, the heating sector is doing relatively well on making progress toward the 2016 CEP goals, with approximately 27% of the heating fuel constituting renewable supply.

2016 Comprehensive Energy Plan Goals

The State has adopted several goals related specifically to thermal energy. The 2016 CEP established a goal of increasing the portion of renewable energy used for thermal energy of 30% by 2025. Vermont statute[28] contains thermal energy goals including the goal to weatherize 80,000 homes by 2020.

Energy Consumption in the Heating Sector

In 2016, the heating sector accounted for roughly 23% of Vermont's GHG emissions.[29] Thermal energy includes all the energy used in Vermont for heating of our homes, public buildings, commercial spaces, and for domestic hot water. Thermal energy is also used in manufacturing processes. Such industrial uses of heat are included in the data but are not broken out or discussed separately in this report.

In 2017, approximately 56,541 billion BTU of thermal energy was consumed in Vermont. [30] Total energy use was approximately 123,270 BBTU. It is important to note that there can be significant variability in thermal usage on a year-by-year basis, depending on weather. The amount of thermal energy required to heat homes during a mild winter will be noticeably less than during a particularly cold winter. Accordingly, looking at the total thermal energy used each year might not provide a meaningful illustration of the effects that weatherization and the installation of electric and wood heating systems are having on heating trends in Vermont. Figure 13 illustrates the connection between cold weather and consumption of fossil fuels for heating.

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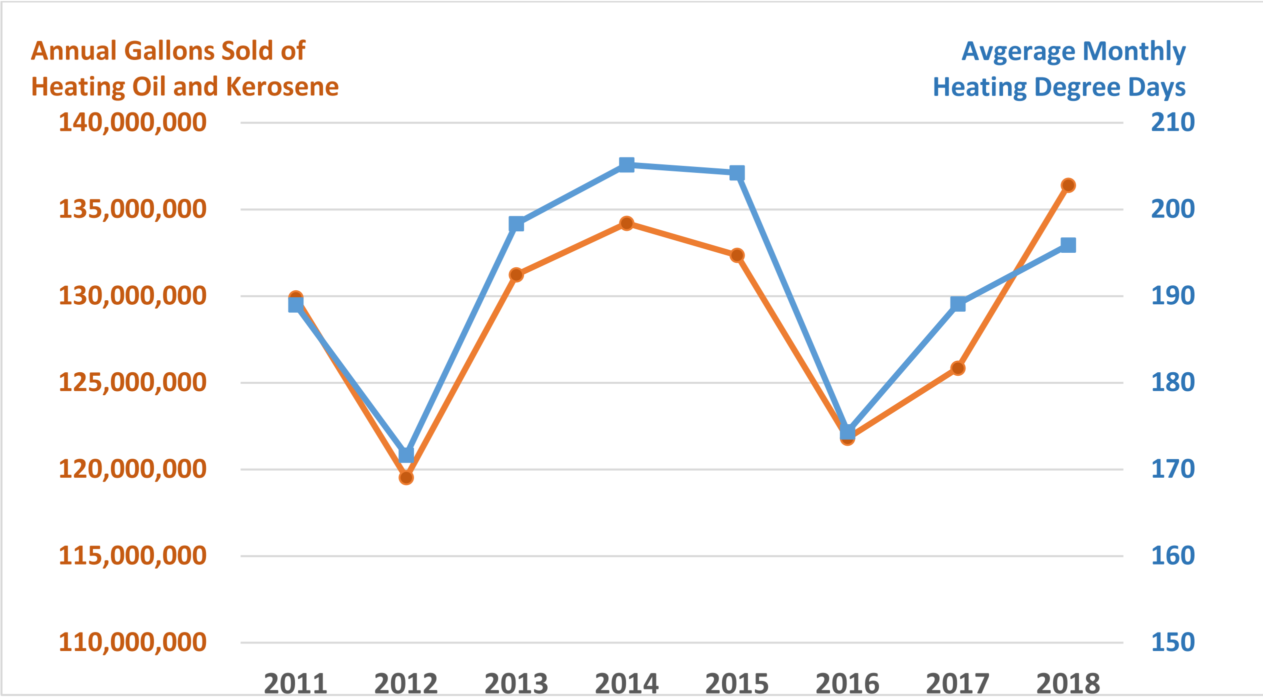
[28] 10 V.S.A. § 581.

[29] Vermont Air Quality and Climate Division, Department of Environmental Conservation, VERMONT GREENHOUSE GAS EMISSIONS INVENTORY AND FORECAST: BRIEF 1990 – 2016. (January 2020). Available at: https://dec.vermont.gov/air-quality/climate-change.

[30] The BTU data in the thermal section is based on 2017 data from EIA (as of Nov. 2019) updated with data compiled by the VT Energy Action Network gathered from: Vermont DMV on electric vehicles, heat pumps & electric resistance heating from EVT, and from PSD data on ISO system mix from 2017. The amount of BTUs reported for thermal uses does not include the electricity used for air conditioning but does include an estimate for the electricity used in heat pumps used for heating.

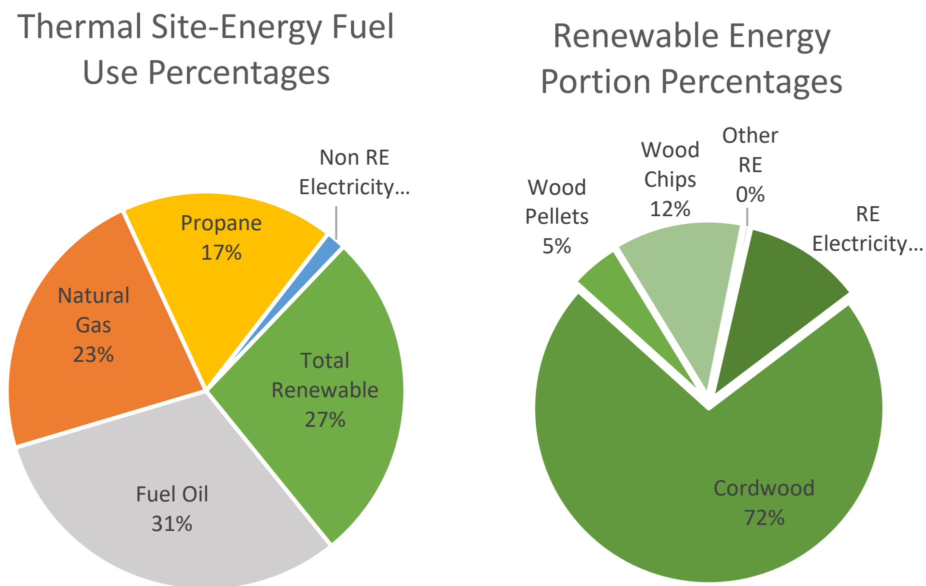
Figure 13: Correlation of Heating Degree Days and Heating Fuel Sales



Renewable Supply

Currently, the most significant source of renewable energy in the heating sector is from cordwood. Electric heating, primarily from heat pumps, is a distant second. Biofuels, including renewable natural gas, is currently playing a relatively small role, although it has the potential to increase over time.

Figure 14: Heating Fuel Source[31]



Advanced Wood Heating

Wood heat is currently the primary renewable supply source for the heating sector. Although the percentage of households using wood heat has decreased as compared to the 1980s, it has increased by nearly four percentage points since 1998.[32] Cordwood remains the most popular renewable fuel used for space heating in Vermont households. According to U.S. Census Data from the 2017 American Community Survey, 42,728 households (nearly one in six) in Vermont utilize wood as their primary home heating fuel.[33] A study completed for the Clean Energy Development Fund (CEDF) in 2017 suggests that the number is closer to 65,000 households.[34]

The 2016 Vermont Wood Heat Baseline Study completed for the CEDF found that wood heat (both traditional and advanced wood heat) accounted for 21% of total heating in Vermont, with 38% of households (96,951 individual households) using wood for at least part of their heat. Of these households, 31,051 (12% of households), heated in part with wood pellets.[35]

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[31] Based on 2017 EIA fuel (site energy) data (as of Nov. 2019) updated with data compiled by the VT Energy Action Network from EVT for electric vehicles, heat pumps & electric resistance heating, PSD for electrical system mix in 2017, and ANR 2018 data for wood use.

[32] Vermont Department of Forests, Parks and Recreation, *Vermont Residential Fuel Assessment for the 2017-18 Heating Season,* 2019.

[33] U.S. Census Bureau, *House Heating Fuel: 2012-2016 American Community Survey 5-Year Estimates*, Available at: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk.

[34] Biomass Energy Resource Center and VEIC, *Wood Heating in Vermont: A Baseline Assessment for 2016*, 2017. Available at: http://publicservice.vermont.gov/sites/dps/files/documents/Renewable_Energy/CEDF/Reports/AWH%20Baseline%20Report%20FINAL.pdf.

[35] Ibid.

Advanced wood heating (AWH) is defined as a space heating system that uses a boiler or furnace that meets the following conditions: 1) utilizes highly efficient combustion technology, 2) produces low levels of emissions, 3) supports healthy forest ecosystems, and 4) consumes local wood. For Vermont to meet its thermal goals it is important that all four of these conditions of advanced wood heating are built into program designs.

Currently there are over 600 AWH pellet boiler installations in Vermont. Of these installed systems, over 500 pellet systems were installed in residential settings, and over 100 pellet systems were in commercial and institutional settings. [36] This includes an increase of 225 pellet systems installed in Vermont over the past three years.[37]

Heat pumps

There are several types of heat pumps. The basic technology uses electricity to run a compressor to force the phase change of a gas and can be used for both heating and cooling. Heat pumps can use the ambient air outside of a building, called air-source heat pumps, or they can also use the constant temperatures underground, called ground-source heat pumps. There are also heat pump water heaters that are used similarly to electric water heaters but which are much more efficient. Heat pumps themselves are not a renewable energy technology but are dependent on the renewable portion of the power supply portfolio of the utility. For 2018 the average renewable portion of all Vermont utilities' power supply was 63% renewable, although this number varies by utility.

Improvements in heat pump technology have made them viable forms of heating in cold climates such as Vermont. These cold-climate heat pumps (CCHP) are the type that Vermont is installing to help increase our use of renewable energy and to meet our GHG reduction goals. CCHPs use 40-70% less electricity than the electric resistance heaters.

Even though ground-source heat pumps are even more efficient than CCHP, they have a high capital cost. Thus, Vermont is focused on the installation of air-source CCHP as a cost-effective measure to reduce fossil fuel usage and generate energy cost savings for Vermonters. As a result of efforts by the electric utilities in compliance with Tier III of the RES, and incentives for more efficient CCHPs by EVT, there has been considerable growth in the use of technology in the past five years.

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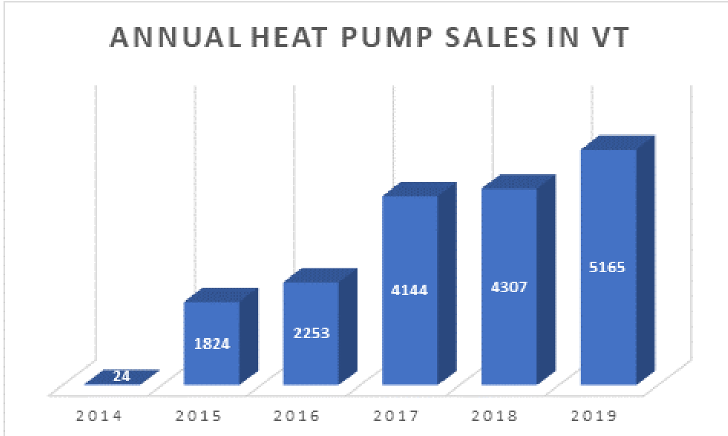
[36] "Wood Heating in Vermont: A Baseline Assessment for 2016" & CEDF program data.
[37] PSD data from CEDF incentive programs.

Figure 15: Heat Pump Sales in Vermont



Biofuels

Biofuels for heating— including biodiesel and renewable natural gas — offer a lower-carbon alternative to fossil fuels, with significant GHG savings and fewer emissions. While biodiesel is preferred to natural gas for heavy- and medium-duty applications, both biodiesel and natural gas are preferred over petroleum products.[38] Approximately 2% of heating oil sold in Vermont is biodiesel. The biodiesel is blended into heating oil by wholesalers, but the precise amount that is blended is not reported. Biodiesel can be blended with heating oil up to a certain percentage without changes in the equipment, and therefore can be used in existing oil boilers and furnaces. This provides the opportunity to lower fossil fuel usage with few (if any) new investments in specialized equipment, or infrastructure. Environmental concerns, including poor energy return on energy invested in oil crops, and questions about the climate change impact associated with some forms of biodiesel have make it a less attractive option.

In September of 2019 heating fuel vendors of the New England Fuel Institute voted unanimously in favor of a resolution to work toward a 15% reduction in carbon emissions by 2023, 40% by 2030, and net-zero carbon emissions by 2050.[39]

Renewable Natural Gas

Renewable natural gas (RNG) is a type of biofuel. It is derived primarily from waste streams that emit methane. Common sources are waste landfills or anaerobic digesters of farm and food waste). As methane is 28 times more potent as a GHG than carbon dioxide, processing it for use as a heating fuel has the dual benefits of destroying the methane and off-setting the use of fossil-fuels.

Vermont Gas Systems (VGS) is working to increase the amount of RNG in its gas supply. In November of 2019 VGS announced plans to increase its levels of RNG so that 20% of its supply mix for retail customers will come from RNG by 2030.[40]

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[38] Vermont Department of Public Service, *2016 Comprehensive Energy Plan*, at page 174.
[39] https://nefi.com/news-publications/recent-news/heating-oil-industry-commits-net-zero-emissions-2050/
[40] https://www.vermontgas.com/vgs-targets-elimination-of-greenhouse-gas-emissions-by-2050/

Prices

Prices for fossil fuels continue to be volatile with increases in the last two years from the historic lows of 2016, after the historic high prices of 2014. Figure 16 below shows the volatility of fossil fuel prices compared to other heating fuel options. This figure also shows the comparison of heating fuels on a dollar per BTU basis.

Figure 16: Comparison of delivered heat price & volatility[41]

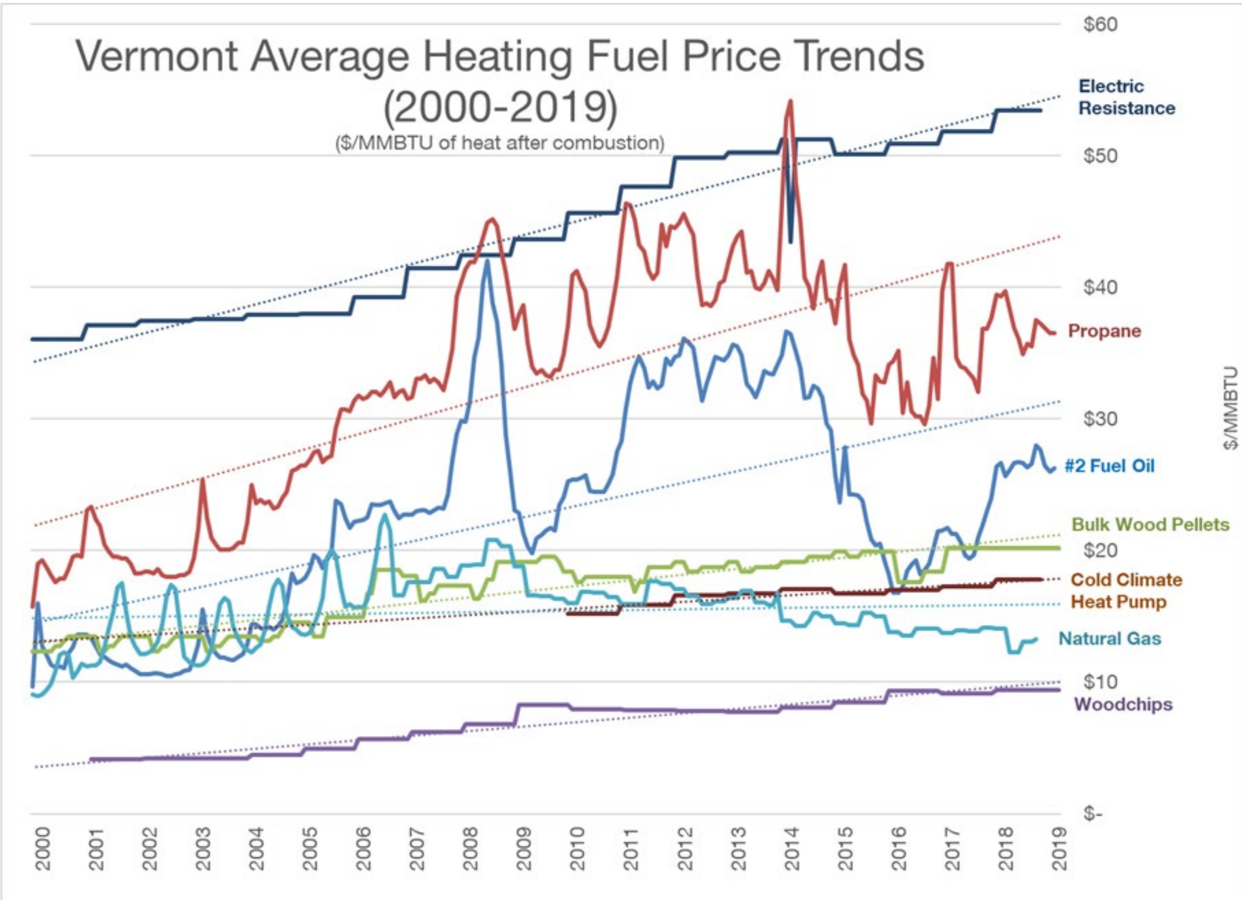

Figure 16 above shows the prices of delivered heat for different heating fuels over the last nineteen years. The prices in the chart account for the efficiency of the heating technology used and other costs, such as monthly service charges for electricity and natural gas. Figure 17 below shows the marginal cost (meaning the cost to purchase one additional unit of each fuel and thus does not include monthly service charges) for heat for the average residential customer in Vermont.

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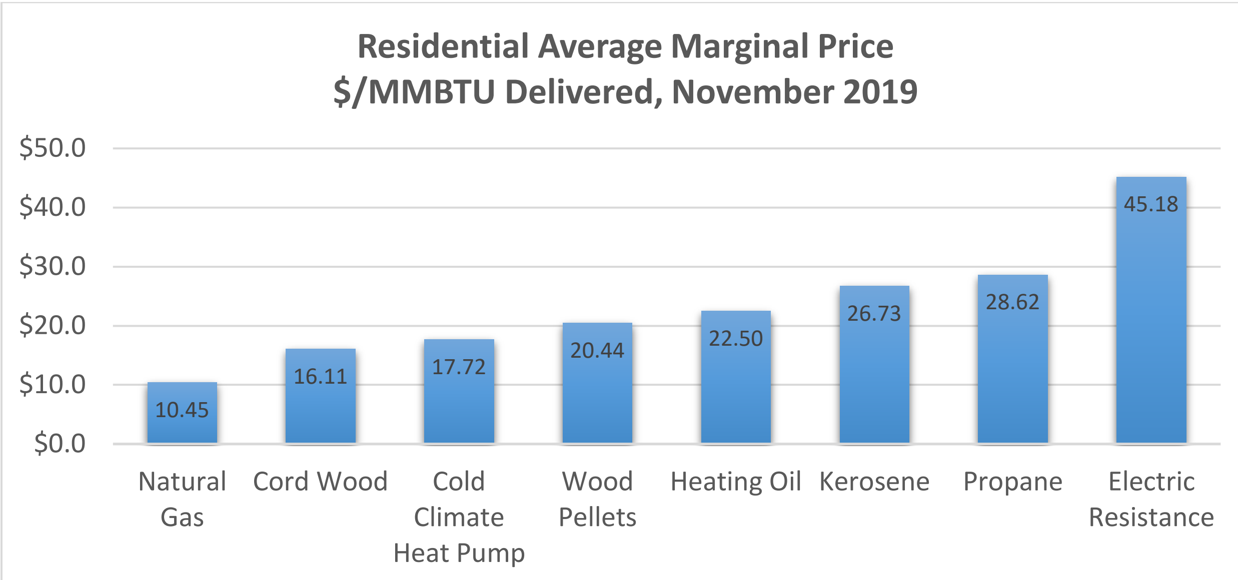
[41] Cost of delivered heat (site energy). The chart was compiled by VEIC for the PSD, using EIA, PSD, and VT Dept. of Forest, Parks and Recreation data.

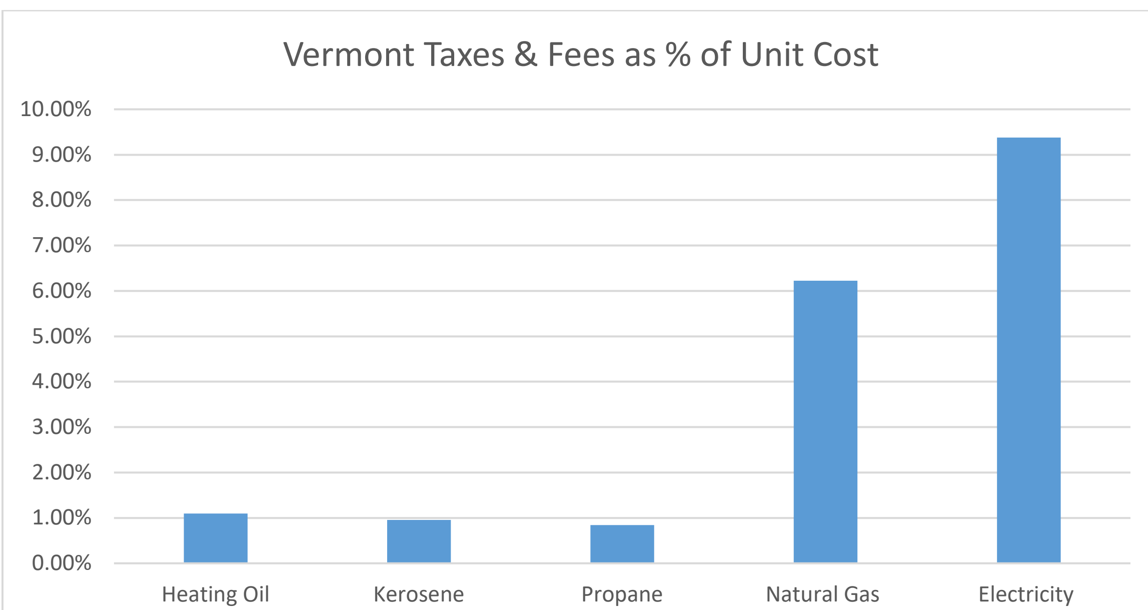
Figure 17: Average Marginal Price per MMBtu of Various Heating Technologies



Residential Heating Fuel Taxes

Vermont imposes several different taxes and fees on heating fuels, although cordwood, wood pellets and wood chips are not subject to taxes or fees. Figure 18 shows the taxes, as a percentage of the residential retail marginal price paid for electricity, natural gas, heating oil, and propane.

Figure 18: Taxes as Percentage of Unit Cost



Reduction in Energy Usage

Vermont's housing stock is, on average, composed of older buildings built at a time when very little attention was given to insulating and air sealing. Thus, there is a significant demand for weatherization in Vermont. However, the up-front costs associated with weatherization can be considerable, and although the investments are long-lived, low heating prices results in the payback for such investments being relatively long. To overcome this barrier there are several programs in Vermont to assist Vermonters in undertaking weatherization projects. There are four major funding sources for weatherization:

(1) Weatherization assistance funds, managed by the Vermont Office of Economic Opportunity;
(2) Funds received from the participation of Efficiency Vermont and BED in ISO-NE's Forward Capacity Market;
(3) Funds received from Vermont's participation in the Regional Greenhouse Gas Initiative (RGGI); and
(4) Energy efficiency charges paid by customers of Vermont Gas Systems (VGS).

On an annual basis, the Department provides a report to the PUC regarding building energy efficiency goals established in 10 V.S.A. § 581. The Department's December 2019 report concluded the following:

> The progress toward the building energy efficiency goals for the State as defined in 10 V.S.A. § 581(1) has been steady since 2008, but well below the rate necessary to achieve the 2020 goal of 80,000 homes. The average savings per home has also tracked slightly below the goal of 25% reduction in energy usage. At the end of 2017, only 42% of the 2017 interim goal of 60,000 comprehensive energy retrofit projects was achieved. The 27,186 project completions through 2018 represent only 41% of the 2020 goal of 80,000 homes. Given these results, it will not be possible to achieve the goal of 80,000 comprehensive energy retrofit projects by the end of 2020 (See Figure 1, below).
>
> The benefits to Vermont residents from the efforts to reach the goals of Section 581 have been substantial, measurable and will continue to pay dividends for decades to come. These benefits include reduced energy bills, increased employment in the energy efficiency sector and reduced greenhouse gas emissions, as well as the non-energy benefits of improved health, safety and comfort for the residents of participating homes.[42]

[42] 2018 ANNUAL REPORT ON VERMONT'S PROGRESS TOWARD BUILDING ENERGY FITNESS GOALS, at 4.

Figure 19: 2018 Weatherization Accomplishments Summary

	Comprehensive Retrofit Projects	Notes
Total Projects (# units served)	**1,777**	The total number of housing units counted toward the annual goal include all comprehensive projects completed through the five participating organizations (EVT, VGS, BED, OEO and 3E Thermal).
Average % Fuel Usage Reduction	**26%**	The average fuel usage reduction for projects completed. Does not include projects that span multiple years. Fuel use reductions are measured using actual fuel usage data when available and reasonable estimates when fuel usage data is unavailable.
Annual Carbon Emissions Reduction	**11,773,784 lbs. (5,887 tons)**	Carbon reductions use a uniform calculation method based on Federal standards published on the EIA website for fossil fuels, and Vermont Agency of Natural Resources values for electricity savings.
Incentive Costs	**$11,726,175**	Direct financial incentives to the homeowner or building owner.
Participant Costs	**$7,110,284**	Participant contributions to the cost of building improvements.
Total project Costs	**$18,836,459**	

Figure 20 below provides data for the past ten years regarding progress toward building efficiency goals.

Figure 20: Progress toward Section 581(1) goals

	Number of Comprehensive Retrofits Qualified Under 10 V.S.A. § 581(1)											
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**Program Total (as of 2018)**
EVT	298	480	644	952	1,132	1,162	1,081	821	834	653	581	8,638
BED	0	3	2	8	7	2	13	5	19	4	17	80
VGS	178	393	465	235	332	360	388	356	331	344	204	3,586
OEO/WAP	1,427	1,570	1,785	1,162	1,479	927	1,102	802	646	674	806	12,380
3E Thermal	0	0	63	813	381	215	190	129	205	337	169	2,502
Statewide Total (annual)	**1,903**	**2,446**	**2,959**	**3,170**	**3,331**	**2,666**	**2,774**	**2,113**	**2,035**	**2,012**	**1,777**	
Statewide Total (cumulative)	**1,903**	**4,349**	**7,308**	**10,478**	**13,809**	**16,475**	**19,249**	**21,362**	**23,397**	**25,409**	**27,186**	

Building Energy Codes

Throughout 2018 and 2019, the Department undertook an extensive public stakeholder engagement process to update Vermont's Building Energy Standards from the 2015 version. The new standards are the building energy codes for Vermont. The codes were approved in 2019 and took effect on January 1, 2020. There are two sets of building energy codes in Vermont, one for residential construction and another for all commercial buildings.

Updates to the Residential Building Energy Standards (RBES) included:

- Improved insulation levels
- Improved window U-values
- Air leakage testing required (blower door testing)
- Allows for cold climate heat pumps, all-electric homes
- EV charging infrastructure encouraged
- Solar ready design encouraged
- More high efficiency lighting
- More efficient ventilation fans

The Department is required to estimate the cost of complying with the new energy codes. The cost of building an average Vermont home will increase with the new requirements in the 2019 RBES, although the resulting energy savings will more than offset those increases. Complying with the 2019 RBES will increase costs by almost $5,000 but will save over $500 per year resulting.

The Department also updated the Commercial Building Energy Standards (CBES) in 2019. The improved codes took effect on January 1, 2020. As with the RBES the standards set minimum efficiency requirements for new and renovated buildings. The standards are designed to provide more reductions in energy use and emissions over the life of a building, when compared with a similar building constructed prior to the standards going into effect.[43]

One issue associated with building codes is the lack of infrastructure to enforce such codes. Compliance evaluations were completed to determine the percent of building projects (new construction and major renovations) covered under the codes that met the technical requirements of the codes. During the 2015 and 2016 period compliance with the residential code was reported to be 66% and for commercial projects compliance was reported to be at 90%.[44]

Thermal Clearinghouse Website

On November 1, 2019, the Department launched the Vermont Energy Saver website (https://energysaver.vermont.gov/), a new online tool to provide resources, links and practical advice to help Vermonters save energy and money be heating and cooling their homes and buildings more efficiently. The Vermont Energy Saver website offers suggestions for a variety of cost-effective projects that can be done with or without the help of a contractor. This includes information on water heaters, furnaces and other systems, correct usage of insulation materials

[43] For detailed information and copies of the 2019 Energy Codes visit the PSD's Energy Standards web page: https://publicservice.vermont.gov/content/building-energy-standards

[44] For the RBES Compliance Report: https://publicservice.vermont.gov/sites/dps/files/documents/VT%20SFNC%20Overall%20Report.pdf For the CBES Compliance Report: https://publicservice.vermont.gov/sites/dps/files/documents/2016%20VT%20Commercial%20Market%20Assessment%20Report_0.pdf

and new technologies to help reduce fossil fuel consumption. The website also includes information on accessing rebates, incentives and financing to assist Vermonters in making home heating improvements as well as health and safety information.

Recommendations

Tier III of the RES requires Vermont's utilities to take action to reduce fossil fuel consumption by their customers. Every utility offers some incentives for customers to switch to cold climate heat pumps and some utilities are offering incentives for wood pellet stoves as well. Washington Electric Cooperative, in recognition of its high electric rates, is focusing on offering weatherization services to its customers. Tier III is still in the relatively early stages of deployment, but the program has demonstrated success in incentivizing the transition to renewable heating.

The PUC's investigation under Act 62 expressly considered the use of the electric efficiency charge for the use of weatherization. The Department is strongly supportive of additional weatherization efforts; however, ever-increasing costs in the electric sector inhibit the transition to heat pumps and electric vehicles. The one limited area where the EEC should be used for weatherization is in those homes that are primarily heated with electricity, as the weatherization efforts there would decrease electric load and provide benefits to all ratepayers.

Moving toward more heating sources such as cold climate heat pumps and advanced wood heating not only reduces GHG emissions but also provides costs savings over heating oil and propane. However, the upfront cost of transitioning to a new heating system can be a barrier, particularly in a period of relatively low fossil fuel prices. Given the price volatility of fossil fuel prices it is important to ensure that there is sufficient time and available workforce to meet a swift increase in demand for thermal efficiency and renewable heating options if a significant and sustained increase in fossil fuel prices occurs.

VI. Transportation

Overview

Transportation represents the largest category of Vermont's total energy consumption. According to the Vermont Agency of Transportation's (AOT) 2019 Transportation Energy Profile,[45] approximately 5.9% of the energy consumed in the transportation sector was renewable.

2016 Comprehensive Energy Plan Goals

The 2016 CEP transportation goal is to increase the share of renewable energy in the sector to 10% by 2025. These goals can be met in a variety of ways including, but not limited to, increased fuel economy of internal combustion engine vehicles, the adoption of Electric Vehicles, increased use of public transit, increased use of alternative transportation, e.g. walking and biking, actions that decrease single-occupancy vehicle trips such as making park-and-ride lots available.

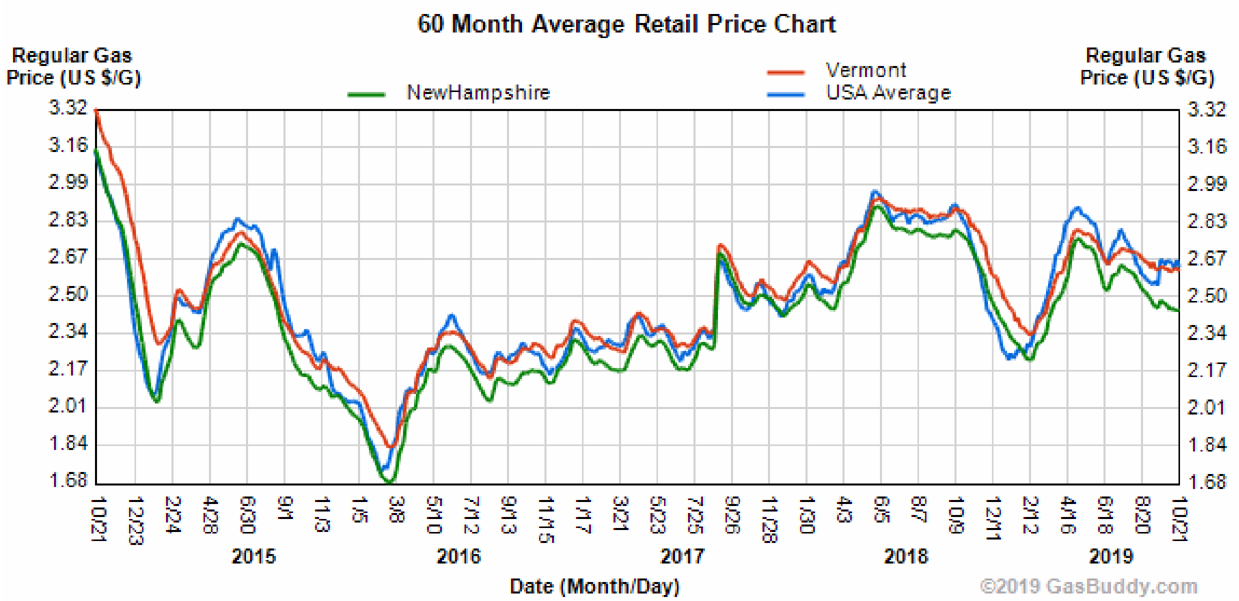
There has been limited progress in meeting the State's transportation related energy and climate goals. Renewable energy accounts for approximately 5.5% of energy in the transportation sector. The 5.5% is largely due to the presence of ethanol in gasoline that is purchased at the pump, but some percentage can be attributed to the EVs that are registered in the State. Additionally, while the average miles-per-gallon efficiency of vehicles statewide continues to increase, the per-capita vehicle-miles-traveled figure continues to rise. These factors provide competing pressures on the amount of energy consumed in the transportation sector in Vermont.

Prices

Gasoline prices have been more stable in 2019 than prior years, but show significant volatility over time.

[45] https://vtrans.vermont.gov/sites/aot/files/planning/documents/planning/The%20Vermont%20Transportation%20Energy%20Profile_2019_Final.pdf

Figure 21: Gasoline Price Comparison 2014-2019[46]



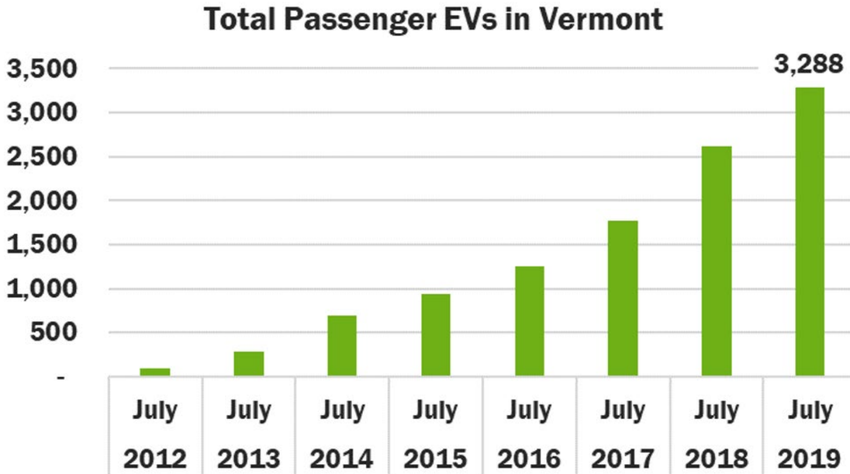
Renewable Energy Supply

The most promising pathway for advancing renewable energy in the transportation sector is by transitioning away from internal combustion engines toward electric vehicles. Every electric utility in Vermont is now offering electric vehicle incentives for EVs through Tier III of RES. Ultimately, consumers must make the decision to purchase an EV and the incentive program only helps to reduce the upfront costs of the purchase. In addition to environmental and economic factors, vehicle choice involves distance traveled, size of family, and a wider range of models suitable to Vermont's conditions, including higher road carriage and the need for all-wheel drive.

Electric vehicle registrations in Vermont continue to grow. As EVs can be powered renewably, the percent of renewable energy consumed in the transportation sector is expected to grow alongside growth in EVs. The figure below shows the growth in registrations over the past several years.

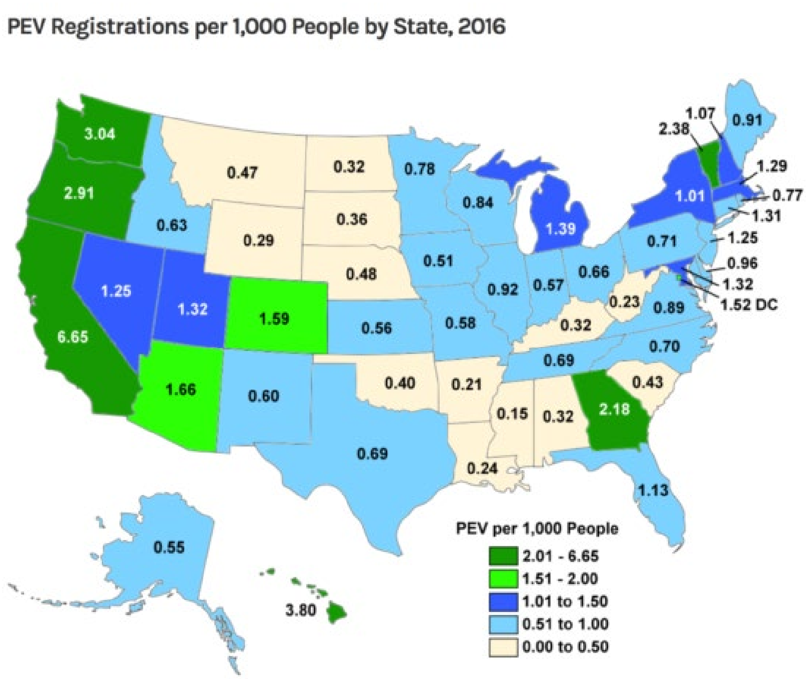
[46] Gas Buddy, Available at: https://www.gasbuddy.com/Charts?_ga=2.132332301.283721332.1547499799-1117221985.1547499799.

Figure 22: EVs Registered in Vermont, 2012-2019



The figure below shows EV registrations by state by population; Vermont has the fifth highest rate of EV adoption in the nation. Growth in the Vermont EV market is influenced by national shifts in EV prices, range, and variety of models, including pickups and all-wheel drive vehicles.

Figure 23: EV Registrations in U.S.[47]



[47] Source: https://cleantechnica.com/2017/11/24/top-state-us-electric-vehicle-concentrations-california/

While electrification for Vermont's light-duty fleet is growing in popularity, electrification of heavy duty transportation presents greater challenges. Improving GHG emissions for this portion of the industry can be met in part by shifting freight to rail. In addition, there are many heavy- and medium-duty applications for which no electric or rail options are available. In those applications, alternative fuels—including biodiesel, ethanol, and compressed or liquefied natural gas—offer a lower-carbon alternative to gasoline and diesel, with significant GHG savings and fewer emissions. While biodiesel is preferred to natural gas for heavy- and medium-duty applications, both biodiesel and natural gas are preferred over traditional liquid petroleum fuels.[48]

Because biodiesel can be blended with diesel and used in existing medium and heavy vehicles, biodiesel in particular offers a unique opportunity to reduce the GHG emissions of Vermont's vehicle fleet without investing in specialized vehicles, equipment, or infrastructure. With respect to ethanol, the environmental concerns, including poor energy return on energy invested, and questions about the associated climate change impact make it a less attractive option when compared to other biofuels. Compressed and liquefied natural gas also offer GHG savings compared to gasoline and diesel, but are currently a non-renewable resource. If adopted, the use of renewable natural gas in transportation will count toward meeting Vermont's sectoral goal of deriving 10% of its energy use in transportation from renewable sources by 2025 and 80% by 2050.[49]

Electric vehicles, including electric buses, are growing in popularity as the range of such vehicles increases and the upfront costs decline. Costs are expected to continue to decline and EV adoption will continue to rise. The graphic below shows the declines in the cost of lithium-ion batteries, one of the major cost drivers for electric vehicles, over the past several years. Model availability and variety are anticipated to drastically increase over the next few years. A majority of auto manufacturers have announced plans to produce more EV models, e.g. SUVs and pick-up trucks, and some have even announced goals to discontinue internal-combustion engine vehicles.[50]

There are several electric bus purchases planned within Vermont. With the assistance of federal grants administered by VTrans, Green Mountain Transit is in the process of acquiring three full-size electric busses that will operate in Chittenden County. Through a separate funding process, two smaller electric shuttle buses are expected to begin operating in Washington County within the next year.

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[48] 2016 CEP at 174.
[49] Ibid.
[50] See Ford's announcement here: https://www.reuters.com/article/us-autoshow-detroit-ford-motor/ford-plans-11-billion-investment-40-electrified-vehicles-by-2022-idUSKBN1F30YZ and GM's announcement here: https://www.nbcnews.com/business/autos/gm-going-all-electric-will-ditch-gas-diesel-powered-cars-n806806.

Electric Vehicle Charging Stations in Vermont

A major issue for larger-scale adoption of EVs in Vermont will be ensuring sufficient opportunities for charging the EV outside of the home. Although most of the charging for EVs currently occurs at the residence, increased adoption, particularly by renters and those who have longer commutes, will require a sufficient charging infrastructure in Vermont.

As of October 21, 2019, there are approximately 236 publicly available charging stations in Vermont, which is a significant increase from the approximately 160 that were available in December of 2017:

- 11 locations with Level 1 charging, which charges at approximately 1.4 kW power and provides 5 miles of range per hour of charging;
- 132 locations with Level 2 charging, which charges at approximately 3-7 kW and provides roughly 10 to 20 miles of range per hour of charging; and
- 23 DC Fast Chargers, which charge at 25-120 kW and generally takes 30 minutes to provide an 80% charge.

The Drive Electric Vermont program (supported by AOT, ANR, BGS, and PSD, as well as private philanthropy) keeps track of the publicly available charging stations in Vermont and maps them statewide.

Reduction in Energy Consumption

Electric vehicles are inherently more efficient than internal combustion engines. For example, an all-electric VW Golf travels roughly four times the distance of a gasoline powered Golf for the equivalent energy from gasoline. A plug-in hybrid typically falls in between these ratings. However, there are other methods of reducing energy consumption within the transportation sector, as described below.

Vehicle Type in Vermont

The composition of Vermont's vehicle fleet can have a significant impact on both the energy consumed in the transportation sector and the GHG emissions associated with the energy consumed. Vehicles powered by alternative fuels, such as electricity or compressed natural gas (CNG), are often more efficient and have significantly lower GHG emissions. This statement is especially true for electric vehicles when they are powered by renewable resources. The table below shows the composition of Vermont's vehicle fleet by fuel type. Recent trends include an increase in plug-in electric vehicles (PEV), which includes both all-electric (AEV) and plug-in hybrid electric vehicles (PHEV), as well as hybrid electric vehicles (HEV) fueled by gasoline alone. Table 12 below shows the quarterly composition of the vehicle fleet in Vermont since 208.

Figure 24: Composition of Vermont Vehicle Fleet, 2008-2019[51]

Year	PEV		Propane/CNG	Diesel	Gasoline	
	AEV	PHEV			ICEV	HEV
2008	N/A	N/A	75	32,140	578,881	4,656
2009	N/A	N/A	69	30,724	528,930	5,473
2010	N/A	N/A	59	25,932	524,810	5,877
2011	N/A	N/A	51	28,513	550,711	7,056
2012	48	140	48	38,684	541,872	7,693
2013	130	466	43	28,209	516,339	7,945
2014	197	670	43	29,879	525,199	9,242
2015	248	865	44	31,239	533,118	9,895
2016	330	1,192	43	31,213	533,021	10,676
2017	381	1,387	47	30,205	532,370	10,901
2018	1,010	1,975	37	30,699	546,340	12,027
2019	1,256	2,032	34	31,107	547,199	12,077

Average fuel economy is another important metric for Vermont vehicles. The federal Corporate Average Fuel Economy (CAFE) standards support increases in the average MPG as older, less efficient vehicles are retired. The table below shows this increasing Miles per Gallon (MPG) trend over the last several years. Additionally, the EPA established the Miles per Gallon Equivalent (MPGe) standard for vehicles that do not use liquid fuels. The MPGe rating for a vehicle represents the number of miles the vehicle can travel using the same amount of energy that is contained in a gallon of gasoline.[52] The table below does not incorporate the MPGe rating of vehicles that do not use liquid fuels.

[51] Vermont Agency of Transportation, THE 2019 VERMONT TRANSPORTATION ENERGY PROFILE, 2019. Available at: https://vtrans.vermont.gov/sites/aot/files/planning/documents/planning/The%20Vermont%20Transportation%20Energy%20Profile_2019_Final.pdf.
[52] US Environmental Protection Agency, ELECTRIC VEHICLES – LEARN MORE ABOUT THE NEW LABEL. Available at: https://www.epa.gov/fueleconomy/electric-vehicles-learn-more-about-new-label.

Figure 25: Fuel Economy Vehicles Registered in Vermont, 2011-2019[53]

Year	Registered Vehicles	Average City MPG	Average Highway MPG	Combined MPG
2011	586,422	18.1	24.2	20.3
2012	578,415	18.4	24.5	20.7
2013	552,665	18.7	24.8	20.9
2014	564,591	19.1	25.3	21.4
2015	589,608	19.5	25.6	21.8
2016	591,864	19.8	25.9	22.1
2017	596,783	20.1	26.1	22.2
2018	592,237	20.4	26.4	22.6
2019	593,877	20.5	26.5	22.7

Public Transit

Public transit saves money for consumers and can be less energy-intensive that single-occupancy vehicles, especially on high volume routes. The Agency of Transportation periodically develops a public transit policy plan[54] and expends around 5% its transportation budget[55] on the capital and operating needs of the state's eight public transit providers.[56] The Vermont Agency of Transportation develops and maintains several transportation demand management (TDM) related programs, including public transit, bike and pedestrian, park and rides, and rail. While the TDM program's ultimate goal may not be energy efficiency, many of the strategies and actions taken in pursuit of TDM also achieve energy efficiency in the transportation sector. Below is an overview of each TDM related program that VTrans administers with links to additional resources maintained by VTrans.

> Transit Overview:
> The Public Transit Section of the Vermont Agency of Transportation (VTrans) provides financial and technical assistance to transit districts, transit authorities, municipal transit systems, and non-profit public transit systems. This function is carried out through the administration of state and federal programs relating to general public transportation and transit programs specific to the needs of senior citizens and persons with disabilities. $37 million was dedicated from the Transportation Fund for this purpose in FY2020. This also includes funding for commuter programs, such as Go Vermont.[57] For more information on this topic please see the Vermont Public Transit Policy Plan at: https://vtrans.vermont.gov/planning/PTPP.

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[53] Vermont Agency of Transportation, THE 2019 VERMONT TRANSPORTATION ENERGY PROFILE, 2019. Available at: https://vtrans.vermont.gov/sites/aot/files/planning/documents/planning/The%20Vermont%20Transportation%20Energy%20Profile_2019_Final.pdf.
[54] Available at: https://vtrans.vermont.gov/planning/PTPP.
[55] https://vtrans.vermont.gov/sites/aot/files/portal/documents/aboutus/capprog/20a/FY20AsPassedBudgetHighlights.pdf
[56] 2016 Comprehensive Energy Plan, at 148.
[57] For more information see: https://www.connectingcommuters.org/

Bike and Pedestrian Overview:
VTrans also delivers a Bicycle and Pedestrian (BP) Program that selects projects through a grant program which funds municipally managed bicycle and pedestrian infrastructure projects. BP also scopes studies to plan for those projects, and directly funds several others. The goal of the BP program is to support projects that complete critical gaps in local pedestrian or bicycle networks, and/or solve a critical safety problems. The budget also identifies any spending earmarked for safety education. Funding for this program in FY2020 via the Transportation Fund is approximately $14.7 million; current allocations decline over time. For more information, please see: https://vtrans.vermont.gov/highway/local-projects/bike-ped.

Rail Overview:
VTrans oversees a rail program that is charged with maintenance activities and upgrades on 305 miles of active rail lines that are owned by the State of Vermont. The state is responsible for 172 rail bridges and over 400 public highway rail crossings. The state also has two Amtrak passenger service routes that it supports financially. These services run on both privately and publicly owned railroads. For more information, please see: https://vtrans.vermont.gov/rail.

Park and Ride Overview:
Vermont is home to 30 state-owned park and ride lots (including 6 with EV charging stations) and over 60 municipal lots.[58] The Park and Ride Program includes the development, assessment, and upgrade of park and ride facilities, coordination with transit providers, and other public information services.[59]

The following chart outlines the 2016 CEP Transportation Goals and the most recent current status update. It also outlines the average annual change that must occur to be on track to reach the CEP goals. For example, to reach the 2016 CEP goal of tripling the number of state park-and-ride spaces, at minimum, 146 spaces must be added each year between 2018 and 2030. This represents an objective, albeit limited gauge for progress toward achievement of the transportation goals outlined.

[58] https://vtrans.vermont.gov/sites/aot/files/planning/documents/planning/VTrans-2018-FactBook-web.pdf
[59] https://vtrans.vermont.gov/sites/aot/files/highway/documents/ltf/2016%20P%26R%20Annual%20Report%20rev.%2001-17-17.pdf

Figure 26: 2016 CEP Transportation Objectives and Current Status

Goal	Goal (Numerical)	Year	Current Status	Source	Requirement to Reach CEP Goals
Triple the number of state park-and-ride spaces	3,426	2030	1,525 (2017)[60]	CEP Transportation Goals (2016)	Add 1901 spaces, adding at least 146 spaces each year.
Increase public transit ridership by 110%	8.7 million annual trips	2030	4.71 million annual trips (2016) 4.69 million annual trips (2017)[61]	CEP Transportation Goals (2016)	Increase ridership by 4.01 million annual trips, adding 308,462 trips each year.
Quadruple Vermont-based passenger rail trips	400,000 annual trips	2030	92,422 annual trips (2016) 145,746 annual trips (2017)**?[62]	CEP Transportation Goals (2016)	Increase rail trips by 254,254, adding 19,558 passenger rail trips each year.
Double the rail freight tonnage in the state	13.2 (based on 2011 figure) million tons	2030	7.3 million tons (2014) 6.7 million tons (2017)[63]	CEP Transportation Goals (2016)	Add 6.5 million tons of rail freight, adding 500,000 tons each year.
Increase the percentage of the vehicle fleet that are EVs	10% of the vehicle fleet	2025	0.3% (2016) 0.6% (2019)	CEP Transportation Goals (2016)	By 2025, an additional 9.4% of vehicles should be EVs, increasing the percentage of EVs in the fleet by 1.21% each year.
Increase the number of medium and heavy-duty vehicles powered by renewable energy	10% of vehicles	2025	None*** A 2009 study estimated Vermont's transportation biodiesel use at approximately 76,000 gallons, or 0.02% of the total transportation fuel portfolio in 2008 (White, 2009).	CEP Transportation Goals (2016)	By 2025, an additional 9.98% of medium and heavy-duty vehicles should be powered renewably, increasing from our current percentage at a rate of 1.25% a year.

[60] Vermont Agency of Transportation, *2018 Fact Book and Annual Report*, Available at: http://vtrans.vermont.gov/sites/aot/files/planning/documents/planning/VTrans-2018-FactBook-web.pdf
[61] Ibid.
[62] Ibid.
[63] Ibid.

Recommended Policies

Progress towards our renewable energy goals can occur in a linear or exponential fashion. Conceptually, the linear approach suggests more early-stage state action whereas an exponential approach relies more heavily upon technological or market developments to drive change. There are positive and negative aspects of both approaches. For example, a linear approach may be more costly than would otherwise be needed to reach a goal, while an exponential approach can cost less but leaves more of the progress up to market innovation that may or may not succeed. The best path forward is an appropriate balance between these two approaches.

Of the three major categories of energy use, Vermont has made the least progress towards our transportation-related goals. Having said that, Vermont has been working diligently towards reducing GHG emissions as well as increasing the share of renewable energy in the transportation sector. The Department and the Agencies of Commerce and Community Development, Natural Resources, and Transportation have been working to set the policy stage for EV adoption in Vermont.

The Department advocated for a Public Utility Commission led process to consider many factors related to increasing EV adoption in VT. This resulted in an EV investigation (Docket 18-2660-INV). The Commission also, at the request of the legislature, undertook a separate investigation looking at EV specific tariffs and whether those tariffs should include per-kWh infrastructure and efficiency assessments.[64] More specifically, it has been clarified through legislation that owners and operators of EV charging stations that sell electricity to the public on a per-kWh basis will not be regulated as a utility, publicly available EV charging stations must display prices to consumers prior to the initiation of a charging session, and that publicly available EV charging stations will be subject to the Agency of Agriculture Farm and Markets Weights and Measures jurisdiction.[65]

Rate design is an important opportunity for Vermont distribution utilities to ensure EV charging costs are both reasonable and responsive to grid conditions. Responsiveness could take the form of price signals or direct load control by the DUs. The ability to shift a majority of EV charging to certain times minimizes negative impacts on the electric grid and can facilitate grid integration of other flexible loads and intermittent generation.

The PUC’s Act 62 proceeding has considered the use of the EEC for efforts in the transportation sector. In recognition of the negative price signals that an increased EEC sends for EV deployment, the Department has recommended that the EEC collected from EV charging be used for transportation supply chain management, but not direct incentives for EVs.

Another policy development is the recent agreement by 12 states within the Northeast and Mid-Atlantic Region, including Vermont, to develop a regional transportation-fuels cap-and-invest policy proposal through the Transportation and Climate Initiative. A draft MOU was developed

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[64] Dockets 18-2660-INV and 19-3009-INV. The final report for Docket 18-2660-INV contains many suggested actions and is available here: https://puc.vermont.gov/sites/psbnew/files/doc_library/Electric%20vehicles%20report.pdf.

[65] See Act 59 (the Transportation Bill) of the 2019-2020 Legislative Session for further details.

by participating states and the Governors of each state will be asked to sign onto the MOU in the spring of 2020. At that point each state will decide whether and how to adopt and implement the policy in its own jurisdiction. For further information, please visit the Transportation and Climate Initiative's website at: https://www.transportationandclimate.org/.

Appendix A - Summary of Energy Services & Programs Provided in Vermont

The Public Utility Commission (PUC), in its August 9, 2019 Order in Case No. 19-2956-INV, accepted the offer of the Public Service Department (Department) to compile an initial summary of energy programs currently delivered to Vermont customers. The information provided below is intended to be a *start* to the conversations necessary to ensure a successful process. Consistent with the PUC Order, other topics will be addressed later in the proceeding, after stakeholders are grounded in current program offerings available. These include identification of gaps as well as advantages and disadvantages of individual programs, delivery methods, or funding. With the goal of ensuring 19-2956-INV provides as many benefits as possible to Vermont energy service and program customers, the Department aspires to provide an objective summary that will not prejudice future discussions.

The programs described below are created by statute, and/or funded with direct allocation of taxpayer or ratepayer dollars.[66] Thus, it may not represent all Vermont activity in a particular area. For example, fuel dealers may provide biofuel blends or biomass heating systems, or contractors may offer trainings outside of those funded by the programs below. The below summaries are organized in the following topic areas: Electric Efficiency, Thermal Energy, Electrification, Electric Load Management, Intermodal Transit, and Cross-cutting. Some programs may include services in multiple topic areas; they are generally summarized once instead of repeated.

A short summary is provided for each program. The program summary is not intended to be a comprehensive description of all activities undertaken by the program, rather it is intended to provide sufficient information to describe the program and direct the reader to locations where more detail can be found. To the extent available, the following information is provided for each program: current delivery agent(s), core services, enabling statute(s) if any, funding source (and amount if known), equity considerations (e.g., low-income, geographic, etc.) and identification of relevant links and materials for more information. Under the "Cross-Cutting" section, information is also provided about economic programs designed to assist Vermont's most vulnerable populations. These offerings are important context when considering the overall delivery of energy services in Vermont.

Finally, the Department notes that programs that support renewable electricity generation are not summarized in this document; changes to such programs are largely outside of the scope of this proceeding. However, it is important to consider how the state's current (and future) energy service program delivery structure interacts with the state's development of renewable energy. This is particularly true with the net metering program, which enables customers to self-generate electricity.[67]

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[66] This includes programs whose allocations are directed by statute and the PUC, as well as other means.

[67] PUC Rule 5.100 contains is the current net-metering rule. Portions of this rule are under review in PUC Docket No. 19-0855-RULE.

Electric Efficiency

Energy Efficiency Utilities

The Vermont Legislature has long required that regulated utilities include “comprehensive energy efficiency programs” as part of their responsibility to deliver services to their customers at least cost, under 30 V.S.A. § 218c. Electric efficiency programs and services are currently delivered primarily through energy efficiency utilities (EEUs) that have been appointed by the PUC. The EEU’s are funded to design and deliver technical, financial, and educational services to help Vermonters overcome barriers to improving the energy efficiency of their homes, businesses, institutions, and municipal facilities. The EEUs provide financial support to retail customers, distributors, and wholesalers, as well as technical assistance across a wide variety of electric technologies, to improve the efficiency of electric consumption across sectors. The EEUs are authorized by 30 V.S.A §209(d).

The City of Burlington Electric Department (BED) is appointed to provide electric energy efficiency services in its electric service territory and VEIC is appointed to operate as Efficiency Vermont (EVT) to provide electric energy efficiency services for the remainder of the state. Where services overlap, BED and EVT coordinate delivery of service to BED customers. The Department provides evaluation, measurement, and verification services to ensure claimed savings materialize.

Electric Efficiency Programs are funded by electric ratepayers through the Energy Efficiency Charge (EEC) on their bills. The EEC is set by the PUC to collect monies sufficient to fund the three-year budgets adopted following the Demand Resource Plan Proceeding. Table 1 identifies the 2018-2020 approved budgets (including Resource Acquisition, Development and Support Services (DSS), Department evaluation funds, and items such as the Fiscal Agent’s expenses.)

Table 1: 2018-2020 Electric Energy Efficiency Charge Budgets

EEU EEC Budgets	2018	2019	2020
EVT	$50,944,146	$51,106,595	$51,403,668
BED	$2,632,256	$2,804,805	$2,825,080
Total	**$53,576,402**	**$53,911,400**	**$54,228,748**

Title 30, § 209(d)(3)(B) requires the PUC establish and adjust energy efficiency charges in order to realize all reasonably available, cost-effective energy efficiency savings, with due consideration to rate impacts and several policy priorities. It requires that the PUC balance a number of considerations when setting the energy efficiency charge, including “providing the opportunity for all Vermonters to participate in efficiency and conservation programs; and targeting efficiency and conservation efforts to locations, markets, or customers where they may provide the greatest value.” The PUC’s three-year performance targets for EVT and BED have minimum spending and equity requirements for residential, commercial, small business, and low-income customers.

Links:

EVT https://www.efficiencyvermont.com/
BED https://www.burlingtonelectric.com/
Department https://publicservice.vermont.gov/content/efficiency
PUC https://puc.vermont.gov/energy-efficiency-utility-program (including links to current governing documents such as Order of Appointments and "Process and Administration of an Order of Appointment")

Customer Programs

The PUC has established three types of programs that qualifying customers can use to manage energy efficiency projects on their own, without going through Efficiency Vermont. Participation criteria vary; however, customers wishing to self-administer energy efficiency must submit an application to the PUC for approval.

- Energy Savings Accounts (ESA) and Energy Savings Accounts Pilot: customers paying an average annual Energy Efficiency Charge of at least $5,000 may apply to the Commission to self-administer energy efficiency through an energy savings account. In addition, Act 150 of 2018 authorized the PUC to create the ESA Pilot. Participants continue to pay their EEC and may receive that total amount back to cover the costs of energy projects, including technical support, evaluation, measurement, and verification. It is a three-year pilot, not to exceed $2 million in diverted EEC contributions. Eligible projects include electric and thermal efficiency, energy productivity, demand reduction, and storage.
- Commercial and Industrial Customer Credit Program: The Commercial and Industrial (C&I) Customer Credit Program specifically targets large commercial and industrial electric customers desiring greater control over energy-efficiency expenditures at their facilities. This program recognizes that certain commercial and industrial customers in Vermont are committed to—and possess considerable expertise in—energy efficiency. Currently there are no participants. To be eligible to participate, the customer must have:
    - Never accepted financial incentives from a Vermont utility-sponsored efficiency program; and
    - Demonstrated a commitment to pursuing cost-effective energy efficiency on its own.
- Self-Managed Energy Efficiency Program (SMEEP): Transmission and industrial electric ratepayers[68] may apply to implement electric and fuel energy efficiency measures on their own, provided certain conditions are met. The ratepayer must have (1) at least $1.5 million in Energy Efficiency charges during calendar year 2008 or 2017; (2) a comprehensive management program with annual objectives or achievement of certification under ISO standard 14001; and (3) commitment to an annual average investment in energy efficiency and energy productivity programs of $500,000 if using 2017 or $1,000,000 if using 2008 as a baseline for EEC charges. An eligible ratepayer may participate in SMEEP instead of participating in services or initiatives offered by

[68] Or the predecessor-in-interest at the served property.

Vermont Energy Efficiency Utilities and would be exempt from the EEC on its bills. There are currently two SMEEP participants.

Links:

PUC: https://puc.vermont.gov/energy-efficiency-utility-program/eeu-customer-programs

State Energy Management Program

Authorized by Act 58 of 2015, the Vermont Department of Buildings and General Services has leveraged services from Efficiency Vermont to develop and deploy an internalized energy saving performance contracting model for taxpayer benefit through the State Energy Management Program (SEMP). The program's intent is to accelerate, for State buildings and facilities, energy management measures, implementation of efficiency and conservation, and the use of renewable energy resources. Efforts are being made to expand this model to address other segments of the institutional or MUSH (municipal, universities, schools, and hospitals) community through creation of a municipally based energy management program.

Thermal Energy

Vermont Gas Systems – Heating and Process Fuel Efficiency

Vermont Gas Systems (VGS) has been offering efficiency services for over 20 years. It was more recently appointed by the PUC to serve as the natural gas EEU in its service territory. VGS offers both residential and commercial energy efficiency programs for new and existing buildings.

The VGS Residential Retrofit Program primarily focuses on higher density users: homes that use at least 50,000 BTUs per square foot per year for heating. The utility provides free comprehensive energy audits, rebates for a portion of the installed costs of the recommended measures, and a zero-interest or low-interest loans. VGS also offers an equipment replacement program, with rebates for hot air furnaces, hot water boilers, and water heaters, among other measures. Customers below the 50 kBTU/sq. ft./year threshold are eligible for a one hour-walk through focused on education and engagement of the customer around their energy usage, or the customer could be referred to EVT's Home Performance with ENERGY STAR (HPwES) program.

For commercial buildings, VGS offers an equipment replacement and retrofit program. VGS conducts free energy audits, offers technical assistance, zero-interest or low-interest loans for energy efficiency improvements, and rebates for certain equipment.

The Vermont Gas Efficiency Programs are funded by the EEC on gas ratepayer bills, as set by the PUC following the Demand Resource Plan Proceeding process. Table 2 describes the currently approved budgets for Vermont Gas.

Table 2: 2018-2020 Vermont Gas Efficiency Budgets

	2018	2019	2020
Vermont Gas	$3,386,237	$3,515,838	$3,576,991

Equity Considerations: 30 V.S.A § 209(d)(3)(B) requires the PUC balance a number of considerations when setting the energy efficiency charge including "providing the opportunity for all Vermonters to participate in efficiency and conservation programs; and targeting efficiency and conservation efforts to locations, markets, or customers where they may provide the greatest value." To reach lower income customers, VGS works closely with Champlain Valley Office of Economic Opportunity ("CVOEO").

Links:
VGS https://www.vermontgas.com/save-money-energy/energy-efficiency-programs/
Department https://publicservice.vermont.gov/content/efficiency
PUC https://puc.vermont.gov/energy-efficiency-utility-program (including links to current governing documents such as Order of Appointments and "Process and Administration of an Order of Appointment")

Efficiency Vermont and Burlington Electric Department – Heating and Process Fuel Efficiency

Beginning in 2010, revenues from the Regional Greenhouse Gas Initiative and Vermont's electric efficiency savings portfolio participation in the Forward Capacity Market have been directed to EVT and BED for the purpose of developing unregulated fuel energy efficiency services. Thermal efficiency services (weatherization services) are offered to homeowners (for existing homes) and to owners of small businesses, multifamily residences, residential rental properties, and mixed-use buildings. EVT and BED coordinate these programs with activities funded through the electric energy efficiency charge; these have included residential and commercial new construction programs and heating system incentives. EVT also provides training, quality assurance, and marketing assistance for contractors, and maintains a statewide network of certified energy-efficiency service contractors on its website.

In addition to building weatherization services as described above some of the Thermal Energy and Process Fuel (TEPF) funds are directed to non-weatherization services. EVT's Business Existing Facilities programs may include snowmaking upgrades, maple sap reverse osmosis, heat recovery and space heating controls, ventilation improvements, HVAC system optimization, burner controls, industrial process heat recovery, and steam trap repair and replacement. Efficient Products programs may include heat pump water heaters, smart thermostats, and low-E storm windows, as well as do-it-yourself home weatherization products for insulating and air sealing. BED has little potential in this space because its territory significantly overlaps with VGS territory, and TEPF funds are prohibited from being used for regulated fuel customers, however a recent statutory change enables BED to use TEPF funds for district heating if possible.

Title 30, § 209(e) directs funding to Thermal and Process fuel efficiency. The Order of Appointments for BED and EVT describe each EEUs' responsibilities. Table 3 below shows funding for EVT and BED resource acquisition programs.[69] In addition (and not reflected in Table 3) Act 62 allocated up to $2.25 million of electric efficiency charge funds and $350,000 of

[69] VGS Existing Homes and Non-Weatherization related budgets are shown for reference, they are not additional to budgets in Table 2.

General Funds to EVT's Existing Homes programs (directed toward customers between 80-140% Area Median Income).

Table 3: Thermal and Process Fuel Efficiency EEU Budgets			
	2018	**2019**	**2020**
EVT TEPF Existing Homes	$4,500,000	$5,973,477	$5,648,840
VGS EEC Weatherization	$1,040,112	$1,085,194	$1,090,971
EVT Business Existing Facilities	$2,500,000	$1,964,650	$1,844,390
EVT Business New Construction	$100,000	$85,350	$80,610
EVT Residential New Construction	$200,000	$156,825	$148,110
EVT Efficient Products	$1,700,000	$819,698	$778,050
BED	$103,300	$105,228	$107,347
VGS	$1,184,573	$1,235,914	$1,242,496

PUC three-year performance targets for EVT, BED, and VGS include equity minimum spending requirements for sector, small business, and low-income customers.

Links: See above links for electric efficiency, under Section I.A.

Weatherization – Low-income

Vermont's Weatherization Assistance Program (WAP) was created by 33 V.S.A. § 2502 and is administered by the Office of Economic Opportunity (OEO). Its mission is "to help low-income Vermonters save energy, thus money, by improving the energy efficiency and health and safety of their homes." The Weatherization Assistance Program was started in 1976, with funding initially provided by the U.S. DOE. This federal funding was augmented in 1990, when Vermont established a permanent source of state funding through the creation of the Vermont Weatherization Trust Fund, now called the Vermont Home Weatherization Assistance Program Fund (HWAP).

Title 33, § 2503 establishes a fuel tax[70] that currently yields about $10.3 million in revenue. 100% of funds go to the Home Weatherization Assistance Program Fund. In addition, the program receives approximately $1,000,000/year from the U.S. DOE Weatherization Assistance Program.

Services, which are 100% funded by the program, include:

- Comprehensive "whole house" assessment of energy-related problems;
- State-of-the-art building diagnostics, including blower door, carbon monoxide, and heating system testing and infrared scans; and
- "Full-service" energy-efficient retrofits, including dense-pack sidewall insulation, air sealing, attic insulation, heating system upgrades and replacements.

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[70] $0.02 per gallon on the retail sale of heating oil, propane, kerosene, and other dyed diesel fuel delivered to a residence or business.
0.75 percent gross receipts tax on the retail sale of natural gas and coal.
0.5 percent gross receipts tax on the retail sale of electricity.

To participate, households must meet income eligibility guidelines listed by the OEO. These are currently 200% of the federal poverty level or less (DOE guidelines), or 80% of the state's median income or less (HWAP guidelines). Eligibility is determined at each regional WAP office.

Low income equity minimum spending requirements are part of PUC three-year performance targets for EVT, BED, & VGS, and each EEU coordinates with the WAP.

Links:
VT WAP - https://dcf.vermont.gov/benefits/weatherization

Clean Energy Development Fund (CEDF) – Advanced Wood Heating

In 2005, the Vermont General Assembly established the Vermont Clean Energy Development Fund (CEDF) through Act 74 (30 V.S.A. § 8015). In recent years, the Fund has focused on advanced wood heating initiatives. The CEDF has budgeted over $1.2 million in fiscal year 2020 to incentivize installations of advanced wood heating. This includes incentives for automated pellet boilers for heating of residential, institutional, and commercial buildings, as well as for residential change-outs of old non-EPA certified stoves for new efficient stoves certified to meet EPA's new 2020 stove standards. The CEDF is also offering $350K in grants to businesses in support of the supply side of local bulk pellet heating market.

The CEDF is deploying approximately $400,000 American Recovery and Reinvestment Act (ARRA) funds, returned from borrowers of an ARRA Loan Fund program, to support the installation of wood heating in low-income Vermonter's homes.

The CEDF does not have on-going funding to continue its wood heating incentive programs. Thus, CEDF funding should not be counted on for future market transformation impacts.

The CEDF works cooperatively with EVT's TEPF Existing Homes program that also provides residential and commercial incentives for automated pellet heating systems as well as for pellet and cord wood stoves for homeowners. EVT's wood heating incentives also include enhanced incentives for low-income Vermonters.

Links: CEDF https://publicservice.vermont.gov/renewable_energy/cedf

Electrification

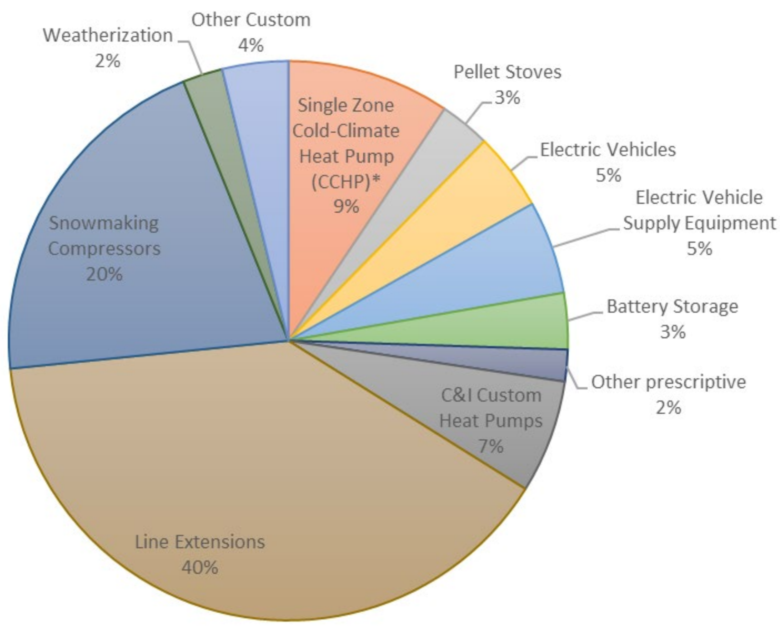
Renewable Energy Standard – Tier III programs

30 V.S.A. § 8004 establishes the Renewable Energy Standard, and § 8005 defines the three tiers: Tier I covers utility-scale renewable generation, Tier II is for distributed renewable generation and Tier III sets goals for "energy transformation." Tier III requires utilities to acquire MWh*e* (Megawatt hour equivalent) savings of 2% of DUs retail sales in 2017, increasing by an additional two-thirds of a percent each subsequent year.[71] Broadly, energy transformation projects are those that reduce fossil fuel consumed by customers of a distribution utility (DU), including by electrification of thermal energy systems. Increases in distributed renewable energy generation above RES Tier II requirements are also eligible. Tier III Requirements have been

[71] The requirement for distribution utilities serving less than 6,000 customers began in 2019.

met mainly with electrification measures, although it is important to note that Weatherization measures are explicitly identified as eligible measures, and some utilities offer incentives for Weatherization or electrification occurring in a home that has met certain building criteria. The DUs to date have funded programs, through upstream or direct incentives as well as technical assistance, to promote cold-climate heat pumps, electric vehicles, electric buses, EV charging stations, battery storage, line extensions to diesel generator-powered maple syrup producers and lumber mills and other custom projects that reduce fossil fuel use. The cost of the Tier III programs is embedded in DU rates. Figure 1 provides a summary of primary Tier III measures implemented by the DUs in compliance with Tier III for 2018, by percent of total savings. Custom measures dominated the profile.

Figure 1: 2018 Tier III Savings Profile



Links: See Utility Tier III Plans and Tier III Compliance Reports available via ePUC

Electric Vehicles

Vermont has authorized funding to support vehicle electrification, in addition to Electric Vehicle Rebates and Electric Vehicle Supply Equipment (EVSE) incentives provided by DUs under their Tier III obligations. Section 34 of the 2019 Transportation Bill (Act 59 of 2019) established two programs for income-qualified Vermonters. Section 34 authorizes $2,000,000 (and requires the use of at least $1,100,000) to support an incentive program for the purchase or lease of new plug-in electric vehicle (PEVs), as well as for a high-fuel-efficiency used-vehicle incentive and an emissions-system repair program. VTrans is currently building these programs with anticipated launch dates around the middle of Fall 2019.

In addition, approximately $2.8 million in grants are available to expand Vermont's network of EVSE. Grant proceeds come from partial settlements of Volkswagen's violations of the Clean Air Act. Funds are available until they are fully invested and may be disbursed until October 2027. The availability of this funding is contingent upon the Trustee's approval of funding requests made by the Agency of Natural Resources and the subsequent transfer of funds. For more information visit the [VW Environmental Mitigation Funds web page](). Approximately $800,000 has been spent to date. It is anticipated that the remaining funds will be spent on building out the State's backbone of Direct Current Fast Charging stations.

VTrans, with the assistance of federal funding, has also pursued the purchase of electric buses. Two full-size buses and two cutaway buses are expected to begin operating in the short term, and VTrans is expected to continue to pursue the electrification of public transit as funding allows.

In addition to direct incentives, each year the Agencies of Natural Resources and Transportation along with the Department allocate funding to support the Drive Electric Vermont program. This program offers education and outreach services to consumers in Vermont, as well as technical assistance to municipalities, Regional Planning Commissions, and the State. Last year, the Agencies provided approximately $70,000 to Drive Electric Vermont (DEV). The Department's contribution has historically come from State Energy Program funds. DEV also maintains a website that includes a map of all the publicly available EV charging stations in the State.

Electric Load Management

Load Management, including Storage

Load management is enabled by the foundational Advanced Metering Infrastructure (AMI, or smart meter) investment made by utilities. Investment costs are defrayed by American Recovery and Reinvestment Act (ARRA) grant funding. More than 80% of the state's meters are now digital. Using AMI in conjunction with data analytics and other emerging control and communications platforms, the utilities, their customers, and/or third parties can actively manage customer loads .across residential, commercial, and industrial sectors. This reduces system costs. Utilities are also examining and, in some cases, implementing rate design solutions that enable customers to actively respond by reducing their demand in response to price signals. Examples of such solutions include time-of-use rates, smart rates, and even energy use feedback, as discussed below).

For example, BED's packetized energy management pilot program controls water heating devices. This helps balance energy supply and demand in real time, while enabling BED to evaluate whether or not coordinating energy consumption of equipment in people's homes can better balance the supply of generation and demand for electricity, reducing costs while improving service to customers. Washington Electric Cooperative's (WEC) "Powershift" pilot, jointly implemented with EVT, aims to test the ability of cold climate heat pumps and water heaters to shift load during peaks and other high cost times, by using two different control platforms to aggregate and dispatch resources. Green Mountain Power (GMP) is piloting the use of distributed energy resources to use controllable load to manage fluctuating demands in the commercial and industrial sector, for example using thermal or ice storage or load shifting.

GMP aggregates distributed energy resources to reduce demand through pilots such as this as enabled by its multi-year rate plan, tariffs, RES Tier III programs, and other capital projects. To manage these resources, it employs several cloud-based, shared-access control platforms to connect to these resources. The resources are, then aggregated and dispatched, to reduce system peaks. One platform is used to manage the fleet of heat pumps, water heaters, EV chargers, and non-Tesla battery storage systems. A proprietary Tesla software is used to manage the Tesla Powerwall (residential-scale) and Powerpack (utility-scale) resources.

Utility funding for load management initiatives is embedded in utility rates, and based upon whether the service provides a net benefit. Many of GMP's pilot programs use a shared-cost, shared-value approach. For example, in the Powerwall pilots, customers pay a fixed monthly price (e.g., $15/month) for access to the storage capability during outages. This defrays the cost to GMP of deploying the systems that, when aggregated, are dispatched to reduce system peaks for the benefit of all customers. Software platforms, licensing fees, device integration, administrative costs, and any API[72] fees are incorporated into the overall program delivery cost. The structure of such categories and costs can vary, from annual subscription fees to per battery fees, depending on the vendor, the number of resources connected, and other variables.

To the extent that there are net benefits to these measures, there are generally not specific equity considerations for these programs as currently designed. A VLITE[73] grant supported deployment of 100 Powerwall systems free of charge to low-income customers with significant need for backup power reliability due to health and mobility issues.

Links:
WEC PowerShift: https://www.efficiencyvermont.com/powershift
BED Packetized Energy Program https://burlingtonelectric.com/hotwater
GMP's Multi-Year Regulation Plan https://greenmountainpower.com/regulatory/filings/2019-multi-year-regulation-plan/
Department report on Energy Storage https://publicservice.vermont.gov/content/energy-storage-report-pursuant-act-53-2017

Rate Design

Rate design can set the foundation for customers' engagement with regulated fuel service delivery. Historically rate design has been used to send a strong conservation price signal through inclining block rate designs and high usage charges. In broad terms Vermont residential consumers receive a retail price signal that typically range from 16 to 23 cents per kWh (lower for some municipalities), even while the direct costs of underlying wholesale products and bulk transmission services are range between 7 and 8 cents per kWh.

Vermont utilities have historically offered special prices to customers in exchange for load control. As mentioned above, utility managed or controlled loads, including load management

[72] API is generally a set of functions and procedures allowing the creation of applications that access the features or data of an operating system, application, or other service

[73] VLITE (Vermont Low Income Trust for Electricity) was created when Central Vermont Public Service and GMP merged in 2012. A significant ownership interest in VELCO was transferred by CVPS to VLITE. As an owner of VELCO, VLITE receives dividend income from VELCO ownership - estimated at $1 million per year to "fund projects and initiatives that further the energy policies of the state of Vermont." https://vlite.org/

hold the potential to minimize system costs. Many Vermont utilities have offered some form of water heater-controlled load program. GMP offers various forms of dynamic prices to both residential and commercial customers. BED offers a deeply discounted Electric Vehicle charging rate in exchange for some measure of load control. Vermont Gas offers interruptible rates to commercial and industrial customers. All utilities rely on demand charges to encourage conservation of commercial and industrial customer peak loads. Three utilities extend those charges to residential customers.

The Department is beginning a process that will, over the next 9 months, work with utilities and stakeholders to examine more advanced forms of retail price signals to encourage a more dynamic environment aimed at reducing system costs (including GHG emissions), while also spurring beneficial electrification and potentially new business models and players. These commercial providers and market participants, including building contractors and financial institutions, play a key role in the delivery of managed load and energy programs and services, as they provide capital, retail products, and contractor services.

Intermodal Transit

Public Transit

The Public Transit Section of the Vermont Agency of Transportation (VTrans) provides financial and technical assistance to transit districts, transit authorities, municipal transit systems, and non-profit public transit systems. This function is carried out through the administration of state and federal programs relating to general public transportation and transit programs specific to the needs of senior citizens and persons with disabilities.

Title 24, § 126 charges VTrans with the following goals:

> (1) Provision for basic mobility for transit-dependent persons, as defined in the public transit policy plan of January 15, 2000, including meeting the performance standards for urban, suburban, and rural areas. . .
>
> (2) Access to employment, including creation of demand-response service.
>
> (3) Congestion mitigation to preserve air quality and the sustainability of the highway network.
>
> (4) Advancement of economic development objectives, including services for workers and visitors that support the travel and tourism industry. . . .

$37 million was dedicated from the Transportation Fund for this purpose in FY2020. This also includes funding for commuter programs, such as Go Vermont. Go Vermont is a "one-click/one-call" resource for efficient transportation options throughout Vermont, offering an automated carpool matching service, subsidized vanpools, and program support for the Way to Go! School challenge and regional Transportation Management Associations (TMAs). Funds are used to invest in technologies such as trip planners and the Automated Vehicle Location services. Financial support is provided to Local Motion, Vermont Energy Education program, and other organizations who support efficient transportation programs and approaches. Fiscal Year 2020 budget for Go Vermont is $800,000.

Links:

Vermont Public Transit Policy Plan
https://vtrans.vermont.gov/sites/aot/files/planning/documents/planning/PTPP%20Draft%20Report_Existing%20Conditions_8-14.pdf

www.govermont.org

Bike & Pedestrian

VTrans delivers a Bike/Ped (BP) program that selects projects through a grant program which funds municipally managed bicycle and pedestrian infrastructure projects. BP also scopes studies to plan for those projects, and directly funds several others. The goal of the BP program is to support projects that complete critical gaps in local pedestrian or bicycle networks, and/or solve a critical safety problems. The budget also identifies any spending earmarked for safety education.

Funding for this program in FY2020 via the Transportation Fund is approximately $14.7 million; current allocations decline over time.

Links:

https://vtrans.vermont.gov/highway/local-projects/bike-ped

Rail

VTrans oversees a rail program that is charged with doing maintenance activities and upgrades on 305 miles of active rail lines that are owned by the State of Vermont. The maintenance activities are mainly focused on overall upgrade projects; the state is responsible for172 rail bridges and over 400 public highway rail crossings. The state also has two Amtrak passenger service routes that it supports financially. These services run on both privately and publicly owned railroads.

Budgeted funding for rail in FY 2020 is:

- Funds spent only on railroad freight lines (no passenger use); $17,103,339
- Funds spent only on passenger services and support projects for passenger services; $9,175,000
- Funds spent on rail lines that support both freight and passenger service; $9,550,526

Cross-Cutting

Building Energy Standards

Vermont has both residential (RBES) and commercial (CBES) building energy standards. The residential energy code has been in effect since 1997, the commercial energy code since 2007. Both standards are based on the widely used International Energy Conservation Code (IECC), produced by the International Code Council. The IECC is updated every three years, and

Vermont statute[74] calls for an energy code update process to begin promptly thereafter. The update process consists of review of the new IECC and presentation and discussion of its new provisions at public and stakeholder meetings, to gather recommendations for Vermont-specific modifications. These modifications to the IECC are then adopted through the state rulemaking process. The Department also adopted the first Vermont residential stretch code, which went into effect December 1, 2015. The Department was given the authority to adopt a residential stretch code through Act 89, passed in 2013. Act 89 defines stretch code as "a building energy code … that achieves greater energy savings than the RBES" (the base code). There is no requirement for the code to achieve a certain percentage of greater efficiency. Act 89 also required that the stretch code apply to all Act 250 projects, and it can also be adopted by municipalities. The Department has also developed Commercial Stretch Energy Guidelines, which will be used by the Natural Resources Board for commercial Act 250 projects.[75]

Additionally, the residential stretch code and commercial stretch energy guidelines have electric vehicle charging requirements. These include having a socket capable of providing either a Level 1 or Level 2 charge for up to 4% of the total parking spaces (the percentage varies in the commercial guidelines based on the type of facility).

The Department funds the code update process through State Energy Program[76] allocations. There is typically an increase in cost to construct new buildings to meet each revised version of the building energy standards. There may also be a cost to builders, architects, and others in the building sector to get up-to-date on new standards. EVT has budgeted funds for the 2018-2020 performance period for energy standards related work. This includes hosting the Energy Code Assistance Center, distributing energy standards materials, and hosting trainings on the standards.

Links:
Department webpages on Building Energy Standards - https://publicservice.vermont.gov/content/building-energy-standards

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[74] *See* 30 V.S.A. § 51, Residential Building Energy Standards, stretch code; 30 V.S.A. § 53, Commercial Building Energy Standards

[75] Vermont's Land Use and Development statute (Act 250) provides a quasi-judicial process for reviewing the environmental, social, and fiscal impacts of major subdivisions and developments in Vermont. Developments subject to Act 250 must meet an energy efficiency criterion, which states: "A permit will be granted when it has been demonstrated by the applicant that … the planning and design of the subdivision or development reflect the principles of energy conservation and incorporate the best available technology for efficient use or recovery of energy." The Act 250 process tends to address developments of significant new buildings and building complexes, so it presents an excellent opportunity to assure quality construction and energy systems.

[76] The Department serves as the Vermont State Energy Office under the U.S. Department of Energy, State Energy Program. The State Energy Program provides funding and technical assistance to states, territories, and the District of Columbia to enhance energy security, advance state-led energy initiatives, and maximize the benefits of decreasing energy waste. SEP emphasizes the state's role as the decision maker and administrator for program activities within the state that are tailored to their unique resources, delivery capacity, and energy goals. For more information see https://www.energy.gov/eere/wipo/state-energy-program

LIHEAP

Title 33, § 2604 created the Home Heating Fuel Assistance Program, known as the Low Income Home Energy Assistance Program (LIHEAP). LIHEAP assists households with low incomes, particularly those with the lowest incomes that pay a high proportion of household income for home energy, primarily in meeting their immediate home energy needs. It provides federally funded assistance in managing costs associated with home energy bills; energy crises; and weatherization and energy-related minor home repair.

Congress established the formula for distributing funds to grantees based primarily on each state's weather, fuel prices, and low-income population. Home energy is defined as a source of space-heating or space-cooling in residential dwellings. Grantees can use funds for heating and/or cooling costs as well as up to 15 percent of their funding (or 25 percent with a waiver) for weatherization assistance. In Vermont, while 15% of funds are used for weatherization assistance, revenues are replaced with revenue from the Weatherization Assistance Program Fund (see Section II.C, above) to cover LIHEAP administrative costs that are above the federal administrative cost cap. Participants' gross household income must be equal to or less than 185% of the federal poverty level, based on household size, regardless of the resources (e.g., savings, retirement accounts, property). Federal Funding for FY 2019 is $20,446,280.

Energy Assistance Program

There are currently two Energy Assistance Programs (EAPs) that assist lower-income Vermont households in affording their energy needs. The programs are available to GMP and VGS customers. GMP customers that have gross monthly household income at or below 150% of the federal poverty level will receive a 25% discount on their customer and energy charges each month. VGS customers that have a gross monthly household income at or below 185% of the federal poverty level will receive a 20% discount on their natural gas bill.

Links:
Agency of Human Services, Department for Children and Families -
https://dcf.vermont.gov/benefits/eap

Green Mountain Power
https://greenmountainpower.com/help/billing-payments/what-is-the-energy-assistance-program-eap/

Vermont Gas Systems
https://www.vermontgas.com/save-money-energy/energy-efficiency-programs/assistance-programs/

Federal Incentives

The Business Investment Tax Credit (ITC) is available for commercial entities that invest in renewable energy. The table below summarizes the technologies that are eligible as well as the credit percentage available based upon investment dates.

Table 1: Business Investment Tax Credit Eligibility and Percentage

Technology	12/31/19	12/31/20	12/31/21	12/31/22	Future Years
Solar PV, Solar Water Heating, Solar Space Heating/Cooling, Solar Process Heat	30%	26%	22%	10%	10%
Large Wind	12%	N/A	N/A	N/A	N/A

The Renewable Electricity Production Tax Credit is an inflation-adjusted, per-kilowatt-hour (kWh) tax credit for electricity generated by qualified energy resources and sold by the taxpayer to an unrelated person during the taxable year. The duration of the credit is 10 years after the date the facility is placed in service for all facilities placed in service after August 8, 2005. The tax credit amount is $0.015 per kWh in 1993 dollars for some technologies and half of that amount for others. The Internal Revenue Service (IRS) publishes the inflation adjustment factor no later than April 1 each year in the Federal Registrar.

Renewable energy equipment can qualify for accelerated rates of depreciation under the Modified Accelerated Cost-Recovery System. Equipment placed in service before January 1, 2018 can qualify for 50% bonus depreciation. Equipment placed in service during 2018 can qualify for 40% bonus depreciation and equipment placed in service during 2019 can qualify for 30% bonus depreciation.

The Residential Renewable Tax Credit was initially available to other forms of renewable energy. However, since 2016 it has only been available to solar thermal and photovoltaic installations. The percent available is listed below and decreases in the out years.

- 30% for systems placed in service by 12/31/2019
- 26% for systems placed in service after 12/31/2019 and before 01/01/2021
- 22% for systems placed in service after 12/31/2020 and before 01/01/2022

State Incentives

The State sets the rate at which net-metering facilities are compensated for the power they produce. The PUC and the PSD review these rates on a biennial basis and the rates have been decreasing over the past several years and are expected to continue to decrease. Net metering is compensated at a rate of up to 18.9 cents/kWh whereas utility projects, Standard Offer projects or bilateral contracts all come in around 10-13 cents/kWh. These above market reimbursement rates represent an incentive for net metering facilities.

The State has also set up the Standard Offer program which offers a certain amount of capacity to renewable projects on an annual basis. The allocations are conducted via an auction, which is designed to leverage competition to bring prices to near or at market values. However, resources that are successful in the auction are offered long-term contracts, which provides a certain amount of stability and predictability that functions like an incentive.

Vermont Small Hydropower Assistance Program

In June 2019, the Department received its first application under the Vermont Small Hydropower Assistance Program (VSHAP) for evaluation of the viability of a potential small hydropower project adjacent to the Putney General Store. Pursuant to the VSHAP program guidelines, staff from the Department, Agency of Natural Resources, and Agency of Commerce and Community Development evaluated the Step 1 application form, and in August, the group visited the site in person to gather additional information. Following the site visit, Department staff compiled comments from the Agencies related to potential cultural and natural resource issues that would need to be addressed in the state and federal permitting processes. The applicant is in the process of evaluating next steps.

Appendix B - Relative Cost of Carbon Reduction Methodology

Measures Included

The measures analyzed in the model include these actions using data for 2018 purchases and installations:

- Electric Vehicles
  - All-Electric Vehicles
  - Plug-in Hybrid Electric Vehicle
  - Electric School Bus
  - Electric Transit Bus
- Electric Efficiency Measures—Efficiency Vermont Portfolio Average
- Cold-Climate Heat Pump
- Weatherization
  - Market Rate
  - Low Income
- Renewable Generation
  - New Net-Metering Installation (5 kW Example)
  - New In-State Solar Qualified Under Tier II of Vermont's RES (4.9 MW Example)
- Advanced Wood Heating
  - Pellet Stove
  - Pellet Furnace
  - Pellet Boiler
- Heat Pump Water Heaters

Important Notes

- The model was completed with best available data.
- The input values used are a ***snapshot in time***, meaning they do not reflect future prices or changes in incentive levels.
- The model **does** include directly attributable economic costs to the participant and the utility, including the incentive cost.
- The model ***does not*** quantify health benefits, comfort, or economic impacts, such the number jobs created. These societal benefits are excluded because reliable estimates are not available for all measures.
- The model ***should be used to give a sense of scale and rough ordering of measures*** *and* ***should not be used for exact numbers***.

About the Cost Effectiveness Test

When conducting cost-effectiveness analysis, there are several different perspectives that can be applied. Each perspective is designed to answer slightly different questions, such how taking a specific action provides a net benefit (or cost) to the individual participant, to other ratepayers, or to society at large. An overview of the tests is provided in the US EPA's National Action Plan for Energy Efficiency.[77]

This model's approach is similar to a total resource cost test, which compares the program administrator and customer costs with overall resource savings.

The test uses the quantifiable costs and benefits associated with a specific measure to analyze cost effectiveness. A result that shows benefits outweighing costs, i.e. a negative cost benefit ratio, doesn't necessarily mean that the individual consumer will be better off or that a consumer will invest in that measure absent incentives as the benefits may not accrue back to the consumer. For example, the societal cost test for net metering includes an energy benefit for the utility, however, this is not likely to be a motivating factor for consumers. The model also estimates the program administrator test for each program or policy. This cost test demonstrates the cost per ton of carbon avoided given an assumed incentive level. For example, AEVs will be analyzed based on an incentive level plus an adder to estimate program administration costs which is then divided by the total tons of carbon avoided to demonstrate the cost per ton avoided for that incentive.

The model first calculates the total carbon reduction associated with each measure over the assumed measure life. The specifics vary for each measure. As an example, for EVs the model calculates the average carbon emissions of the internal combustion engine vehicle that is displaced by a consumer purchasing an EV. Then, if necessary, the model calculates the total carbon emissions from the measure itself over the measure life and reduces the carbon reduction amount calculated in the first step by this amount. For all of the programs and policies in this model, with the exception of energy efficiency, the model does not account for free-ridership (those people who would have taken the particular action being incentivized regardless of the inventive) or spillover (actions not incentivized by a particular program or policy, but that were taken as a result of the program or policy existing). These two steps provide the total tons of carbon that are assumed to be reduced for each measure.

The model then calculates the readily quantifiable costs and benefits of each measure for each year of the measure life and performs a net-present value calculation to evaluate those figures in today's dollars. This provides the total cost (or benefit) that is then divided by the total tons of carbon avoided to arrive at cost ($) per ton of carbon avoided for each measure. Two specific measures were written up below to provide examples of the how the calculations work.

EV Calculations

The calculations for electric vehicles start by estimating the amount of fossil fuels the vehicle is assumed to offset. This is accomplished by dividing annual miles traveled by the assumed efficiency of the vehicle. Then a carbon coefficient is applied to the amount of fossil fuel based on the fuel type of the vehicle being displaced in order to calculate the amount of carbon emission avoided. Next, the model calculates the emissions associated with the increased electricity consumption of the EV. This calculation divides the annual miles traveled by the

[77] Available at: https://www.epa.gov/sites/production/files/2015-08/documents/cost-effectiveness.pdf

electric efficiency of the vehicle to generate the electricity consumption (in number of MWh) per year. Then that number is reduced by the utilities' assumed fossil-fuel-free percentage to reflect the effects of the RES. Finally, the remaining MWh are assigned the carbon content of the NEPOOL GIS residual mix.

Costs for the electric vehicles are calculated as the purchase price premium, or the difference between the upfront purchase price of an internal combustion vehicle and the electric equivalent. Additionally, operations and maintenance savings are quantified annually for both internal combustion vehicles as well as electric vehicles and a net-present value of the difference between the two offsets the upfront purchase price of the EVs.

Finally, the net cost (upfront purchase premium minus O&M savings) is divided by the lifetime carbon emissions avoided to arrive at the dollars per ton of carbon figure (for the societal cost test). For the program administrator cost test, the lifetime emissions avoided are divided into an assumed incentive level (marked up by 30% for administration costs which is meant to capture the overhead costs needed to deliver a program; examples include incentive processing, other staff time, etc.) to arrive at the dollars per ton of carbon figure.

Solar Calculations (Net Metering and Tier II Resources)

The solar section of the model starts by calculating the systems annual production, which is a function of the systems assumed nameplate capacity and the capacity factor. Once the annual production has been calculated, the model discounts the production by the distribution utilities' fossil-fuel-free percentage and percentage to reflect the effects of the RES. Next, the remaining MWh are assigned the carbon content of the NEPOOL GIS residual mix to calculate the tons of carbon avoided figure.

Construction cost is calculated by multiplying the nameplate capacity by the assumed dollars-per-watt construction costs. To arrive at the full societal cost, the cost of integration and the intermittent nature of solar generation is added to the construction costs and then the costs are discounted by the benefits that the project provides. These benefits are energy, capacity, and avoided ancillary services. Energy is calculated as 95% of the around-the-clock annual price per MWh. Capacity benefits are calculated by forecasting FCM prices, applying a coincidence factor to recognize that solar production doesn't perfectly align with the regional system peak, and a 95% scalar applied to the coincidence factor to reflect the fact that as more solar is put onto the regional system, the peak will be pushed later into the day. This value is multiplied by the project's nameplate capacity as well as a reserve margin benefit (35% over the lifetime of the project).

REC benefits are calculated by multiplying the systems assumed annual output by a forecast of REC prices. Avoided ancillary services are quantified by assuming a value of $1/MWh and multiplying by the annual production. Net present value calculations are performed across all of these benefit streams prior to netting the costs described above. Finally, the net value of costs and benefits is divided by the amount of carbon emissions avoided in order to arrive at the dollars per ton of carbon avoided.

The program administrator cost test for the net metering facilities calculates the annual production of the system and what that system would have been compensated at for its production through the net metering program and, separately, at market rates. The net-present value of the difference between these two value streams is the assumed incentive paid to a net metering system over its lifetime.

Using default assumptions, the analysis finds that many of the measures have a negative cost of saved carbon. This means that—for these measures—total benefits exceed costs, and that carbon reduction has a negative net cost. Many of these measures offer lower operating costs. For example, heat pump water heaters cost more upfront, but offer lower annual fuel bills compared to oil or propane water heaters.

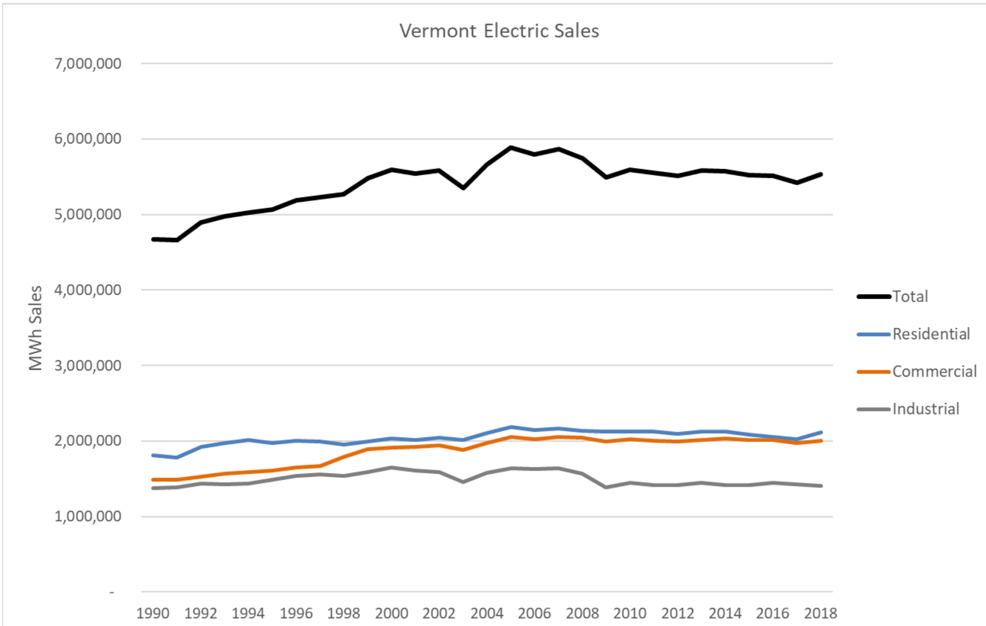
Selected Assumptions for Summary Table	
Fossil Free Scenario for Future Electricity Purchases	Base Case - RES
Internal Combustion Engine Type - MSRP	Light-Duty Average
Internal Combustion Engine Type - MPG	Car/SUV
EV Incentive Amount	$5,000
Electric Bus Incentive	$50,000
Cold Climate Heat Pumps - Single Zone - Nameplate Capacity BTU	12,000
Cold Climate Heat Pumps - Multi Zone - Nameplate Capacity BTU	18,000
Cold Climate Heat Pump Incentive	$500
Heat Pump Water Heater – Tank Size	< 55 Gallon
Heat Pump Water Heater – Incentive	$500

Appendix C – Electricity Data

Energy Consumed

Vermont kWh Sales 1990-2018

Total kWh sales by utilities to customers from 1990 through 2018. In 2018, total retail sales were 5.5 GWh which is equivalent to 18,871,594 MMBtus.



Source: US Energy Information Administration (https://www.eia.gov/electricity/data.php).

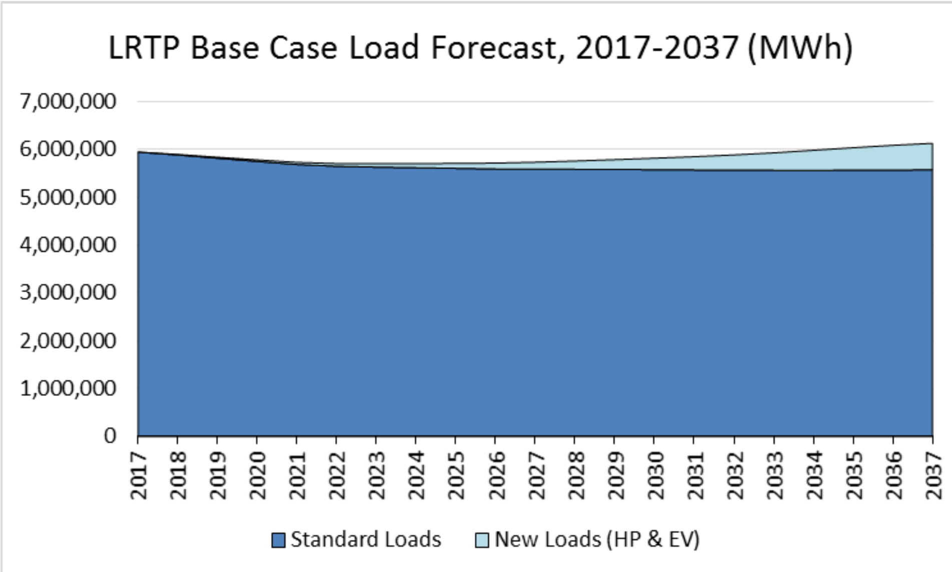
Forecasted Annual Energy Use (GWh)

Energy use is estimated to be relatively flat over the next ten years. The Vermont forecast specifically anticipates electrification in the heating and transportation sectors, while the ISO-NE load does not account for electrification. This explains why Vermont's load shows a slight increase at the end of the ten-year period, while New England load continues to decline.

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Vermont	5,834	5,778	5,727	5,702	5,697	5,701	5,706	5,713	5,730	5,756
New England	125,823	123,560	121,876	121,288	120,576	120,544	119,924	119,916	120,227	121,336

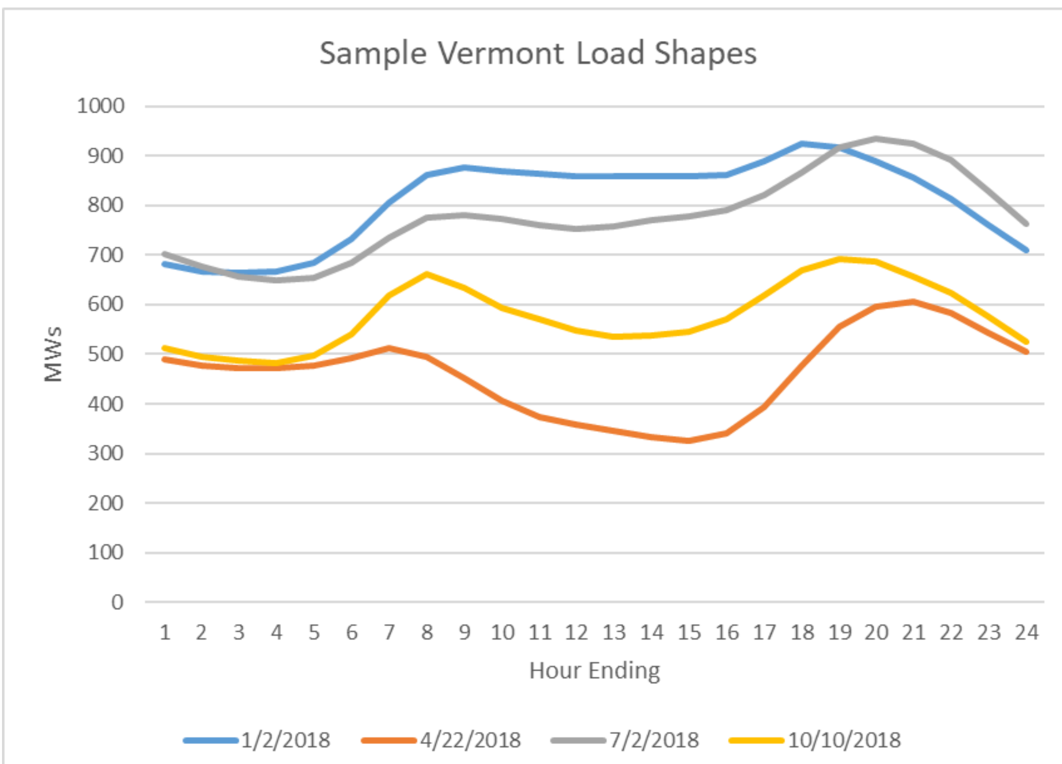
Source: Vermont data from: Vermont System Planning Committee, Load Forecast Subcommittee (available at: https://www.vermontspc.com/vspc-at-work/subcommittees/lfc-data)
New England data from: 2019 ISO-NE CELT Report (available at https://www.iso-ne.com/system-planning/system-plans-studies/celt)

VELCO LRTP Load Forecast



Source: VELCO, Vermont Long-Range Transmission Plan, available at: https://www.velco.com/assets/documents/2018%20LRTP%20Final%20_asfiled.pdf.

Vermont Seasonal Load Profiles



Peak Loads

Historic Peak Loads

	ISO-NE System				Vermont		
Year	Peak Date	Hour Ending	System Peak Load (MW)	Vermont Coincident Peak (MW)	Peak Date	Hour Ending	System Peak Load (MW)
2001	8/09/2001	15:00	24,723				
2002	8/14/2002	15:00	25,103				
2003	8/22/2003	15:00	24,311				
2004	8/30/2004	16:00	23,719				
2005	7/27/2005	15:00	26,618				
2006	8/02/2006	15:00	28,038				
2007	8/03/2007	15:00	25,773		8/3/2007	14	1,001
2008	6/10/2008	15:00	25,691		1/3/2008	19	983
2009	8/18/2009	15:00	24,708		12/17/2009	18	969
2010	7/06/2010	15:00	26,701	979	7/8/2010	14	1,007
2011	7/22/2011	15:00	27,312	931	7/22/2011	12	984
2012	7/17/2012	17:00	25,543	920	6/21/2012	16	945
2013	7/19/2013	17:00	26,911	946	7/18/2013	14	988
2014	7/02/2014	15:00	24,068	900	1/2/2014	18	972
2015	7/29/2015	17:00	24,052	868	1/8/2015	18	924
2016	8/12/2016	15:00	25,111	849	1/4/2016	18	931
2017	6/13/2017	17:00	23,508	726	12/29/2017	18	942
2018	8/29/2018	17:00	25,559	837	7/2/2018	20	935

Net Forecasted Summer Peak (MW)

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Vermont	980	976	975	973	979	981	984	983	984	992
New England	25,323	25,025	24,793	24,620	24,479	24,383	24,329	24,315	24,341	24,408

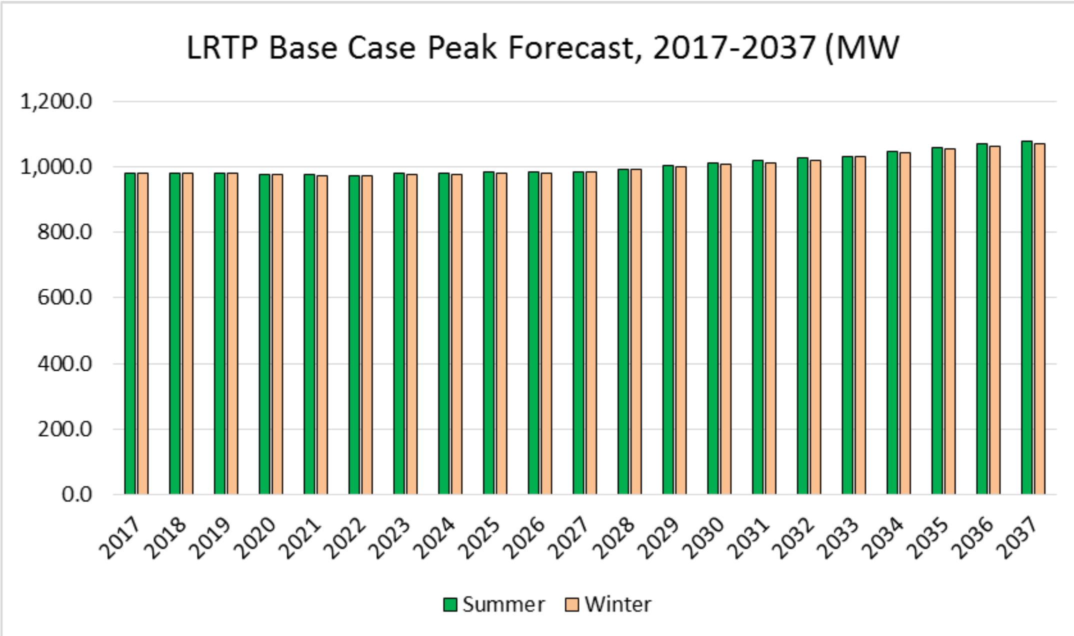
Source: Vermont data from: Vermont System Planning Committee, 2017 Load Forecast Subcommittee (available at: https://www.vermontspc.com/vspc-at-work/subcommittees/lfc-data)
New England data from: 2019 ISO-NE CELT Report (available at https://www.iso-ne.com/system-planning/system-plans-studies/celt)

Net Forecasted Winter Peak (MW)

	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29
Vermont	976	972	972	975	977	979	980	985	99	1,001
New England	20,476	20,215	19,997	19,808	19,654	19,528	19,436	19,380	19,360	19,368

Source: Vermont data from: Vermont System Planning Committee, Load Forecast Subcommittee (available at: https://www.vermontspc.com/vspc-at-work/subcommittees/lfc-data)
New England data from: 2019 ISO-NE CELT Report (available at https://www.iso-ne.com/system-planning/system-plans-studies/celt)

VELCO 2018 Long Range Transmission Plan Peak Forecast



Source: VELCO, Vermont Long-Range Transmission Plan, available at:
https://www.velco.com/assets/documents/2018%20LRTP%20Final%20_asfiled.pdf.

Regional Network Service Forecasted Rates

Year	2020	2021	2022	2023
RNS Rate ($/kW-year)	$120	$126	$133	$138

Source: July 16 & 17, 2019 NEPOOL Reliability Committee/ Transmission Committee Summer Meeting

ISO-NE Forward Capacity Auction Results

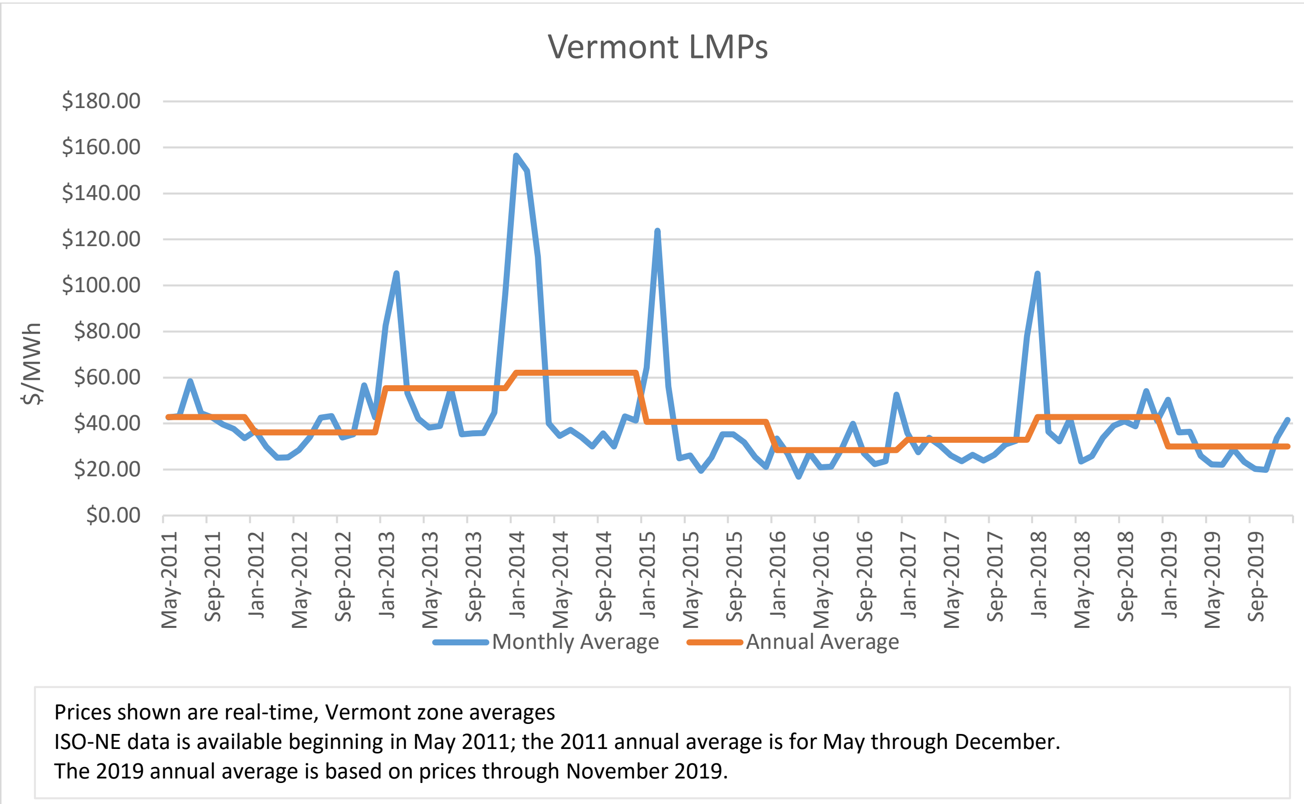
AUCTION COMMITMENT PERIOD	TOTAL CAPACITY ACQUIRED (MW)	NEW DEMAND RESOURCES (MW)[1]	NEW GENERATION (MW)[2]	CLEARING PRICE ($/KW-MONTH)
FCA #1 in 2008 for CCP 2010/2011	34,077	1,188	626	$4.50 (FLOOR PRICE)
FCA #2 in 2008 for CCP 2011/2012	37,283	448	1,157	$3.60 (FLOOR PRICE)
FCA #3 in 2009 for CCP 2012/2013	36,996	309	1,670	$2.95 (FLOOR PRICE)
FCA #4 in 2010 for CCP 2013/2014	37,501	515	144	$2.95 (FLOOR PRICE)
FCA #5 in 2011 for CCP 2014/2015	36,918	263	42	$3.21 (FLOOR PRICE)
FCA #6 in 2012 for CCP 2015/2016	36,309	313	79	$3.43 (FLOOR PRICE)
FCA #7 in 2013 for CCP 2016/2017	36,220	245	800	$3.15 (FLOOR PRICE)
FCA #8 in 2014 for CCP 2017/2018	33,712	394	30	$15.00/new & $7.025/existing*
FCA #9 in 2015 for CCP 2018/2019	34,695	367	1,060	$9.55
FCA #10 in 2016 for CCP 2019/2020	35,567	371	1,459	$7.03
FCA #11 in 2017 for CCP 2020/2021	35,835	640	264	$5.30
FCA #12 in 2018 for CCP 2021/2022	34,828	514	174	$4.63
FCA #13 in 2019 for CCP 2022/2023	34,839	654	8,373	$3.80

*The blended price that was paid to settle load was $7.60/kW-Month.

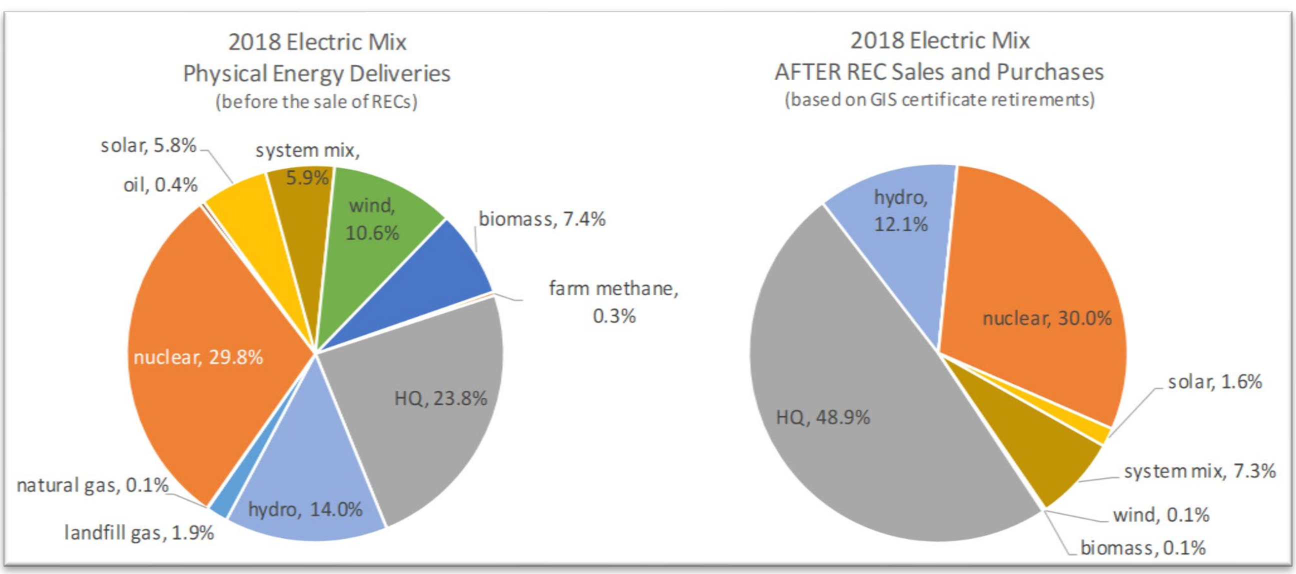
Source: https://www.iso-ne.com/about/key-stats/markets#fcaresults

Wholesale Energy Prices

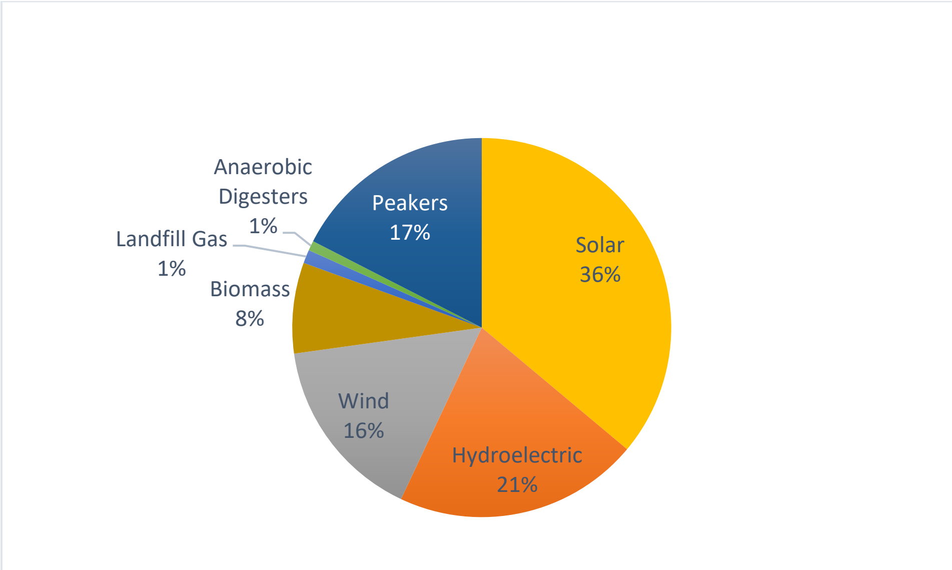
The chart below, illustrates both the annual and monthly wholesale energy prices from May 2011 to November 2019. As can be seen in this chart, in the past five years, prices spike considerably during the winter and then are considerably lower for the rest of the year. New England experienced particularly mild weather in 2016, which resulted in the lowest average annual prices since the start of the wholesale markets.



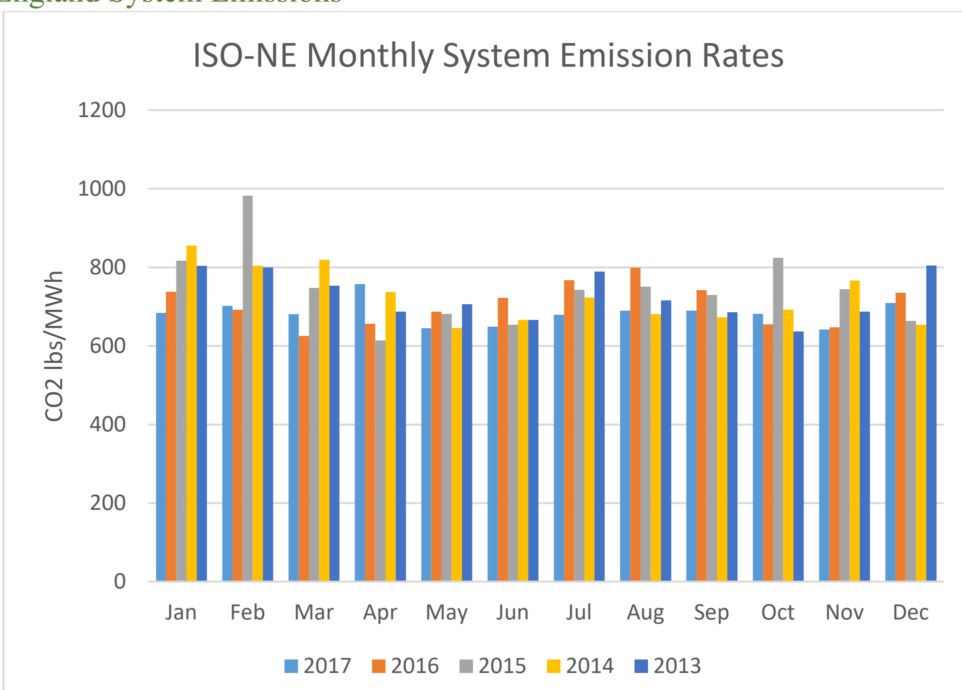
Vermont's Power Supply Mix



In-State Generation



ISO New England System Emissions



Energy Efficiency Charge Rates – Efficiency Vermont

EEC Rates for Customers Without Demand Charges	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Residential Energy $/kWh	0.0077	0.0092	0.0093	0.0103	0.0109	0.0117	0.0128	0.0140	0.0141	0.0137
Commercial Energy $/kWh	0.0067	0.0081	0.0080	0.0088	0.0093	0.0101	0.0109	0.0119	0.0109	0.0109
Industrial Energy $/kWh	0.0052	0.0066	0.0054	0.0063	0.0066	0.0072	0.0077	0.0086	0.0077	0.0077

Energy Efficiency Charge Rates – Burlington Electric Department

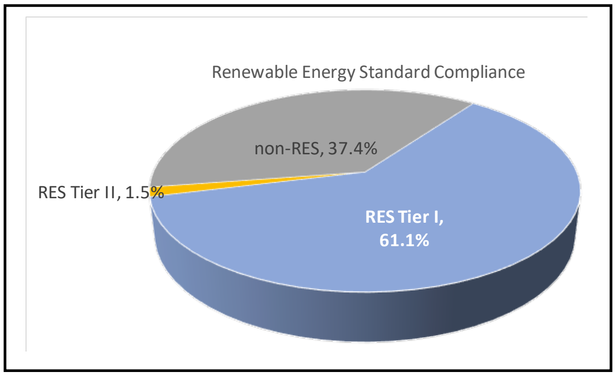
Rates for Customers Without Demand Charges	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Residential Energy $/kWh	0.0062	0.0071	0.0064	0.0078	0.0080	0.0090	0.0098	0.0091	0.0089	0.0095
Commercial Energy $/kWh	0.0053	0.0061	0.0061	0.0069	0.0071	0.0081	0.0087	0.0081	0.0074	0.0084
Industrial Energy $/kWh	0.0039	0.0045	0.0054	0.0056	0.0057	0.0065	0.0070	0.0064	0.0062	0.0054

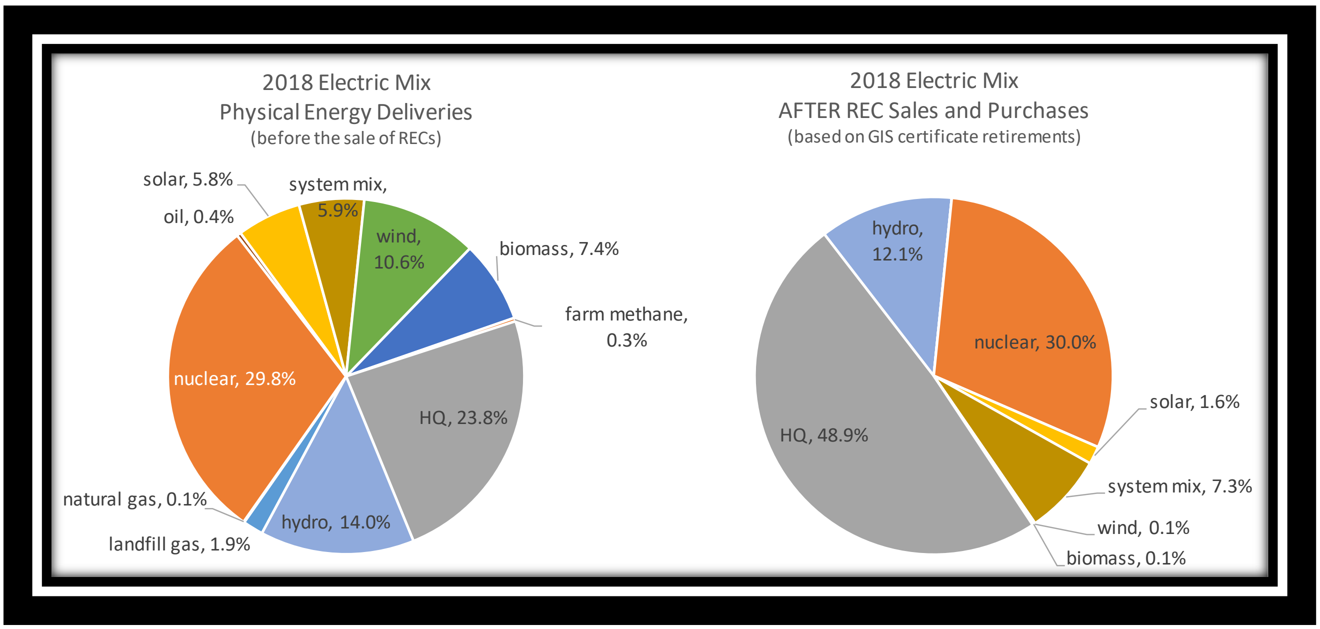
Appendix D – Electric Distribution Utility Facts

VERMONT ELECTRIC UTILITIES

2018 Gross Revenues:	$834,860,000
Retail Sales:	5,520,421,775 kWh
Percent of VT Total Retail Sales:	100%
Peak Load:	935 MW
Date & Time of Peak:	7/2/2018 hour ending 20

Customer Class	Number of Customers	Average Rate ($/kWh)
Residential	314,975	$0.179 / kWh
Commercial	55,860	$0.150 / kWh
Industrial	224	$0.107 / kWh

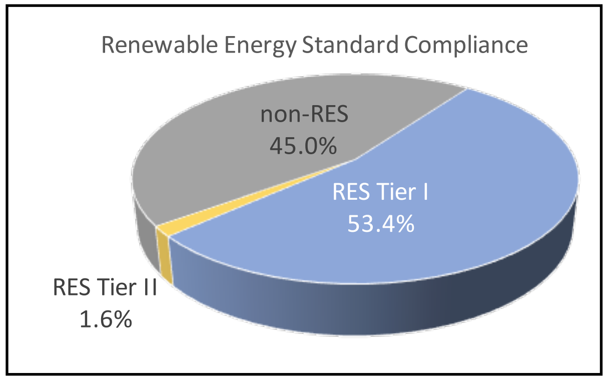


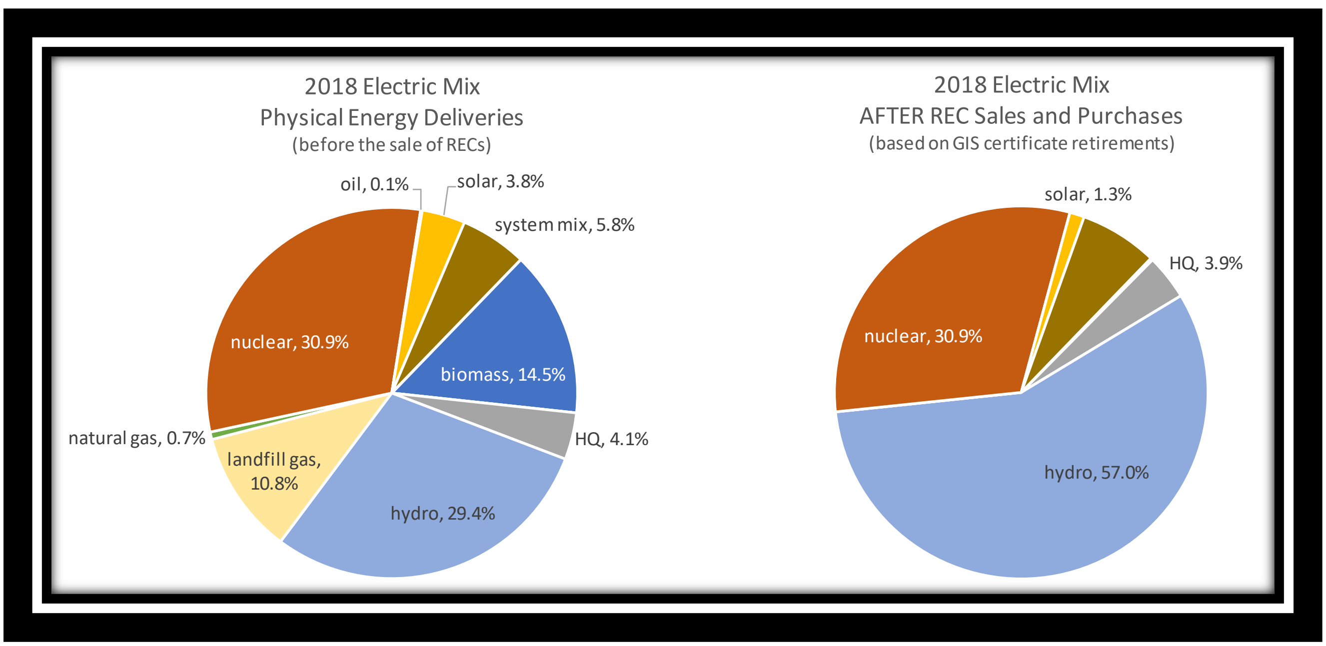


BARTON VILLAGE, INC

2018 Gross Revenues:	$2,756,000
Retail Sales:	13,646,122 kWh
Percent of VT Total Retail Sales:	0.25%
Peak Load:	2.98 MW
Date & Time of Peak:	7/5/2018 hour ending 19

Customer Class	Number of Customers	Average Rate ($/kWh)
Residential	1,946	$0.199 / kWh
Commercial	183	$0.206 / kWh
Industrial	-	n/a



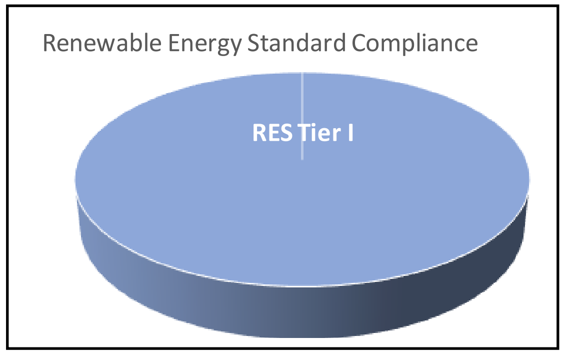


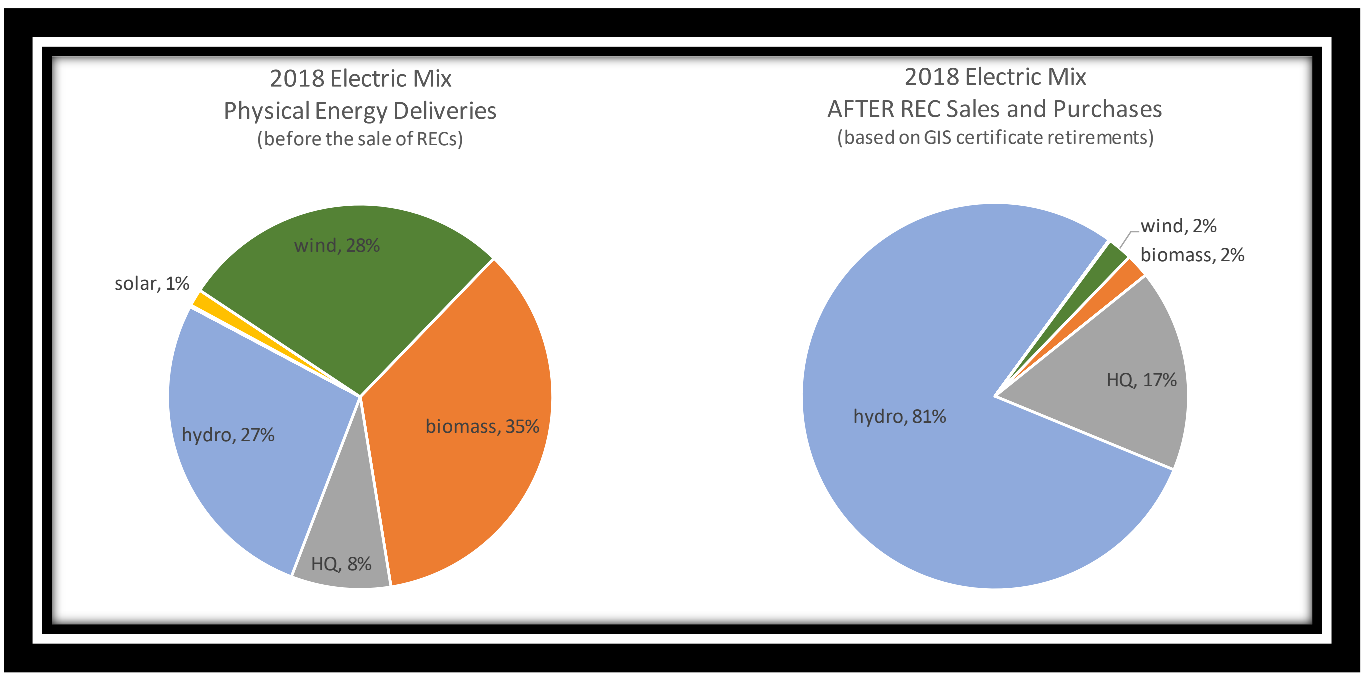
- ❖ The charts above reflect VPPSA as a whole for the Physical Energy Deliveries and the Electric Mix after REC purchases and sales; individual utility entitlements and REC retirements vary.

BURLINGTON ELECTRIC DEPARTMENT

2018 Gross Revenues:	$47,233,000
Retail Sales:	333,764,032 kWh
Percent of VT Total Retail Sales:	6.05%
Peak Load:	65.25 MW
Date & Time of Peak:	8/29/2018 hour ending 16

Customer Class	Number of Customers	Average Rate ($/kWh)
Residential	17,208	$0.157 / kWh
Commercial	3,877	$0.139 / kWh
Industrial	2	$0.115 / kWh

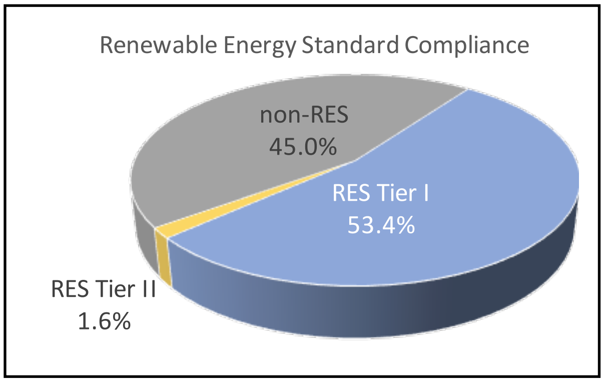


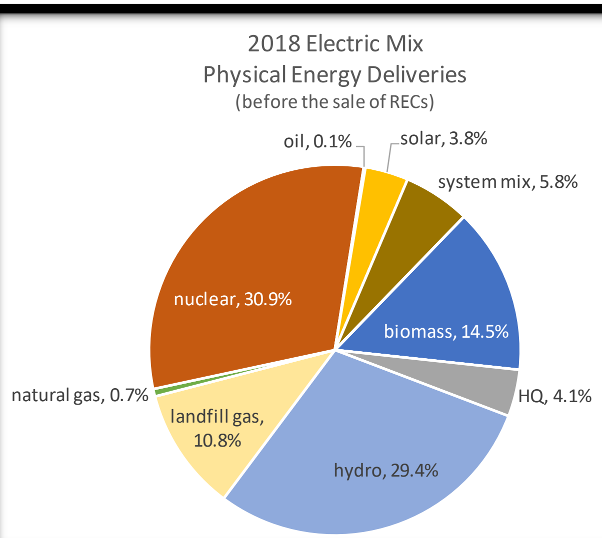


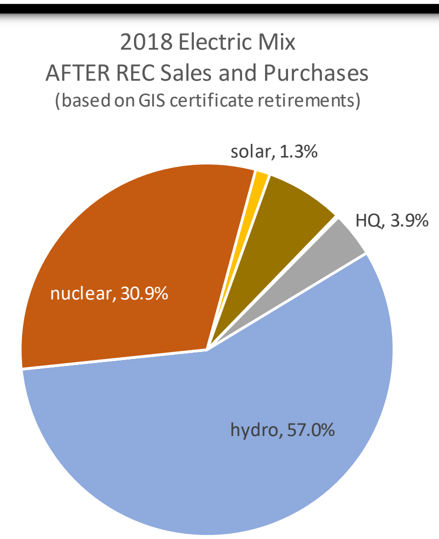
ENOSBURG FALLS VILLAGE

2018 Gross Revenues:	$4,145,000
Retail Sales:	26,848,098 kWh
Percent of VT Total Retail Sales:	0.49%
Peak Load:	4.86 MW
Date & Time of Peak:	7/5/2018 hour ending 18

Customer Class	Number of Customers	Average Rate ($/kWh)
Residential	1,528	$0.157 / kWh
Commercial	149	$0.163 / kWh
Industrial	21	$0.146 / kWh





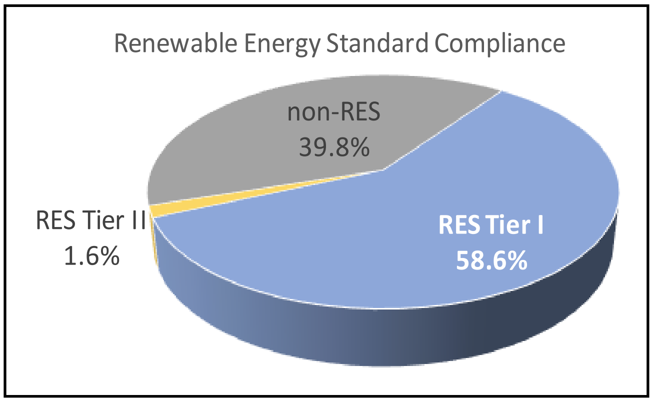


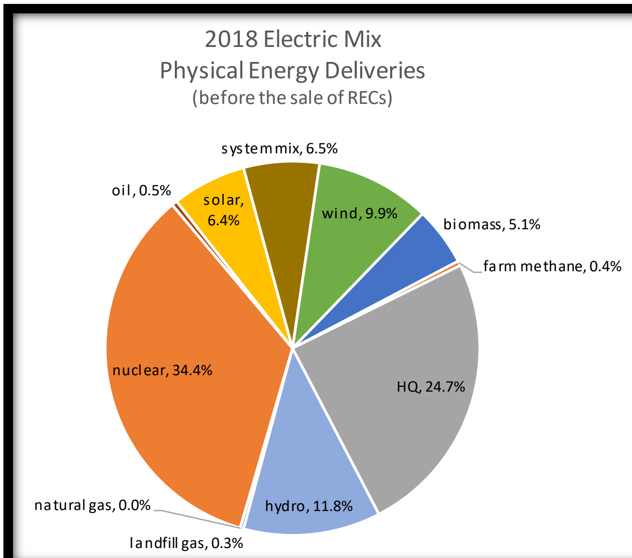
❖ The charts above reflect VPPSA as a whole for the Physical Energy Deliveries and the Electric Mix after REC purchases and sales; individual utility entitlements and REC retirements vary.

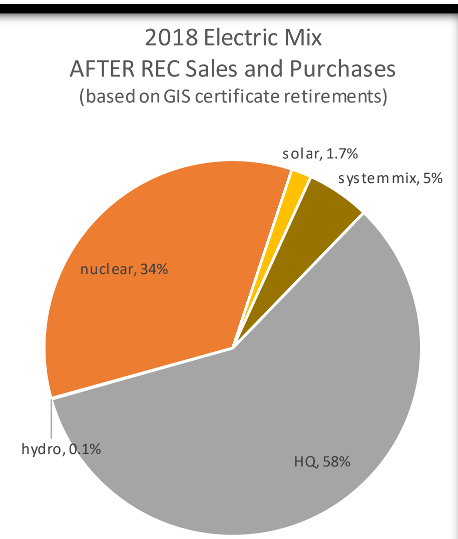
GREEN MOUNTAIN POWER CORPORATION

2018 Gross Revenues:	$629,465,000
Retail Sales:	4,222,266,000 kWh
Percent of VT Total Retail Sales:	76.48%
Peak Load:	726.13 MW
Date & Time of Peak:	7/2/2018 hour ending 20

Customer Class	Number of Customers	Average Rate ($/kWh)
Residential	221,983	$0.182/ kWh
Commercial	42,600	$0.153/ kWh
Industrial	67	$0.153/ kWh



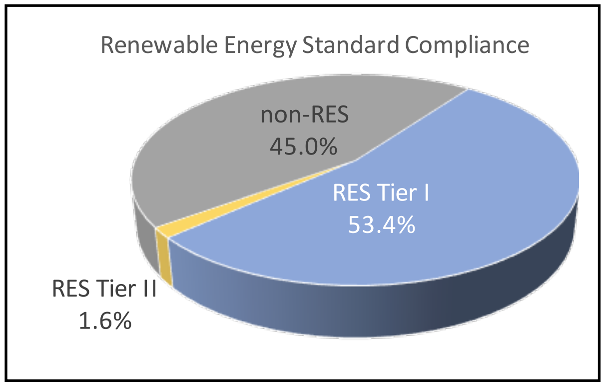


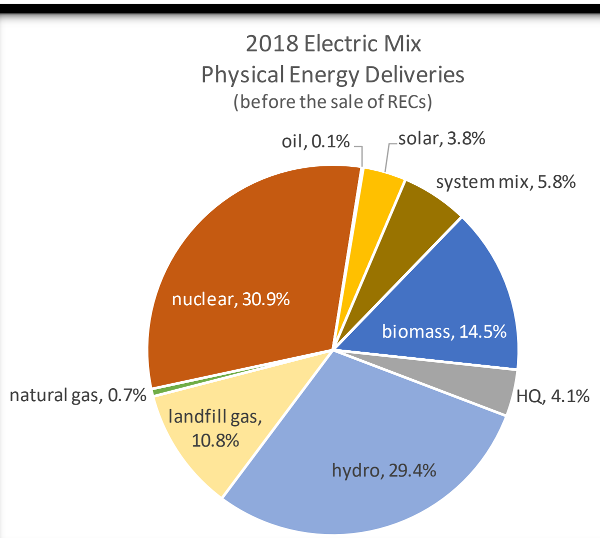


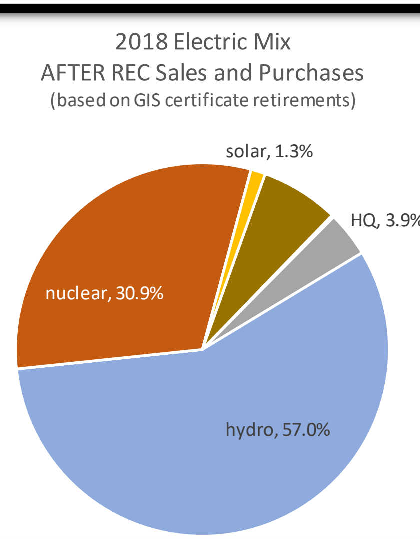
HARDWICK VILLAGE

2018 Gross Revenues:	$5,882,000
Retail Sales:	33,545,766 kWh
Percent of VT Total Retail Sales:	0.61%
Peak Load:	7.16 MW
Date & Time of Peak:	1/2/2018 hour ending 18

Customer Class	Number of Customers	Average Rate ($/kWh)
Residential	4,066	$0.174 / kWh
Commercial	381	$0.183 / kWh
Industrial	29	$0.170 / kWh





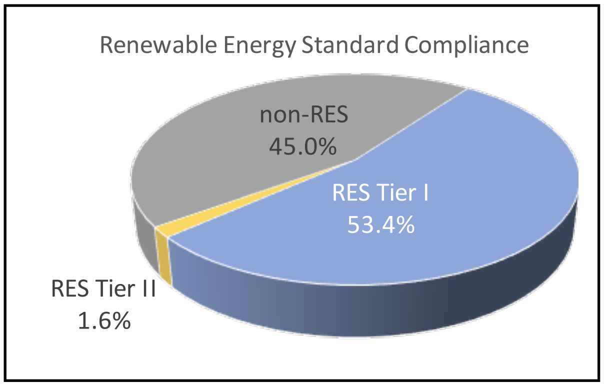


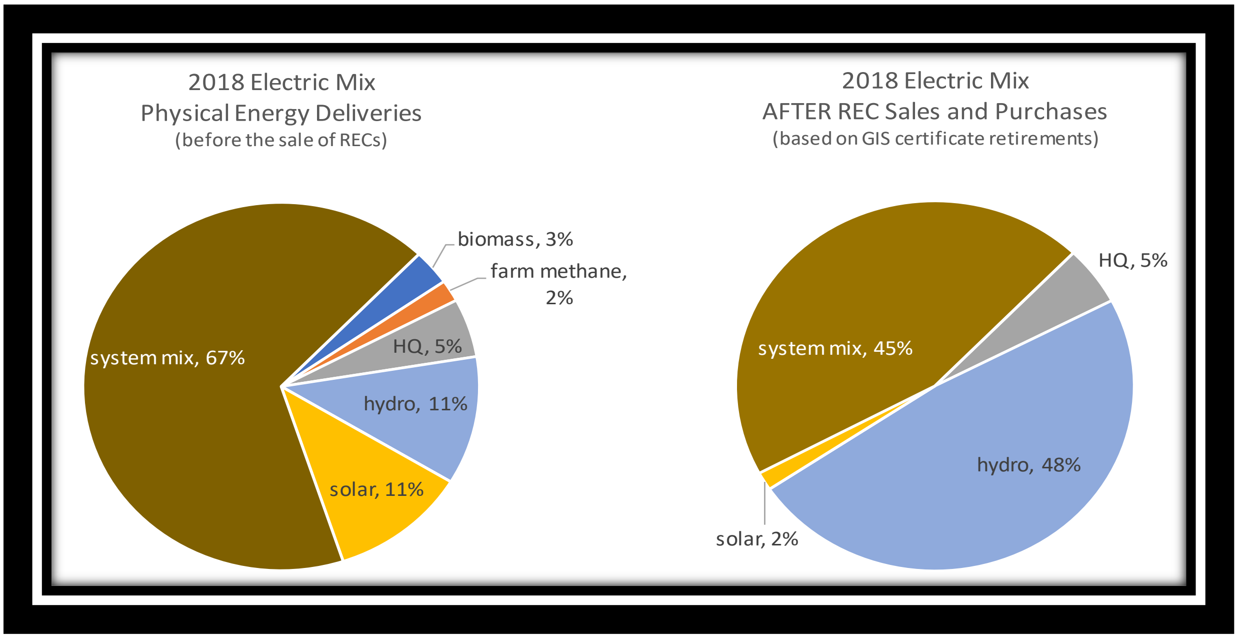
❖ The charts above reflect VPPSA as a whole for the Physical Energy Deliveries and the Electric Mix after REC purchases and sales; individual utility entitlements and REC retirements vary.

HYDE PARK VILLAGE

2018 Gross Revenues:	$2,134,000
Retail Sales:	11,773,664 kWh
Percent of VT Total Retail Sales:	0.21%
Peak Load:	2.66 MW
Date & Time of Peak:	1/1/2018 hour ending 18

Customer Class	Number of Customers	Average Rate ($/kWh)
Residential	1,184	$0.174 / kWh
Commercial	129	$0.192 / kWh
Industrial	-	n/a

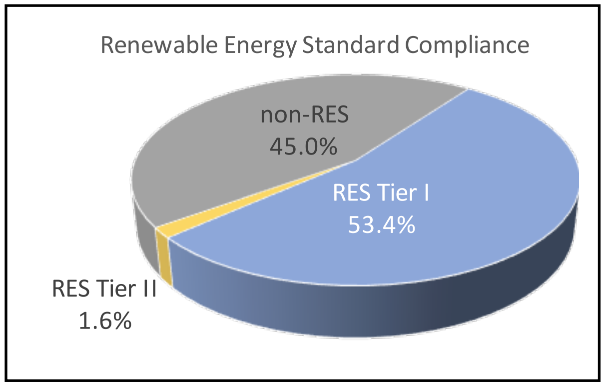


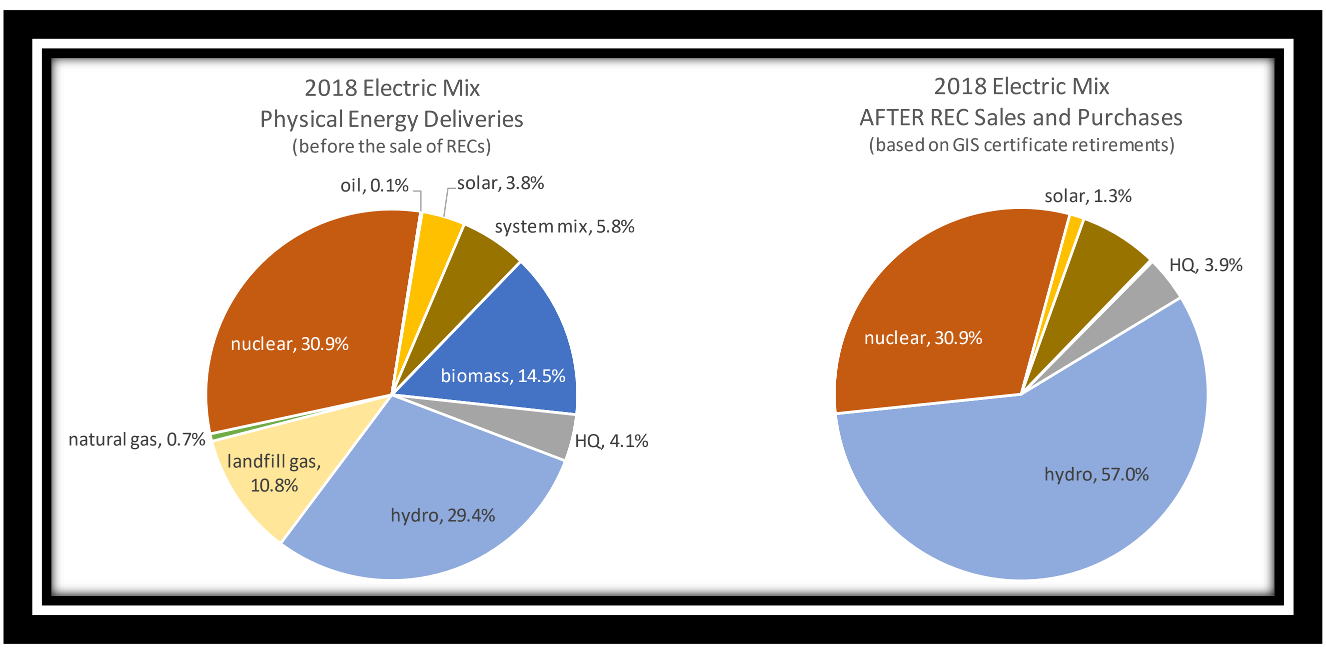


JACKSONVILLE VILLAGE

2018 Gross Revenues:	$862,000
Retail Sales:	4,987,290 kWh
Percent of VT Total Retail Sales:	0.09 %
Peak Load:	1.28 MW
Date & Time of Peak:	1/2/2018 hour ending 8

Customer Class	Number of Customers	Average Rate ($/kWh)
Residential	658	$0.171 / kWh
Commercial	51	$0.173 / kWh
Industrial	4	$0.175 / kWh



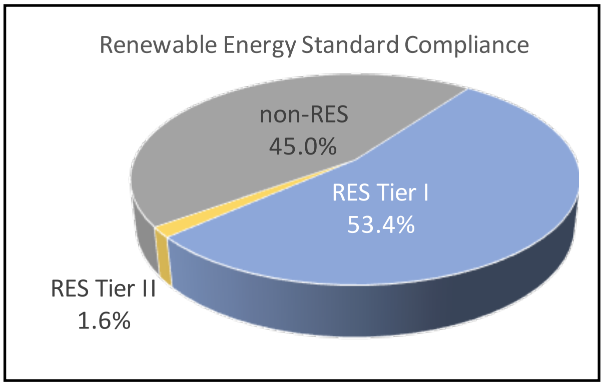


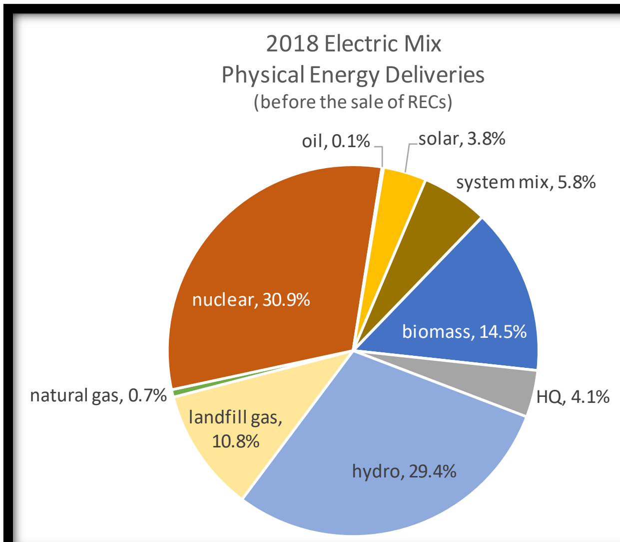
❖ The charts above reflect VPPSA as a whole for the Physical Energy Deliveries and the Electric Mix after REC purchases and sales; individual utility entitlements and REC retirements vary.

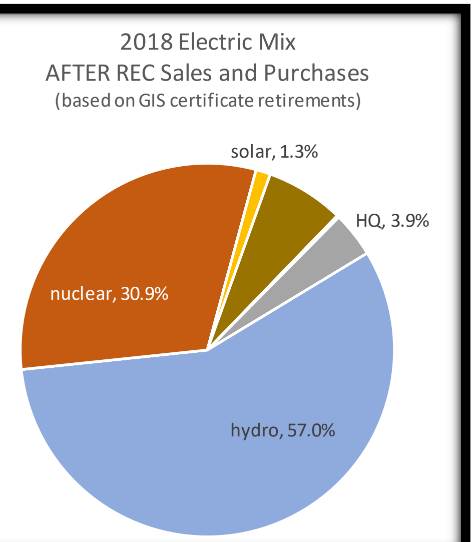
JOHNSON VILLAGE

2018 Gross Revenues:	$2,147,000
Retail Sales:	12,509,491kWh
Percent of VT Total Retail Sales:	0.23 %
Peak Load:	2.41 MW
Date & Time of Peak:	1/24/2018 hour ending 18

Customer Class	Number of Customers	Average Rate ($/kWh)
Residential	802	$0.174 / kWh
Commercial	96	$0.199 / kWh
Industrial	15	$0.162 / kWh





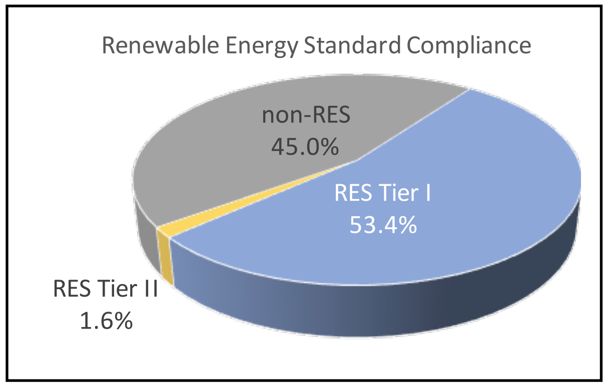


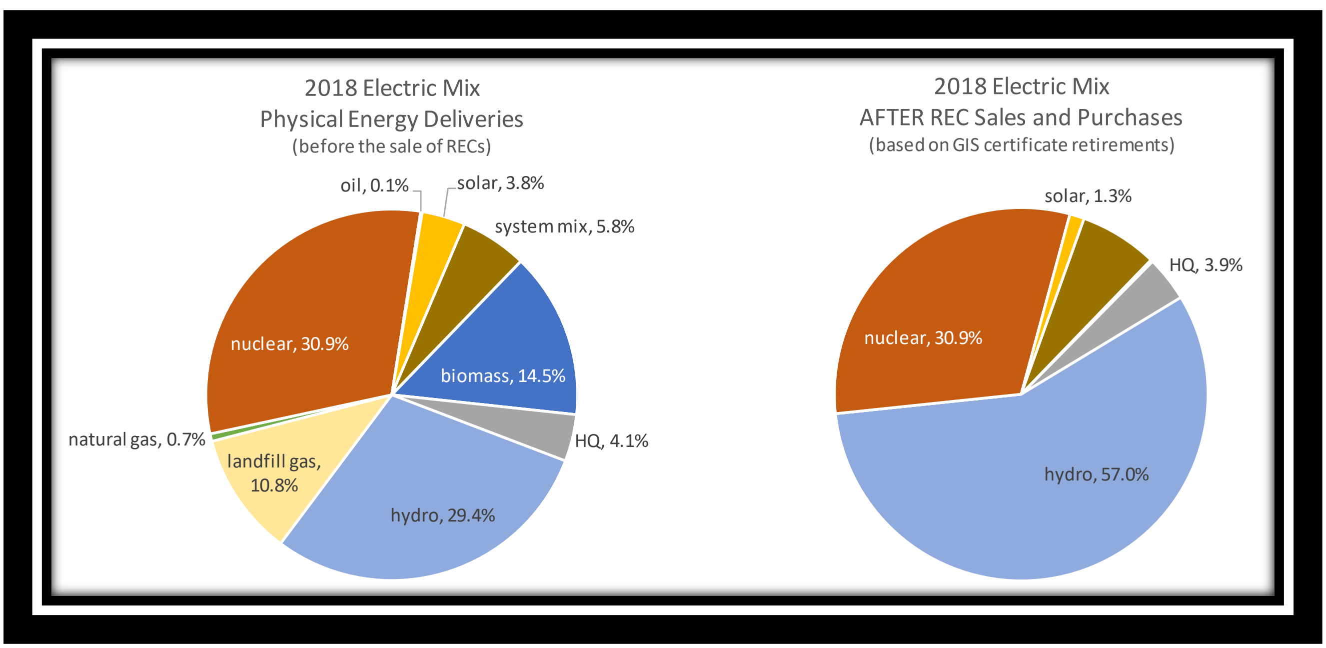
- The charts above reflect VPPSA as a whole for the Physical Energy Deliveries and the Electric Mix after REC purchases and sales; individual utility entitlements and REC retirements vary.

LUDLOW VILLAGE

2018 Gross Revenues:	$8,314,000
Retail Sales:	54,579,417 kWh
Percent of VT Total Retail Sales:	0.99 %
Peak Load:	13.44 MW
Date & Time of Peak:	12/18/2018 hour ending 16

Customer Class	Number of Customers	Average Rate ($/kWh)
Residential	3,045	$0.131 / kWh
Commercial	704	$0.170 / kWh
Industrial	4	$0.142 / kWh



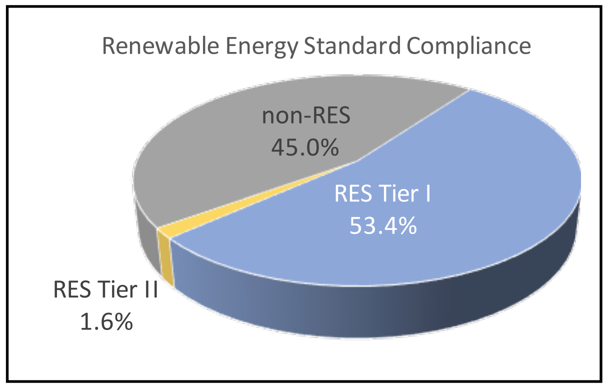


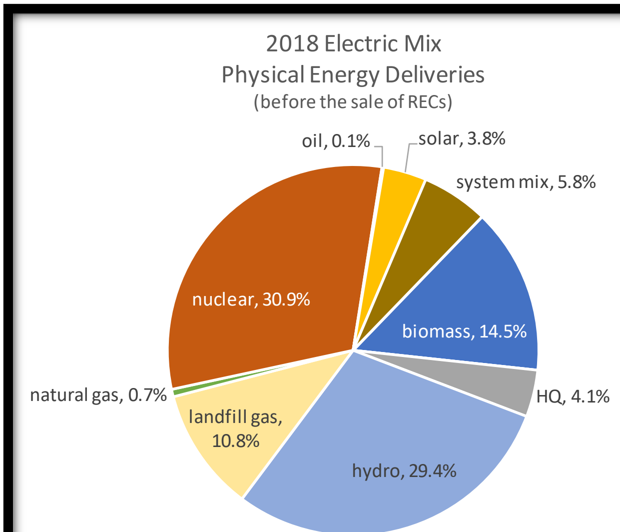
❖ The charts above reflect VPPSA as a whole for the Physical Energy Deliveries and the Electric Mix after REC purchases and sales; individual utility entitlements and REC retirements vary.

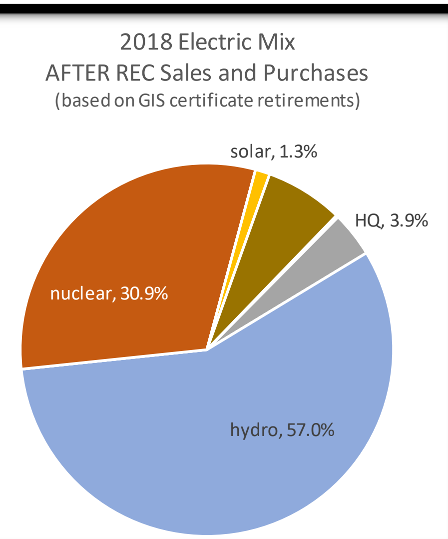
LYNDONVILLE VILLAGE

2018 Gross Revenues:	$9,208,000
Retail Sales:	58,532,590 kWh
Percent of VT Total Retail Sales:	1.06 %
Peak Load:	12.21 MW
Date & Time of Peak:	12/12/2018 hour ending 19

Customer Class	Number of Customers	Average Rate ($/kWh)
Residential	4,830	$0.157 / kWh
Commercial	872	$0.168 / kWh
Industrial	41	$0.161 / kWh





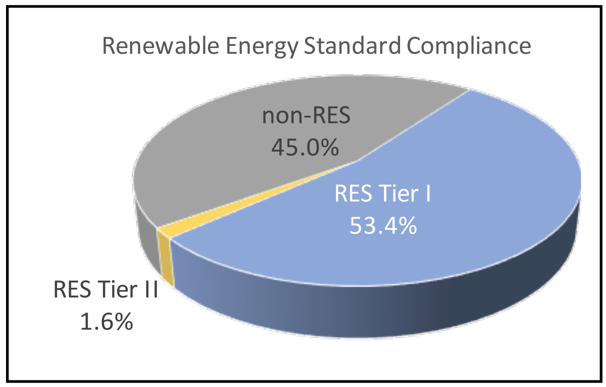


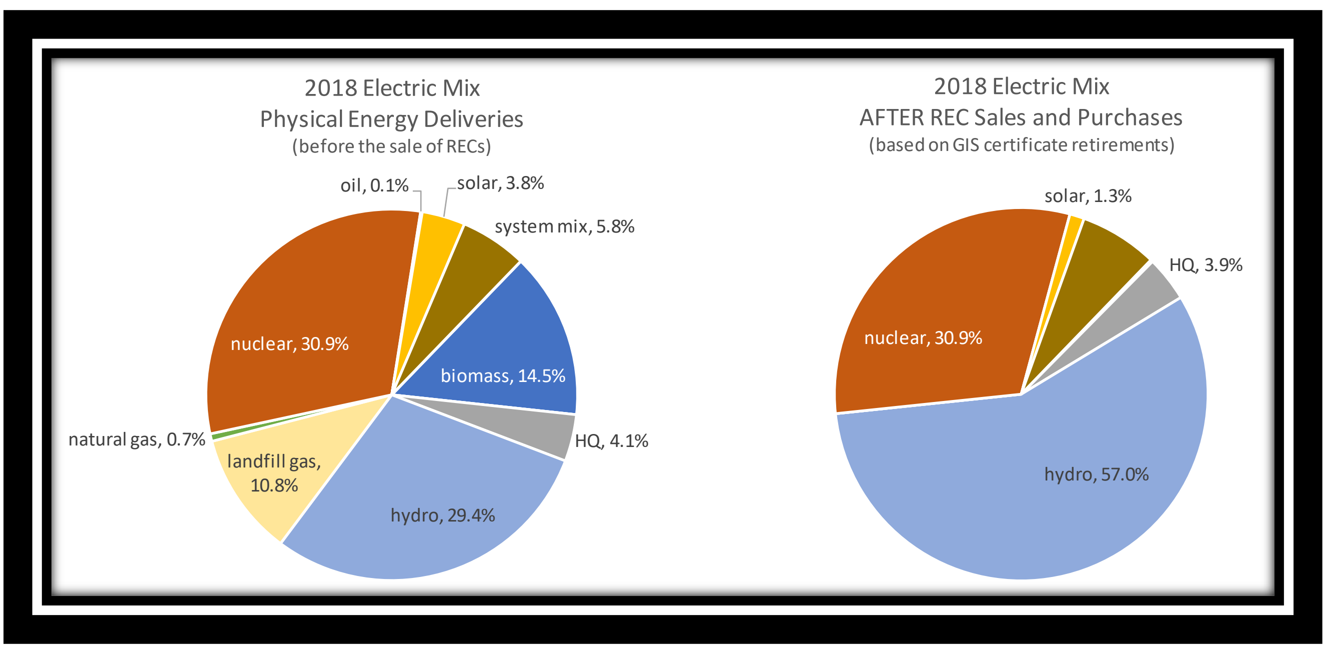
❖ The charts above reflect VPPSA as a whole for the Physical Energy Deliveries and the Electric Mix after REC purchases and sales; individual utility entitlements and REC retirements vary.

MORRISVILLE VILLAGE

2018 Gross Revenues:	$7,082
Retail Sales:	45,788,872 kWh
Percent of VT Total Retail Sales:	0.83 %
Peak Load:	8.43 MW
Date & Time of Peak:	8/29/2018 hour ending 18

Customer Class	Number of Customers	Average Rate ($/kWh)
Residential	3,568	$0.155 / kWh
Commercial	648	$0.153 / kWh
Industrial	-	n/a



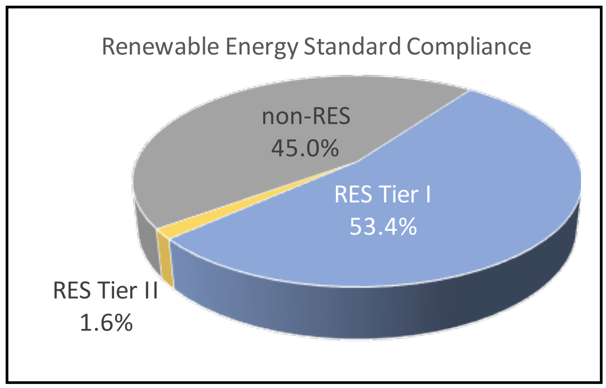


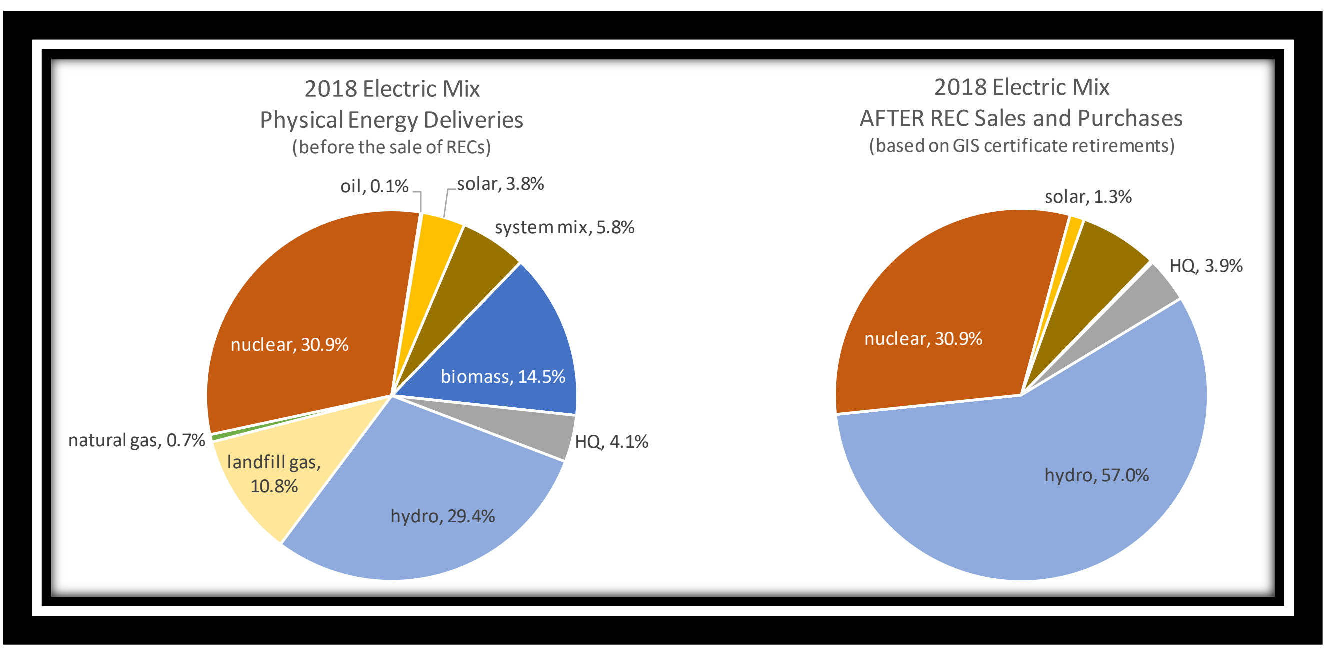
❖ The charts above reflect VPPSA as a whole for the Physical Energy Deliveries and the Electric Mix after REC purchases and sales; individual utility entitlements and REC retirements vary.

NORTHFIELD ELECTRIC DEPARTMENT

2018 Gross Revenues:	$3,770
Retail Sales:	28,217,275 kWh
Percent of VT Total Retail Sales:	0.51 %
Peak Load:	5.3 MW
Date & Time of Peak:	9/5/2018 hour ending 20

Customer Class	Number of Customers	Average Rate ($/kWh)
Residential	1,610	$0.138 / kWh
Commercial	176	$0.147 / kWh
Industrial	12	$0.132 / kWh



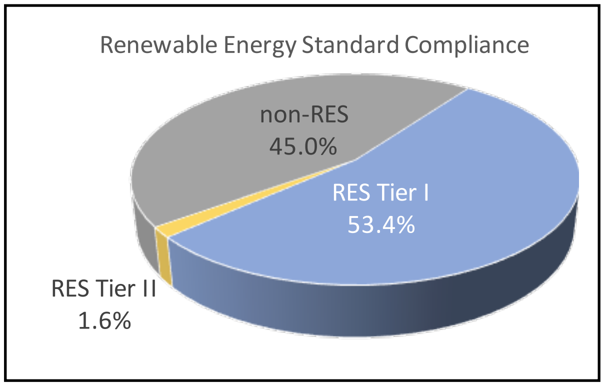


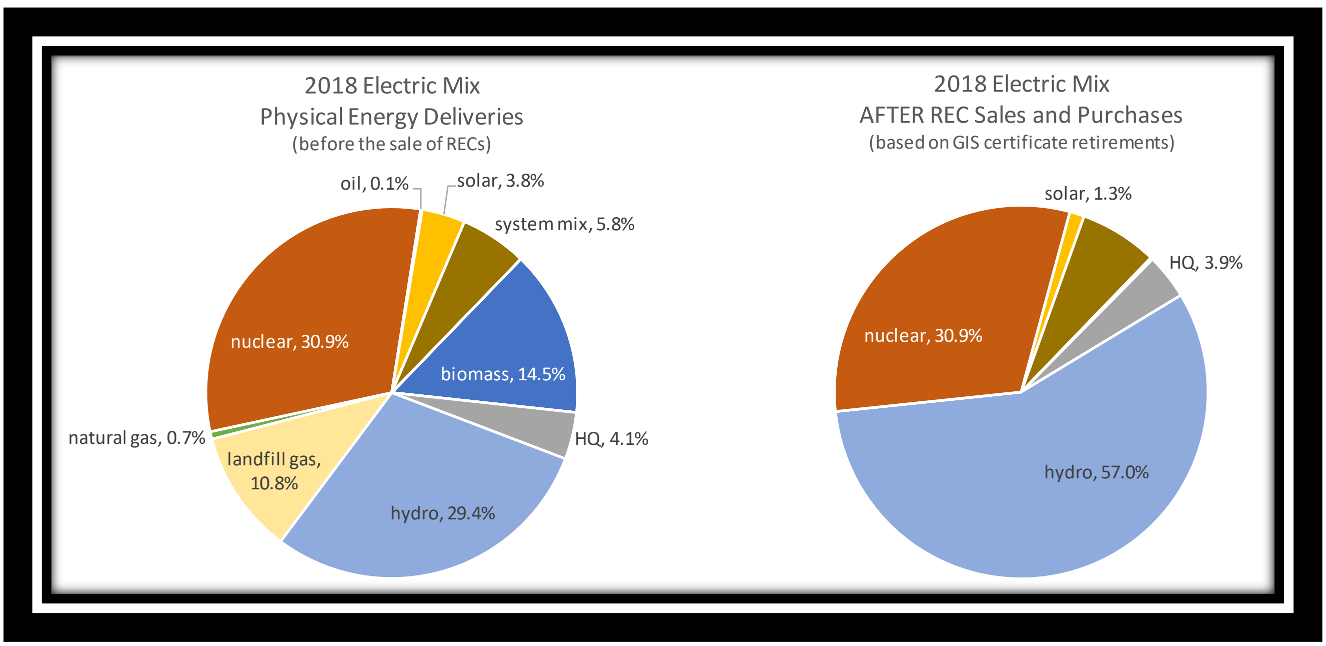
❖ The charts above reflect VPPSA as a whole for the Physical Energy Deliveries and the Electric Mix after REC purchases and sales; individual utility entitlements and REC retirements vary.

ORLEANS VILLAGE

2018 Gross Revenues:	$1,939,000
Retail Sales:	13,690,057kWh
Percent of VT Total Retail Sales:	0.25 %
Peak Load:	3.38 MW
Date & Time of Peak:	1/2/2018 hour ending 9

Customer Class	Number of Customers	Average Rate ($/kWh)
Residential	582	$0.129 / kWh
Commercial	65	$0.141 / kWh
Industrial	1	$0.148 / kWh



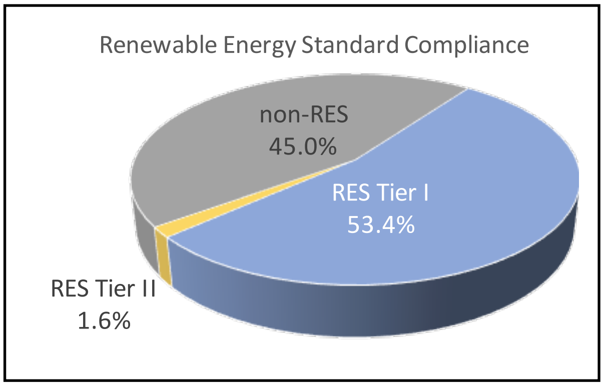


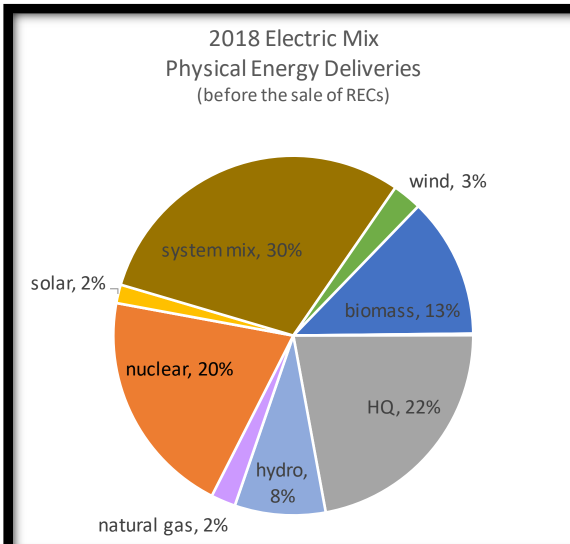
❖ The charts above reflect VPPSA as a whole for the Physical Energy Deliveries and the Electric Mix after REC purchases and sales; individual utility entitlements and REC retirements vary.

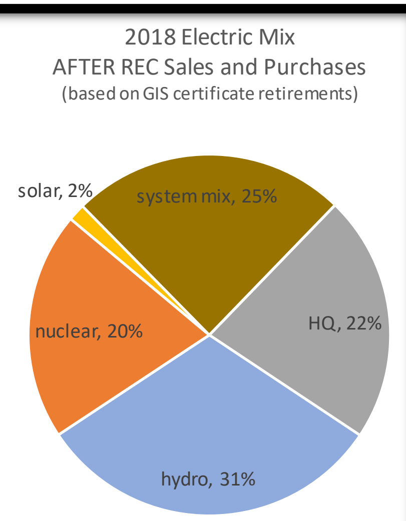
STOWE VILLAGE

2018 Gross Revenues:	$13,174,000
Retail Sales:	75,164,574 kWh
Percent of VT Total Retail Sales:	1.36 %
Peak Load:	17.55 MW
Date & Time of Peak:	1/1/2018 hour ending 18

Customer Class	Number of Customers	Average Rate ($/kWh)
Residential	3,390	$0.183 / kWh
Commercial	679	$0.143 / kWh
Industrial	1	$0.128 / kWh



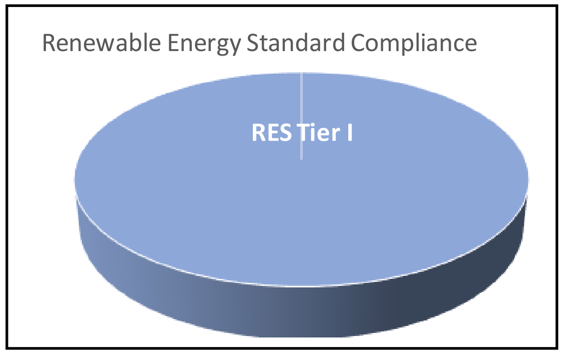


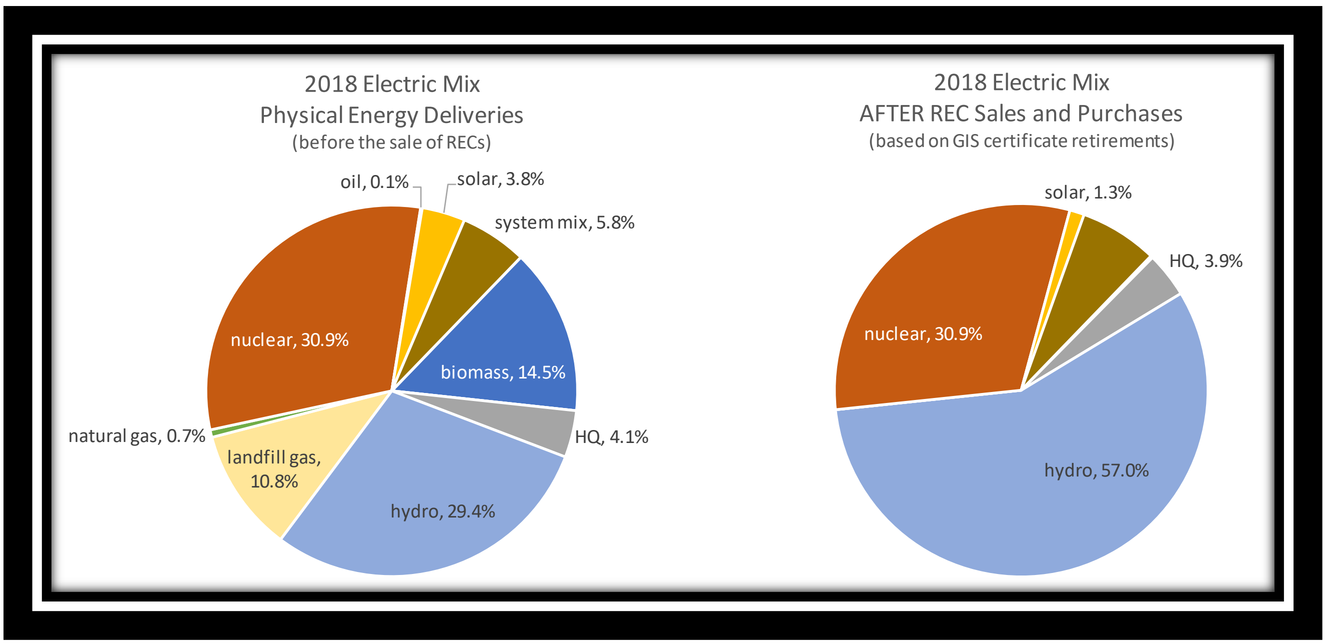


SWANTON VILLAGE ELECTRIC DEPARTMENT

2018 Gross Revenues:	$7,002,000
Retail Sales:	54,619,790 kWh
Percent of VT Total Retail Sales:	0.99 %
Peak Load:	10.89 MW
Date & Time of Peak:	8/6/2018 hour ending 18

Customer Class	Number of Customers	Average Rate ($/kWh)
Residential	3,192	$0.131 / kWh
Commercial	509	$0.126 / kWh
Industrial	-	n/a



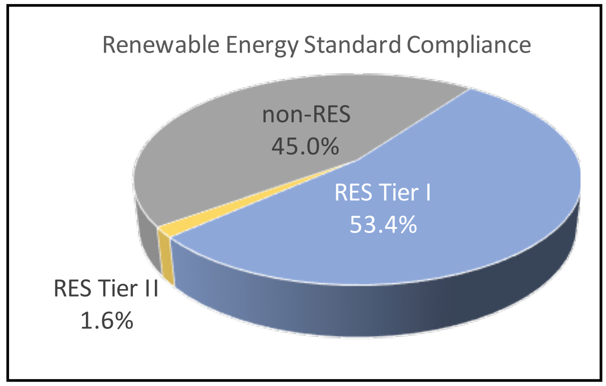


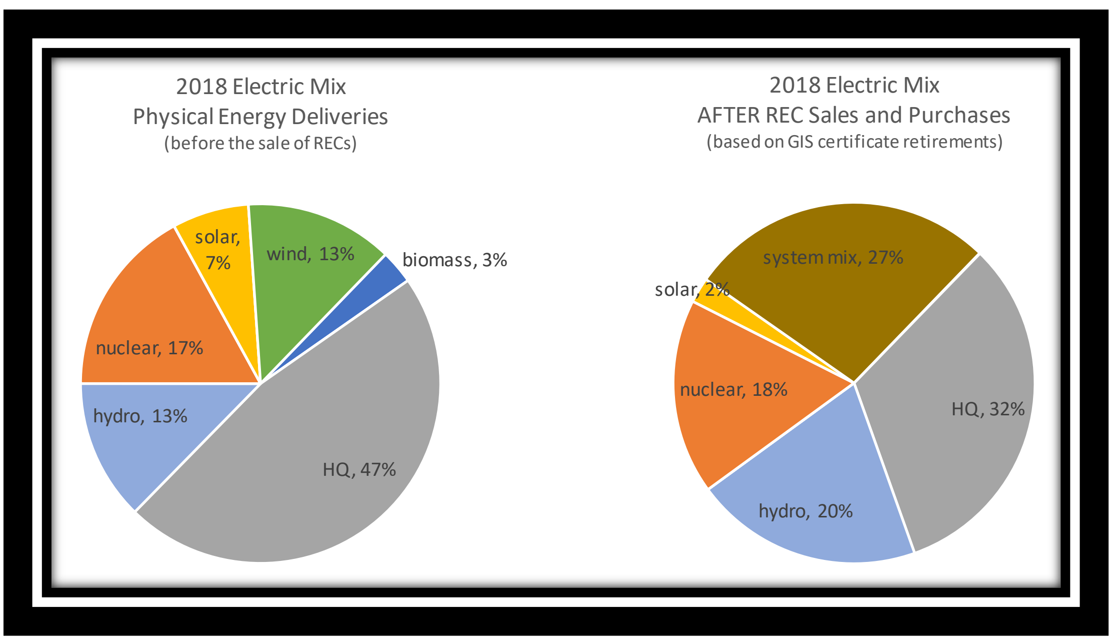
❖ The charts above reflect VPPSA as a whole for the Physical Energy Deliveries and the Electric Mix after REC purchases and sales; individual utility entitlements and REC retirements vary.

VERMONT ELECTRIC COOPERATIVE

2018 Gross Revenues:	$74,790,000
Retail Sales:	459,994,853 kWh
Percent of VT Total Retail Sales:	8.33%
Peak Load:	77.65 MW
Date & Time of Peak:	1/14/2018 hour ending 18

Customer Class	Number of Customers	Average Rate ($/kWh)
Residential	34,585	$0.191 / kWh
Commercial	4,084	$0.156 / kWh
Industrial	15	$0.110 / kWh

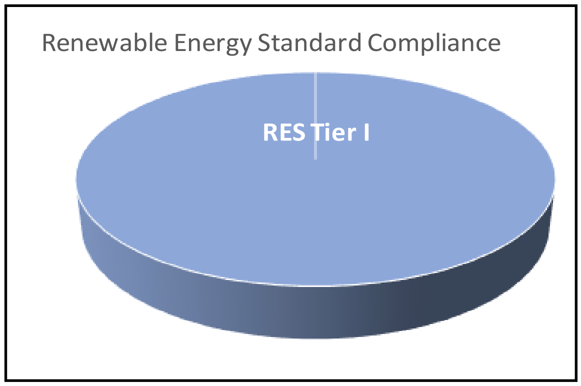


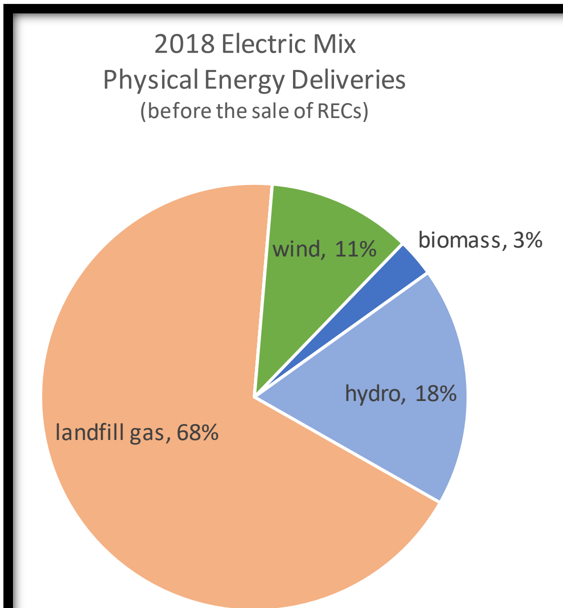


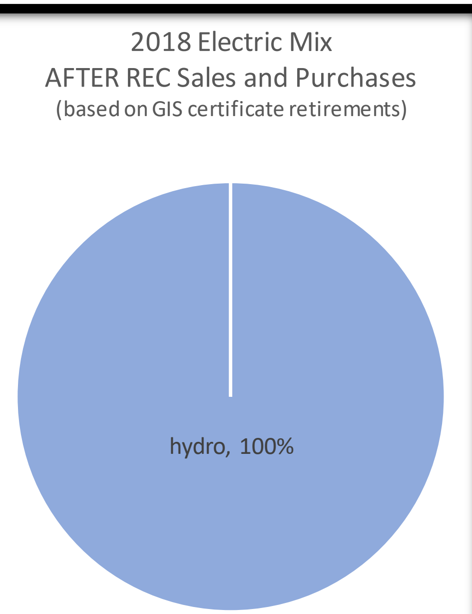
WASHINGTON ELECTRIC COOPERATIVE

2018 Gross Revenues:	$14,958,000
Retail Sales:	70,493,884 kWh
Percent of VT Total Retail Sales:	1.28 %
Peak Load:	18.14 MW
Date & Time of Peak:	1/24/2018 hour ending 19

Customer Class	Number of Customers	Average Rate ($/kWh)
Residential	10,798	$0.216 / kWh
Commercial	657	$0.209 / kWh
Industrial	12	$0.147 / kWh







Appendix E – 2020 Annual Report on the Renewable Energy Standard

2020 Annual Report on the Renewable Energy Standard

Vermont Department of Public Service

January 15, 2020

Submitted to the House Committee on Commerce and Economic Development, the Senate Committees on Economic Development, Housing and General Affairs and on Finance, and the House and Senate Committees on Natural Resources and Energy

Introduction

Pursuant to 30 V.S.A. § 8005b, the Department of Public Service (PSD or Department) provides this annual assessment of the historical and ongoing impacts of the Renewable Energy Standard (RES).

The annual report, as set forth in subsection (b) of Section 8005b[78], must address three issues:

1. An assessment of costs and benefits of the RES based on the most current available data;
2. Projected impacts of the RES on electric utility rates, total energy consumption, electric energy consumption, fossil fuel consumption, and greenhouse gas emissions; and
3. An assessment of RES compliance to date.

The first section, *Summary of Program Performance to Date,* is retrospective in nature; it evaluates the historical performance of the RES program with respect to its costs and benefits. The second section, *Projections of Future Program Performance,* is prospective in nature; it summarizes the results of modeling exercises undertaken by PSD in projecting the impacts of RES on Vermont, given historical information and current trends. The final section, *RES Compliance,* presents an assessment of whether the RES requirements have been met to date.

The report also includes a methodology section, *Methodology and RES Model Overview*, and two appendices. The methodology section describes the mechanics of the model that was used to support the quantitative projections. Appendix I contains the statutory language describing the purpose and requirements of this report. Appendix II lists the values assigned to the key modeling variables that drive different results in PSD's scenario analysis model.

Summary of Findings

- Utility compliance with the RES will mean significant ongoing reductions in fossil fuel consumption by Vermonters, primarily through the greening of the State's electricity supply and the electrification of both transportation and heating. PSD estimates that Vermonters will reduce fossil fuel consumption over the next 10 years by a total of 135,000,000 mmBtu, and carbon dioxide (CO_2) emissions by roughly 7,000,000 tons as a direct result of the RES. A reduction of 7,000,000 tons is the equivalent of lifetime savings associated with over 300,000 electric vehicles.

- All Vermont Distribution Utilities (DUs) met the 2018 RES requirements. Net compliance costs for 2018 were approximately $7.5 million.

- There will likely be upward electricity rate pressure associated with RES. PSD estimates the net cost of continuing to meet RES obligations over the next ten years will have a net present value (NPV) cost of between $11 million and $106 million. PSD's base case estimates an annual average of about 2.8% rate impact over the projection period, with one scenario resulting in retail rates less than 1.3% higher over the next ten years, and other scenarios with rates almost 4% higher. This estimate includes the expectation that Tier III of RES will lower compliance costs to some degree by increasing revenues from higher electric sales. Given the large quantity of RECs required for compliance, a relatively small difference in REC prices can result in a large difference in costs. The Tier I requirement in 2018 was over 3,000,000 RECs with about half of that exposed to market conditions, so a $7/MWh increase in market prices translates to an additional $10.5 million in compliance costs for that single year.

[78] Appendix I of this document contains the relevant language of Section 8005b.

- The primary drivers of utility compliance expenditures include REC prices, net-metering adoption rates, Tier III incentive costs, and whether new load increases peak loads. The high-versus-low REC price forecast results in a 0.8% difference in rate impacts. The high-versus-low net-metering deployment forecast results in a 1.3% difference in rate impacts. If new load from Tier III measures including cold climate heat pumps (CCHPs) and electric vehicles (EVs) are deployed without controls to avoid adding to peak demand, the rate impact would be about 0.3%. It is important to note that this figure does not include costs associated with Transmission and Distribution (T&D) investments required to accommodate additional load from electrification associated with meeting Tier III requirements. Upgrades could range from a simple relay setting change, which carry minimal costs of around $1,000, to a complete station rebuild, which can be in the millions of dollars. The state of Vermont has more than 250 substations, as an upper bound, if we assume an average upgrade cost of $2 million per station then total costs would be $500 million. If invested over the course of 10 years, this would translate to an additional 7% of rate pressure on average each year over the course of the investments.
- The first two compliance years of RES, combined with the Department's modelling, suggests the RES will have moderate rate impacts while producing meaningful reductions in fossil-fuel usage and greenhouse gas emissions. If utilities meet Tier III requirements with measures that increase electric load and do not contribute to peak loads, the increased consumption of electricity will spread utility costs over a greater volume of sales, mitigating the upward pressure on rates associated with RES compliance expense.

Overview of RES and Reporting Requirement

Section 8 of Public Act No. 56 of 2015 (Act 56) directed the Public Utility Commission (PUC) to implement a renewable energy standard, by means of "an order, to take effect on January 1, 2017". This requires Vermont's DUs to retire a minimum quantity of renewable energy attributes or Renewable Energy Credits (RECs), and to achieve fossil-fuel savings from energy transformation projects.[79] The structure of the RES is divided into three tiers.

Tier I requires DUs to retire qualified RECs or attributes from any renewable resource capable of delivering energy into New England to cover at least 55% of their annual retail electric sales starting in 2017. This amount increases by 4% every third January 1 thereafter, up to 75% in 2032. A utility can also make an Alternative Compliance Payment (ACP) in lieu of retiring Tier I RECs. ACP payments are made to the Clean Energy Development Fund (CEDF), which "promotes the development and deployment of cost-effective and environmentally sustainable electric power and thermal energy or geothermal resources for the long-term benefit of Vermont consumers."[80]

Tier II requires DUs to retire qualified RECs equivalent to 1% of their annual retail sales starting in 2017. Tier II eligible resources include renewable generators with a nameplate capacity of less than 5 MW, commissioned after June 30, 2015, and connected to a Vermont distribution or subtransmission line. The Tier II requirement increases by three-fifths of a percent each year, up to 10% in 2032. Like Tier I, a utility can make an ACP in lieu of retiring Tier II RECs. Pursuant to Section 8005(a)(1)(C), Tier II resources also count towards a DU's Tier I requirement. Additionally, to the extent that a DU is 100% renewable, the DU

[79] 30 V.S.A. § 8005(b).
[80] 30 V.S.A. § 8015(c).

is not required to meet the annual requirements set forth in Tier II but is required to accept net-metering systems and retire the associated RECs.[81] [82]

The implementation of REC retirements for RES Tier I and Tier II compliance brings Vermont in line with the rest of the New England states. Starting in 2003, other states in the region began implementing renewable portfolio standards (RPS). By 2008, all other states in the region had an RPS to be met with REC retirements or an ACP. During that time, Vermont encouraged renewable development through the Sustainably Priced Energy Enterprise Development (SPEED) program but did not require utilities to serve their load with renewable energy or to retire RECs. The use of RECs to track renewability is the generally accepted standard across the country.

Act 56 also created Tier III, which requires DUs to achieve fossil-fuel savings from energy transformation projects or retire Tier II RECs. For Tier III, the RES requires savings of 2% of a DU's annual retail sales in 2017 increasing to 12% by 2032, except for municipal electric utilities serving less than 6,000 customers, which have a delayed start and no obligation until 2019. Energy transformation projects implemented on or after January 1, 2015 are eligible to be counted towards a DU's Tier III obligation. Like Tier's I and II, a utility can make an ACP in lieu of achieving sufficient fossil fuel savings or retiring Tier II RECs. Energy transformation projects include weatherizing buildings, installing air source or geothermal heat pumps, biomass heating systems and other high-efficiency heating systems, switching industrial processes from fossil fuel to electric, increased use of biofuels, and deployment of electric vehicles or related charging infrastructure. The Tier III requirements are additional to the Tier I requirements and an ACP option is available for Tier III compliance.

Methodology and RES Model Overview

To project the impacts of RES, the Department developed a spreadsheet-based scenario-analysis tool, the Consolidated RES model or RES model. This tool is capable of modeling a range of assumptions regarding energy and REC price, net-metering deployment, technologies used to meet Tier III requirements, and the impact of new Tier III load on peaks.[83] The RES Model is not a forecasting tool, but instead is designed to facilitate a bounding exercise for reasonable best and worst case scenarios. This section provides a high-level explanation of the key relationships that determine the different assumption-dependent results reported below in the prospective section of this document, *Projections of Future Program Performance*. Appendix II to this report provides additional documentation of the key variables used by the RES model and the values assigned to them in PSD's scenario analyses.

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[81] Net-metering RECs must be retired per Section 5.127(B)(1) of Rule 5.100 and 30 V.S.A. § 8010(c)(1)(H)(ii)

[82] A REC is the renewable attribute associated with a MWh of generation from a qualified renewable resource. With each MWh of electric generation, an environmental attribute is also created. An eligible renewable resource can qualify its generation in different states such that attributes associated with that resource receive a "REC" designation. The energy (MWh) and attributes (RECs) can be separated and traded independent of each other so that a DU can achieve RES compliance by purchasing RECs and does not necessarily need the physical energy from the renewable resources. RECs are the currency used to demonstrate renewable energy compliance in all New England states. NEPOOL Generator Information System (NEPOOL GIS) is the platform used in New England that tracks the characteristics of all generators in the region. It is in this system that all RECs in the region are created, traded and retired.

[83] The RES Model is available on the Department's website at: http://publicservice.vermont.gov/publications-resources/publications

The main outputs of the RES model, for any given set of assumptions, is a calculation of the total incremental utility expenditure required, the resulting rate impact of compliance with the RES requirements, and the cumulative greenhouse gas (GHG) emission reductions over the next ten years. The compliance cost can be mapped to each tier of RES. The costs of Tier I and Tier II compliance are determined primarily by the amount that utilities are assumed to pay in order to acquire RECs from eligible renewable generation resources. The cost of Tier III compliance includes incentives paid by utilities to encourage customer adoption of fossil fuel reduction measures, program administration overhead, and the cost to serve any new electric load associated with customer adoption of fossil fuel reduction measures, less the revenue received from additional retail sales. Reduced GHG emissions reported are a result of Tiers I, II and III, and do not include other changes in Vermont's energy portfolio.[84]

Loads

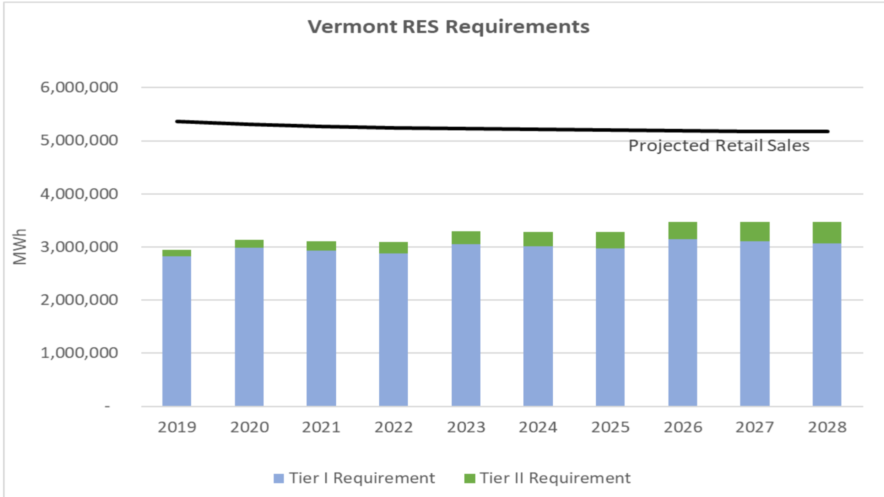
RES obligations are based on a utility's retail sales in the compliance year. The load forecast used in the RES model is based on the 2018 VELCO Long-Range Transmission Plan (LRTP) base load forecast, which includes existing efficiency, net metering and load from electrification measures through 2016.[85] The LRTP forecast was then modified to reflect more recent data and forecasts regarding net-metering installations and additional load from Tier III measures. The baseline forecast was developed by aggregating monthly regression model forecasts for each customer class. The VELCO net-metering forecast assumes continued high deployment rates in the near-term that slow in the long-term as the market becomes saturated. The PSD's projections use the VELCO forecast as the base-case assumption, but alternative scenarios to reflect higher and lower net-metering deployment have also been developed. In the ongoing net-metering rulemaking, the Department has proposed adjusting the net-metering compensation structure downward, to better align the compensation with the value it provides and the system installation costs, as well as to minimize the program's cross-subsidy.[86] If the compensation rates are adjusted in line with the Department's straw proposal, the pace of net-metering deployment will likely decrease, making the low net-metering scenario the most probable. Additional load from Tier III measures is dependent on the assumptions regarding the technologies deployed to achieve Tier III fossil fuel reductions. For example, a future where weatherization is the primary tool used to meet Tier III requirements will have a lower load forecast than a future that targets thermal and transportation electrification with cold climate heat pumps (CCHP) and electric vehicles (EV).

Based on the forecasted loads, Tier I, II and III requirements forecasts follow. The chart below shows Vermont's projected retail sales including additional load from Tier III, and Tier I and II RES requirements through for the 10-year projection period.

[84] From 2017 to 2018, Vermont's share of energy from nuclear generators increased from 13.5% to 30%, resulting in a significant decrease in GHG emissions. These reduced emissions are not included in the reported GHG emission reductions in this report.

[85] The LRTP can be found at: https://www.velco.com/assets/documents/2018%20LRTP%20Final%20_asfiled.pdf. Further information can be found at: https://www.vermontspc.com/.

[86] See the net-metering section of this Annual Report and Case No 19-0855-RULE for additional details.



Tier I and Tier II Compliance Costs

Utilities must demonstrate Tier I and Tier II compliance with the retirement of qualified RECs. Absent sufficient RECs, an ACP must be paid to the CEDF. The RES Model makes assumptions about the price utilities will pay to procure RECs to estimate the cost of compliance. For each MWh of generation from qualified renewable resources, a REC is also created. The Department expects Vermont utilities to have sufficient RECs to meet their Tier I and Tier II requirements from a combination of:

1. Net-metered projects that transfer RECs to the utility;
2. Standard-Offer projects, where RECs are transferred to the Standard-Offer Facilitator and then to DUs;
3. Utility-owned renewable generation;
4. Long-term “bundled” (e.g. energy, capacity and RECs) Power Purchase Agreements (PPA); and
5. REC-only market purchases.

If a utility does not have sufficient RECs to cover its obligation, in the near-term, PSD expects RECs will be available for purchase at prices lower than the ACP and consistent with premium RECs in other New England states.

In order to understand Vermont REC price forecasts, it is important to first understand the relationships among the different regional REC markets. Vermont Tier I RECs are generally equivalent to Class II or existing RECs in neighboring states, with the exception that imports from Quebec and New York are eligible in Vermont. It follows that Vermont Tier I prices tend to be very similar to Class II prices in neighboring states. Vermont Tier II resources are a small subset of Class I or premium resources in other states, so when there is sufficient Tier II supply in Vermont, excess RECs will be sold as Class I to neighboring states, which results in Tier II prices that are very similar to Class I prices. However, if a shortage of Vermont Tier II resources develops, then prices will diverge with Tier II prices approaching the ACP while Class I prices trade at a different market price.

REC markets provide the opportunity to claim renewability without having to make a long-term commitment of purchasing or generating physical power. However, REC markets can be volatile and illiquid. The ACP, or the price paid when insufficient RECs are retired acts as a price ceiling for trading prices. The Tier I ACP was $10.13/REC and Tiers II and III were $60.78/REC in 2018; each will escalate annually with the Consumer Price Index.

Tier I resources include any renewable generator in ISO-NE and imports from neighboring control areas (e.g., Hydro Quebec, New York Power Authority hydro). This category of RECs has consistently been in excess supply since the inception of renewable standards in the region, as there is no requirement that the eligible resources be new or limited to a certain size, and the RPS requirements have been well below available supply. In recent years, Tier I RECs have traded at a wide range of prices from about $0.25/ REC to $10.00/REC[87]. There is currently a lack of clarity on the use of imported environmental attributes to be used for Tier I compliance. The PUC recently requested comments on the use of unbundled (attributes that do not include the associated energy) imported environmental attributes for compliance in Case No. 19-2568-RULE. An order has not yet been issued on this matter, but the decision could have a meaningful impact on the Tier I prices going forward. If the PUC determines that unbundled RECs can be used for compliance, the available supply will be greater than Vermont's demand and prices will likely remain low (i.e. less than $1/REC). However, if the PUC determines that imported attributes must be bundled, then available Tier I REC supply may be limited. As Tier I requirements increase over time, prices will increase as the supply is constant and the demand rises.

The Department expects utilities will be able to meet most of their obligations in the near-term with the RECs produced by their owned resources, those they are entitled to by long-term contracts, and the balance from short-term REC only purchases. The RES Model includes three REC price forecasts that are intended to capture the market's supply side uncertainty. The Tier I base case assumes an average price of around $2.60/REC, with prices starting at $1/REC in 2019 and increasing to about $5/REC by year 2028. The low case remains flat at $1/REC, and the high case averages $5.50/REC for 10 years.

Tier II of the RES defines eligible resources as renewable generators with a nameplate capacity of less than 5 MW, commissioned after June 30, 2015, and connected to a Vermont distribution or subtransmission line. These narrow criteria will be a limiting factor on tradable Tier II REC supply going forward and could result in Vermont Tier II RECs trading at a slight premium to other comparable REC markets in the region. The Department expects there to be limited opportunity for utilities to purchase unbundled Tier II RECs. Instead, most Tier II RECs will come from net-metering, standard-offer, utility-owned resources, and long-term bundled purchases. In the near term, Tier II obligations are expected to be met mostly with net-metering[88] and standard-offer RECs, and the balance will likely trade at prices very similar to Massachusetts and Connecticut Class I markets. However, looking further out, as RES requirements increase and cannot be met with net-metering and standard-offer projects alone, additional RECs will be needed to meet the requirements and greater price separation between Vermont and other states may emerge because only a subset of the total New England REC supply qualifies as Vermont Tier II. The Tier II base-case price forecast assumes a flat price of $24/REC for Tier II RECs. The low-case averages $15/REC, and the high-case averages $34/REC for 10 years.

RES allows for the banking (of up to 3-years) of excess RECs to then be used for compliance in future years; however, for simplicity, the Department's analysis disregards banking and assumes that excess RECs in a

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[87] Not all Tier I traded RECs were used for Vermont compliance; Tier I RECs are generally qualified in other New England states and used for compliance outside of Vermont.

[88] Net-metering RECs must be retired per Section 5.127(B)(1) of Rule 5.100 and 30 V.S.A. § 8010(c)(1)(H)(ii)

given year will be sold at market prices to offset total compliance costs. By not fully modelling the banking of RECs, the cost of RES is overstated in the high REC price scenario due to the steep upward slope of forecasted REC prices where utilities are expected to sell excess RECs in the near-term at low prices, then acquire RECs in future years at higher prices.

In the RES model, total compliance costs for Tiers I and II are calculated as the product of the assumed cost per REC and the total utility obligation (MWh). The utility obligation quantity is determined by applying the relevant statutory percentage to the annual retail sales forecast. Much of Vermont's Tier I obligation will be satisfied with RECs from existing long-term purchases from Hydro-Quebec (HQ) and the New York Power Authority (NYPA) Niagara Project[89] that come at no additional cost. The forecasted Tier I REC price is then applied to the balance of the obligation.[90] A similar method was applied to Tier II costs, with expected RECs from net-metering being assigned the REC adjustor spread, standard-offer RECs assigned a $25/REC price[91], and the balance (purchases or sales) assigned Tier II price forecast. Assuming all else equal, when the load forecast is higher, it follows that the obligations are higher, and therefore compliance costs will also be higher. The factors that most significantly impact obligations and costs are REC prices, net-metering deployment and the extent to which utilities comply with Tier III obligations with measures that increase electric load.

The RES model projects costs assuming that Vermont utilities will meet the RES requirements. However, in the short two-years of experience, Vermont utilities have exceeded RES requirements. Three utilities have demonstrated 100% renewability with the retirement of Tier I RECs, resulting in exemption from their Tier II requirements, and one utility has elected to exceed Tier I requirements. The retirement of excess Tier I RECs has come at a very low cost, to date. These deviations from explicit RES requirements are not captured in the modelling going forward.

Effect of Net-Metering on Obligations and Costs

Net-metering is a financial arrangement whereby a participating customer provides the financing for the development of a renewable resource—almost always solar—in return for the ability to use generation to help offset that customer's bill. Net-metering reduces the volume of electricity that utilities would otherwise sell to ratepayers. Under Vermont's current net-metering rates, high net-metering deployment leads to higher costs. Larger volumes of generation from net-metering results in lower load and lower RES obligations, but also lower retail sales revenues and more RECs from high-priced net-metering projects. Vermont utilities may not sell RECs associated with net-metering generation, which effectively makes net-metering a carve-out for Tier II. In other words, Tier II requirements are first met with net-metering RECs, and the remaining requirement is met with other Tier II resources. So, while RES could be satisfied at a lower cost with RECs from other resources, net-metering statute[92] is such that utilities must purchase and retire the RECs for RES compliance. The costs associated with net-metering RECs are also included in the net-metering section of the annual report.

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[89] The Niagara contract expires September 1, 2025.

[90] Tier I obligations are expected to be met with RECs from owned and purchased renewables. It is assumed that absent RES, utilities would sell the RECs from owned generation at the associated price so the cost represents the lost opportunity of REC revenue.

[91] This represents the estimated imputed price between the wholesale energy and capacity value and the PPA price paid to the generator.

[92] Net-metering RECs must be retired per Section 5.127(B)(1) of Rule 5.100 and 30 V.S.A. § 8010(c)(1)(H)(ii)

As outlined in PUC Rule 5.100, in 2017 net-metered customers received $0.06 per kWh ($60 per MWh) more for their generation when they transferred their RECs to the host utility, compared to if the customer elected to retain the RECs. In July 2018 the REC adjustor differential decreased to $50 per MWh, and in July 2019 it decreased another $10 per MWh to $40 per MWh. Absent further reductions to the differential and/or changes to the net-metering compensation structure, given the current favorable customer economics of selling RECs to utilities, PSD expects the majority of future net-metering customers will continue to choose to transfer their RECs, which will then be used by host utilities towards Tier II obligations. RECs from net-metering customers reduce the amount of RECs that utilities would have otherwise acquired from other sources, which would generally carry a lower cost. Further, because most DUs expect to have excess Tier II RECs and REC forecasts are currently lower than the REC adder, the sale of excess RECs will come at a cost to the DUs. From a DU power supply perspective, net-metering generation can be very difficult to forecast in large part due to changing rules and tax credits; therefore, many DUs, in preparation for RES, invested in Tier II-eligible projects or entered into long-term bundled PPAs and now have an excess of Tier II RECs that need to be sold into Massachusetts or Connecticut REC markets. Currently, regional premium REC markets are relatively balanced and trading around $30/REC, so while DUs are acquiring net-metered RECs at $60/REC, they are selling equivalent RECs for half of that. In the scenarios analyzed by PSD for this report, RECs from net-metering generation are more expensive than RECs from all other sources and in excess of what will be needed for Tier II obligations.

Effect of Tier III Electrification on Tier I and Tier II Obligations

Several eligible Tier III measures offer sources of new load for utilities.[93] The RES model allows the user to specify which Tier III measures utilities will incentivize to meet their obligations. [94] If utilities are assumed to incentivize Tier III measures that build electric load, their retail sales will be higher and thus their Tier I and Tier II obligations will also be higher. For example, a single passenger electric vehicle that displaces a standard internal combustion engine might use around 2 MWh per year. In a scenario where utilities rely exclusively on electric vehicles for Tier III compliance, this would amount to over 113,000 new EV's on the road between 2019 and 2028, and a total of 244,000 MWh of new load by 2028 that is not in the baseline load forecast. Higher costs for utilities to serve the additional load would be offset by additional retail revenues from increased electric sales. In contrast, if utilities exclusively incentivized non-electric Tier III measures, like biofuel burning equipment or weatherization upgrades, there would be no additional load or costs, and the Tier III costs would not be offset by higher retail sales.

PSD has assumed the following constant allocation of technologies will be used to meet Tier III requirements in each year of the projections:

Tier III Technology Allocation	
Cold Climate Heat Pumps	30%
Electric Vehicles and Charging Stations	45%
Weatherization	5%

[93] Tier III measures are represented in the RES Model consistent with the characterizations in the Technical Reference Manual (TRM). The TRM is developed and maintained by the Technical Advisory Group (TAG), of which the PSD is a member. Since the establishment of the RES in 2015, the TAG has been developing calculations that prescribe the amount a given Tier III measure will be credited toward a DU's Tier III obligation, informed by a variety of primary and secondary empirical and engineering studies.

[94] The current version of the RES model includes CCHPs, EVs, weatherization and custom projects as Tier III compliance measure options. For all projections, the technology allocation has been kept constant.

Custom	15%
Tier II RECs	5%

This allocation is intended to be a proxy for the State over 10 years, but each utility will have a different allocation of measures based on its territory and customers' needs that will change over time. This illustrative allocation was informed by utilities' Tier III plans, Efficiency Vermont's Demand Resource Plan, and conversations with the utilities. The allocation does not, however, consider any other State goals such as those for weatherization or electric vehicles. The Department does not expect this to be the actual allocation in each year but uses this illustrative allocation of measures in an effort to quantify the associated additional load and costs. In the first two years of compliance, more than 70% of obligations were met with custom measures; however, over the next 10 years, custom projects will likely become more difficult to identify and the electrification of transportation, including commercial scale, is expected to ramp up. It is expected that this allocation will vary greatly across utilities, for example Burlington Electric Department customers are primarily natural gas customers as well and much less likely to adopt CCHPs than customers that primarily heat with oil due to poor customer economics. With the current calculation method for Tier III credits where a heat rate is applied to fossil-fuel offset measures, utilities have generally not focused on weatherization because the credits are discounted, and no additional load is gained. The Department anticipates raising this issue in the 2020 Program Review.

Tier III Compliance Cost Components

Incentive Payments

Fossil-fuel price levels and project incentives influence customer adoption of Tier III measures. In general, consumers are assumed to act rationally, and the benefits of a Tier III measure must outweigh the costs to justify the investment. When fossil fuel prices are low, then the cost to own and operate standard fossil fuel equipment (furnaces, boilers, internal combustion engines, etc.) is also low relative to the cost to install, own and operate a substitute Tier III measure. Therefore, in a low fossil-fuel price environment, utilities may need to offer a greater financial incentive to encourage Tier III measures. Conversely, when fossil fuel prices are high, then the cost to operate traditional fossil fuel equipment relative to alternative Tier III measures is also high, and customers may not need as significant of a financial incentivize to invest in a Tier III measure.

The RES model allows for different assumptions about the future price of fossil fuels. In the scenarios analyzed by PSD for this report, three possibilities were explored: a base case assuming current fossil fuel prices will persist in real terms over the next ten years, and high price and low price cases that assume by 2028, prices will be 55% higher or 10% lower than they are today. The low fossil-fuel price scenario features utility incentive payments that are 30% higher than the base case, while the high fossil-fuel price case scenarios decreases incentives by 25%.

Retail rates are also affected by the fossil fuel scenario. For this analysis, retail rates are assumed to be tied to the market, inflation and depreciation. The portion that is tied to the market is assumed to be 50% of rates, and includes costs associated with energy, capacity, and transmission.[95] Energy prices in New England tend to track closely with natural gas prices such that in the high fossil fuel scenario, wholesale

[95] No T&D investments associated with upgrades to accommodate Tier III loads have been included in this analysis.

electricity prices reflect higher natural gas prices which then flow through to higher retail electric rates. The opposite is true for the low fossil fuel scenario, which results in lower retail rates.

Program Administration Overhead

Utilities will incur new costs to design, administer and document their Tier III programs. The scenarios PSD analyzed for this report assume these costs will total $800,000 in 2019, escalating by 3% thereafter.[96] This represents a small share of the total compliance expenditure in any scenario. In the early stages of RES, program costs may have significant year-over-year changes as experience will lead to gains in efficiency as the programs mature, but programs that capture low-hanging fruit will dry up. Future reports will provide opportunities to refine overhead cost assumptions with historical information.

Costs and Revenues of New Tier III Loads

If the Tier III measures incentivized by utilities are sources of new electric load, utilities will incur additional costs to supply and deliver that power to customers, which may be offset by higher retail sales. The RES model captures the cost of service for new load in energy, capacity, and regional transmission costs. The costs included in this model do not include investments in T&D infrastructure that may be both significant and required to accommodate additional loads. The incremental costs to provide capacity and transmission is determined by the operations of the Tier III equipment. If Tier III equipment increases peak loads, capacity and transmission costs will be incurred, increasing the cost to serve. Conversely, Tier III loads that are controllable or do not add to peak demand will have much lower costs associated with them. From a policy perspective, most new load associated with Tier III measures should be controllable and not increase peak loads so that they will help to offset other RES compliance costs. The contribution of new Tier III load to peak loads is a variable in the RES model, and used to test the financial implications of load management; the scenario resulting in the low incremental cost of RES assumed 10% of the new load is present at the time of the peak, and the high incremental cost scenario assumed 75% of new load would add to the peak.

Public Comments

Pursuant to the statute, the Department has made the RES model and all relevant assumptions public on its website and sought public comments on it. Comments were received from Burlington Electric Department (BED), Green Mountain Power (GMP), and Washington Electric Cooperative (WEC). BED noted that its costs will differ substantially from the statewide average that is modelled because BED is 100% renewable and exempt from Tier II and Standard Offer, and it has a different customer base from the statewide average which will result in different Tier III measures. BED emphasized that the model does not account for T&D costs which may offset the declining RES costs over time. Each set of comments provided an independent REC price forecast, which were all different but similar to the base forecast used in the model. Both GMP and WEC highlighted the difficulty in forecasting net-metering deployment rates and the significant impact it can have on the overall cost of RES, but found the Department’s three scenarios to be reasonable.

[96] Actual 2018 overhead costs were reported to be $820,025. See Case No. 19-0716 for 2018 RES compliance filings made by utilities.

Summary of Program Performance to Date

Pursuant to the PUC's *Order Implementing the Renewable Energy Standard*, issued in Docket 8550 on June 28, 2016, Vermont utilities were required to submit the annual RES filings by August 31, 2019 demonstrating compliance for 2018. As of January 15, 2020, the PUC has not yet issued an order in Docket 19-0716 on 2018 RES compliance. In our review of the compliance filings, the Department found that utilities demonstrated compliance with Tiers I and II of the RES by retiring RECs in the NEPOOL GIS, which closed its trading period for 2018 on June 15, 2019. Additionally, utilities submitted Tier III compliance claims to PSD on March 15; the Department evaluated Tier III performance and presented those findings in a Tier III Report filed on July 16, 2019.

All utilities met the 2018 RES requirements. Tier I was met with RECs from a variety of resources including owned hydro facilities, long-term Hydro-Quebec bundled purchases, regional hydro REC only purchases, and unbundled attribute-only Hydro-Quebec purchases among others. In 2018, Tier II was satisfied with continued growth in net-metering, commissioning of standard-offer projects, and in-state solar, both utility and merchant owned. With respect to Tier III, obligations were met with a variety of measures including programs to promote the adoption of cold climate heat pumps, electric vehicles, electric vehicle charging stations, weatherization, and wood heat. Additionally, several utilities developed custom projects to meet their Tier III obligations which were both cost effective and delivered significant fossil-fuel savings, while other DUs met portions of their Tier III obligation with the retirement of Tier II RECs. Custom projects included extending electric lines to sawmills and maple sugaring operations that were previously dependent on diesel or gasoline generators, upgrading snowmaking equipment and lighting.

Key metrics summarizing 2018 RES performance are included in the table below:

2018 RES Performance

	REC Retirements		*Compliance Cost*
Tier I	3,475,732	RECs	$1,740,000
Tier II[97]	98,222	RECs	$2,570,000
Tier III	124,083	Mwhe[98]	$3,150,000
Total Cost of Compliance			$7,460,000
Rate Impact of RES Compliance[99]	0.8%		
CO2 Reduction from RES[100]	610,211	tons of CO2	

[97] The 98,222 2018 Tier II REC retirements include 15,980 RECs retired for Tier III compliance.

[98] MWhe is the nomenclature for MWh equivalent for Tier III savings claims.

[99] The rate impact is based on the 2018 total gross receipts of $886,117,966

[100] Emissions reductions for 2018 are based on the change in Vermont's power supply portfolio from renewables, which increased from 35% in 2016 to 62% in 2018, resulting in a reduction in the amount of energy from the residual mix, which in 2018 had an emissions factor of 882 lbs/MWh. Emission reductions associated with Tier III measures are also included. Tier III credits are based on lifetime savings. Based on average 13 year life of Tier III measures, the annual MWh savings was calculated to be 9,545 MWh resulting in the equivalent of 3,820 tons of CO2 avoided.

Compliance costs for 2018 were estimated to be about $7.5 million, compared to maximum potential costs of $44 million.[101] Carbon Dioxide (CO2) emissions were reduced by approximately 990,000 tons from 2016 emissions.[102] This shift to more renewables combined with an increased share from nuclear energy brings Vermont's average emissions rate down to 69 pounds of CO2 compared to the regional New England average of 682 pounds per MWh in 2017.[103]

With only two years of experience, it is too early to draw any conclusions about the overall economic impacts, customer savings, fuel price stability, and effects on transmission and distribution upgrade costs. The Department will continue to monitor each of these areas as the program matures.

Projections of Future Program Performance

In 2016, Vermonters directly consumed around 103,000,000 mmBtu of fossil-fuel energy for heating buildings and transportation. [104] Additionally, Vermonters indirectly consumed around 22,000,000 mmBtu of fossil fuel through electric usage.[105] Meeting the RES Tier III obligations requires ongoing reductions in direct fossil fuel consumption (or end-use consumption) of several tens of thousands of mmBtu each year. Similarly, meeting the Tier I and Tier II requirements implies ongoing reductions in utility procurement of non-renewable source-energy of hundreds of thousands MMBtu per year. At this trajectory, PSD estimates that end-use consumption of fossil fuels will be about 3,300,000 mmBtu lower in 2028. This represents a reduction of 2.7% in overall fossil fuel end-use as a result of RES Tiers I, II and III. There will be much more significant reductions in consumption of source fossil-fuel energy from the greening of Vermont's electric mix, which will be lower by almost 14,000,000 mmBtu in 2028, a reduction of 11% relative to 2016 levels.[106] Additionally, Vermont's portion of electricity from nuclear has increased from 13% in 2016 to 30% in 2018; while that share could decrease with contract expirations, the Department has assumed that 30% will continue to come from nuclear or other non-fossil fuel sources for the entire projection period. Overall, across all energy using sectors, PSD estimates that by 2028 Vermont will consume around 14% less fossil-based energy than it does today as a direct result of RES, with an additional 10% reduction resulting from the increased share of nuclear. Similarly, carbon dioxide emissions could be reduced by 900,000 tons in 2028 as a direct result of RES, a reduction on the order of 9% relative to recent levels across all sectors (estimated to be around 10,000,000 tons[107]), with an additional 375,000 tons of carbon saving resulting from the assumed increased share of electricity from non-fossil generators.

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[101] Maximum potential costs reflect what the costs would have been if ACP was paid to meet all 2018 RES requirements.

[102] In addition to CO2 reductions directly resulting from RES, Vermont's electric mix was 30% nuclear in 2018 compared to 12% in 2016. This increase may be a result of utilities being incentivized to decrease their share of fossil fuel energy for Tier III purposes, but for purposes of this report, the reduction in emissions from increased nuclear has not been categorized as being attributable to RES, except as accounted for in the Tier III credit calculation.

[103] https://www.iso-ne.com/static-assets/documents/2019/04/2017_emissions_report.pdf

[104] http://eanvt.org/wp-content/uploads/2018/06/EnergyActionNetwork_AR_2017_AA_final.pdf

[105] Based on 52% of load from ISO-NE residual mix at an average heat rate of 8,000 mmbtu/MWh

[106] Much of Tier I and Tier II savings are a result of purchasing RECs from existing resources, so while Vermont is reducing its fossil fuel consumption, the regional impact on incremental renewable energy is limited.

[107] Vermont Greenhouse Gas Emissions Inventory Update: Brief 1990-2015, published the Agency of Natural Resources.

Using the RES model, PSD finds there to be a wide range of credible outcomes of the total incremental cost of the RES requirements over the next ten years (2019-2028). Costs could be as low as $10 million (NPV), or as high as $106 million. The primary net cost drivers in the model are:

1) Tier I and Tier II REC prices,
2) Net-metering deployment rates and costs,
3) Tier III incentives paid by utilities to customers, and
4) the cost to serve new load associated with Tier III measures.

The table below summarizes what the PSD considers credible ranges for each compliance tier over the next 10 years.

	HIGH INCREMENTAL COST	LOW INCREMENTAL COST
REC Price Forecast	HIGH	LOW
NM Adoption Rate	HIGH	LOW
Peak contribution of New Load	90%	None
Fossil Fuel Price	LOW	HIGH
Tier 1 Cost	$136,000,000	$20,000,000
Tier 2 Cost	$63,000,000	$48,000,000
Tier 3 Net Cost	-$28,000,000	-$60,000,000
TOTAL Cost of RES	**$171,000,000**	**$8,000,000**
Rate Impact	5.02%	0.56%

The most significant difference between the upper and lower bounds in the table above is related to Tier I REC prices. PSD expects Tier I compliance costs to be around $30 million over the course of 10 years, but changes to renewable policies in neighboring states can alter the supply and demand landscape and have significant price implications. Tier II costs are most impacted by net-metering deployment and to a lesser extent REC prices. The fossil fuel price environment has a significant impact on Tier III costs. If fossil fuel prices fall to and remain at historically low prices over the next ten years, utilities will likely have to pay higher incentives to entice customers to transition toward fossil fuel alternatives like cold climate heat pumps and electric vehicles.

All else equal, to the extent that utilities comply with Tier III obligations by incentivizing load-building measures like heat pumps, electric vehicles, and other custom electrification projects, upward rate pressures associated with RES compliance will be lower than if utilities incentivize non-load building Tier III measures such as weatherization or biofuel-burning equipment. With increased electricity consumption, the costs of meeting the RES requirements can be spread across a greater volume of unit sales and will dampen the rate impacts. For example, if utilities were to rely exclusively on heat pumps to meet Tier III obligations, by 2028 they would be selling an additional 400,000 MWh of electricity. This additional load represents almost 8% of current retail sales (about 5,500,000 MWh annually) and has a meaningful moderating effect on upward rate pressures if the new load does not contribute to peak loads and do not require significant transmission and distribution upgrades. All but one scenario analyzed for this report resulted in upward rate pressure. In the scenarios PSD considers most likely, the rate impacts attributable to the RES ranged from a 2% to 4% percent higher than a baseline rate path on average over the next ten years. In the unlikely scenario where Tier III is met without load building measures (i.e. weatherization) the annual rate impact averaged 6.5%.

The higher compliance cost-scenarios analyzed by PSD for this report assume that 75% of all new electric load resulting from Tier III measures will add load during times of peak demand. This could be the case if heat pumps and electric vehicle charging do not have custom operational programming or time-of-use controls. On the other hand, if it is assumed that heat pump and electric vehicle loads come online without adding at all to peaks, it is conceivable that utility compliance with the RES would exert no net upward rate pressure over time.

Overall, PSD anticipates the RES will result in slight upward long-term pressure on retail electric rates. But whatever actual RES compliance costs turn out to be, it is certain that ratepayer costs will be lower if utilities ensure all new Tier III loads come online as flexible demand-side resources that do not add to existing levels of peak demand. To illustrate this point, a heat pump or electric vehicle that draws large amounts of power from the grid during peak times might cost the utilities as much as several hundred dollars per MWh consumed by the equipment. This is significantly more than the current retail rate of roughly $180 per MWh (and would thus contribute to upward rate pressure). This does not account for the fact that increases in peak could also result in increased distribution and subtransmission costs. If those same technologies can avoid loading the grid at peak times though, it might only cost utilities $30 to $50 per MWh consumed by the equipment.

RES Compliance

As of January 15, 2020, the PUC has not yet issued an order in Docket 19-0716 on 2018 RES compliance. At this time, no changes to the requirements are recommended. There will be a 2020 Program Review of RES at which time the Department anticipates a comprehensive review of the program.

Conclusion

The first two compliance years of RES, combined with the Department's modelling, suggests the RES will have moderate rate impacts while producing meaningful reductions in fossil-fuel usage and greenhouse gas emissions. If utilities meet Tier III requirements with measures that increase electric load and do not contribute to peak loads, the increased consumption of electricity will spread utility costs over a greater volume of sales, mitigating the upward pressure on rates associated with RES compliance expense.

Key Assumptions

The table below documents the key input assumptions in the scenario analyses that produced PSD's compliance cost and rate impact projection ranges for what it considers most likely high and low cost scenarios (see *Projections of Future Program Performance*). Low and high fossil fuel price levels are relative to a base case assumption that escalates current prices at the assumed rate of inflation. The cost to serve Tier III load does not capture possible local transmission or distribution capital expenses or other retail-level costs. Wholesale power costs are inclusive of energy charges, capacity charges and regional network service charges. PSD has constructed the below scenarios to represent what it considers realistic worst and best case scenarios.

	Higher Rate Impact	Base Case Assumptions	Lower Rate Impact
General Assumptions			
Inflation Rate	+1.9%	+1.9%	+1.9%
Customer Discount Rate	6.0%	6.0%	6.0%
Tier III Load Profile	75% Peak Contribution	25% Peak Contribution	10% Peak Contribution
Net-Metering Deployment	397 MW by 2028	330 MW by 2028	313 MW by 2028
Tier I REC Price	Avg $5.50 /MWh	Avg $2.60/MWh	Avg $1.00/MWh
Tier II REC Price	Avg $33.80 /MWh	Avg $23.60/ MWh	Avg $15.30/MWh
Energy Price Assumptions			
Fossil Fuel price scenario	Low	Mid	High
Fossil Fuel price trend	-1%/yr	1.6%/yr	+5.0%/yr
Wholesale power cost trend	-1.2%/yr	1.4%/yr	+4.9%/yr

Assumuptions Tab

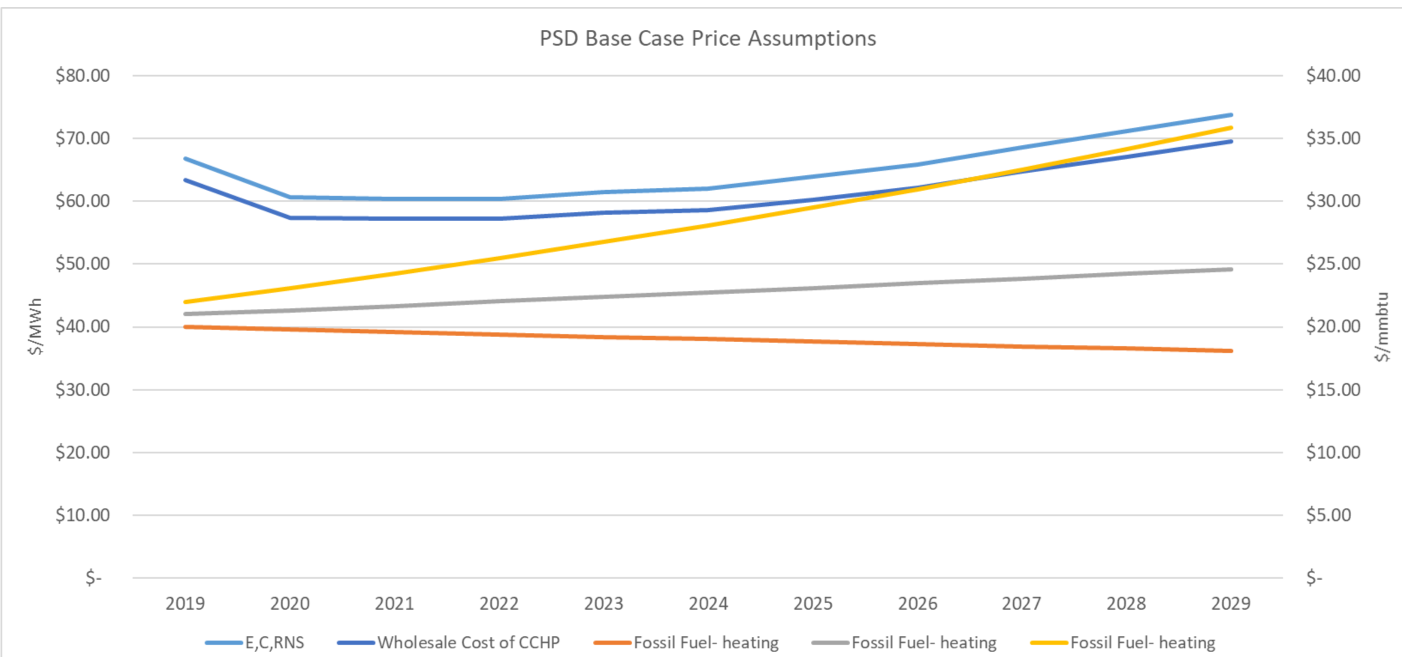
Assumption Level of Certainty	ASSUMPTIONS	PSD BASE CASE	HIGH SCENARIO	PSD BASE CASE
	base year	2019	2019	2019
high	inflation rate	1.90%	1.90%	1.90%
high	customer discount rate	6%	6%	6%
high	depreciation rate	-1%	-1%	-1%
low	NM Escalation Rate	VELCO	HIGH	LOW
mid	REC Scenario	MID	HIGH	LOW
mid	residential electricity rate ($/MWh)	$ 172	$ 172	$ 172
mid	retail electricity price trend	2.2%	2.2%	2.2%
low	Fossil Fuel Scenario	MID	LOW	HIGH
	Low Fossil Fuel escalation	-1%	-1%	-1%
	Mid Fossil Fuel escalation	1.6%	1.6%	1.6%
	High Fossil Fuel escalation	5%	5%	5%
mid	**Tier III Technology Allocation**			
	CCHP	30%	30%	30%
	EV	45%	45%	45%
	Weatherization	5%	5%	5%
	Custom	15%	15%	15%
	Tier II RECs	5%	5%	5%
	TOTAL	100%	100%	100%
	Tier III BASE Incentive Rates ($/claimed MWh)			
	CCHP	$ 25.0	$ 25.0	$ 25.0
	EV	$ 30.0	$ 30.0	$ 30.0
	Weatherization	$ 20.0	$ 20.0	$ 20.0
	Custom	$ 12.0	$ 12.0	$ 12.0
	Tier III Incentive Escalation			
	CCHP	0%	0%	0%
	EV	-2%	-2%	-2%
	Weatherization	0%	0%	0%
	Custom	15%	15%	15%
	Tier II RECs	0%	0%	0%
	CCHP LMP multiplier	1.05	1.05	1.05
	EV LMP multiplier	0.97	0.97	0.97
	Weatherization multiplier	1	1	1
	Custom multiplier	1	1	1
	Tier III contribution to RNS peaks	0.25	0.75	0.1
	Tier III contribution to FCM peaks	0.25	0.75	0.1
	Tier III Overhead in Year 1	$ 800,000	$ 800,000	$ 800,000
	Tier III Overhead escalation	3%	3%	3%

Annual Base Case Output Results

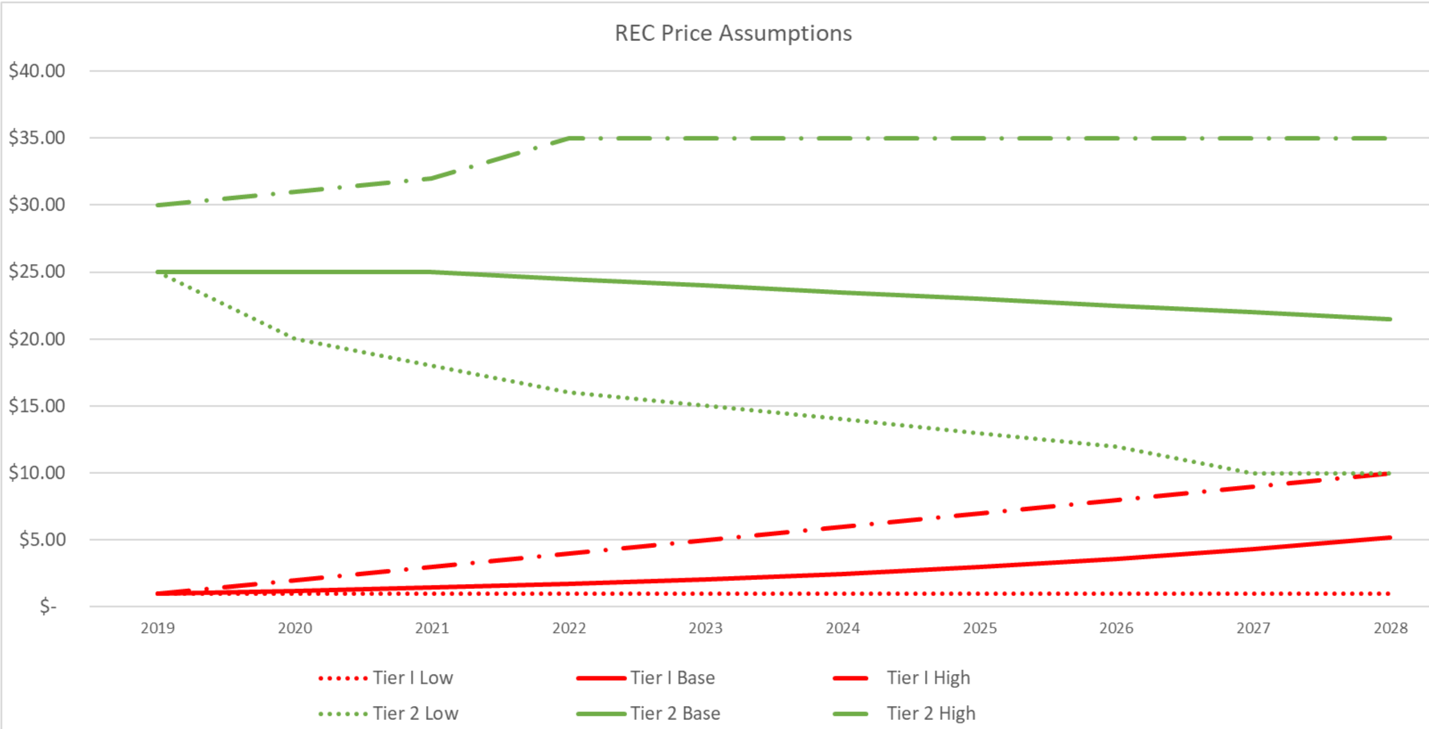
PSD BASE CASE	TOTAL	2019	2020	2021	2022	2023
TOTAL Cost of RES	$52,827,854	$ 9,322,111	$ 10,004,936	$ 9,974,234	$ 9,249,585	$ 8,466,973
Rate Impact	2.80%	3.29%	3.80%	3.97%	3.82%	3.50%
Total Energy Consumption Impact (mmbtu)	(11,009,868)	(357,015)	(522,230)	(712,251)	(925,803)	(1,164,177)
Electric Energy Consumption Impact (MWh)	1,080,040	34,005	50,038	68,578	89,601	113,185
Electric Energy Consumption Impact (%)	2.6%	0.64%	0.95%	1.31%	1.73%	2.19%
Total Fossil Fuel Consumption Impact (mmbtu)	(134,511,649)	(9,143,807)	(10,995,203)	(11,168,291)	(11,425,141)	(13,446,146)
Total lbs of CO2 Saved	15,527,533,939	1,023,384,358	1,236,357,810	1,265,710,740	1,305,729,131	1,541,706,008
Total tons of CO2 Saved	7,045,161	464,330.47	560,961	574,279	592,436	699,504

	2024	2025	2026	2027	2028
TOTAL Cost of RES	$ 6,754,504	$ 4,769,877	$ 4,247,460	$ 2,882,600	$ 1,425,381
Rate Impact	2.88%	2.17%	1.64%	1.04%	0.44%
Total Energy Consumption Impact (mmbtu)	(1,428,198)	(1,718,277)	(1,963,952)	(2,217,965)	(2,484,022)
Electric Energy Consumption Impact (MWh)	139,416	168,351	194,613	222,253	251,544
Electric Energy Consumption Impact (%)	2.70%	3.27%	3.79%	4.33%	4.90%
Total Fossil Fuel Consumption Impact (mmbtu)	(13,832,887)	(14,259,534)	(16,333,015)	(16,738,274)	(17,169,352)
Total lbs of CO2 Saved	1,599,012,936	1,662,264,305	1,904,466,288	1,963,270,806	2,025,631,559
Total tons of CO2 Saved	725,505	754,203	864,095	890,776	919,071

Base Case Price Assumptions



REC Price Assumptions



Appendix F – Additional Data – Transportation

The Table Below is from VTrans' 2017 Transportation Energy Profile and includes the CEP's Transportation related goals and estimated progress towards those goals.

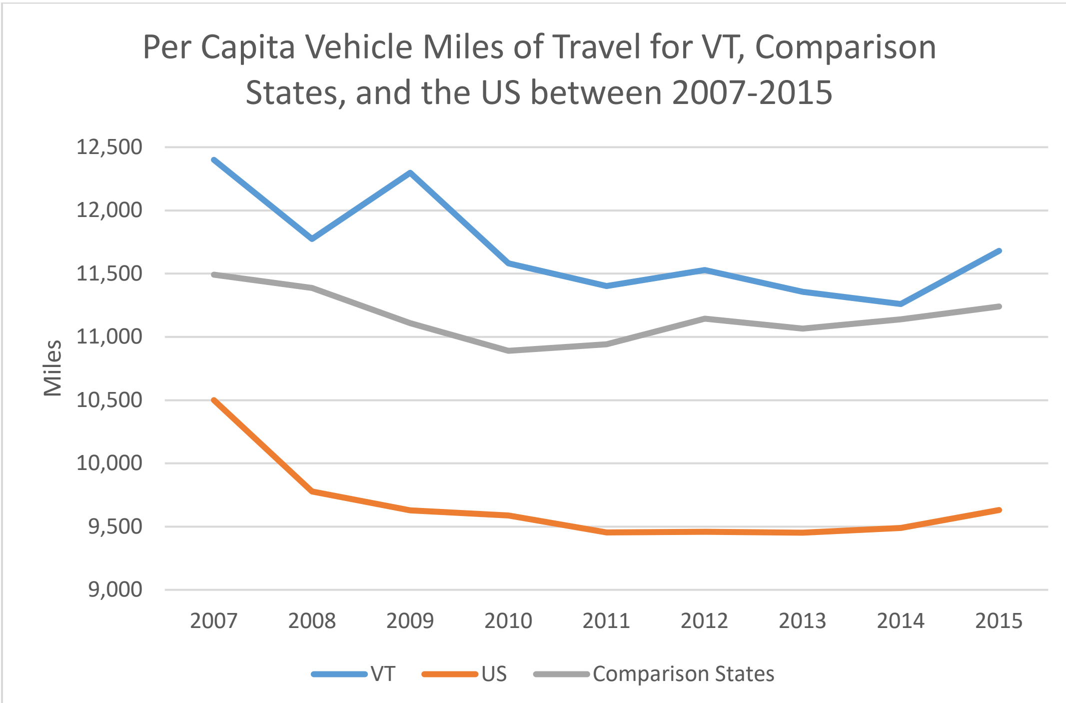
Table E-1. Current Progress toward Achieving CEP Transportation Targets

	2016 CEP Transportation Targets	Baseline		Most Recent		Average Rate of Change[1]		
		Value[3]	Year	Value	Year	Period	Target	To Date
Goals for 2025	1. Reduce energy use by 20%	49.1	2015	49.1	2015	'16-'25	-1.09[3]	N/A
	2. Increase the share of renewable energy to 10%	5.5%	2015	5.5%	2015	'16-'25	0.5%[3]	N/A
	3. Reduce GHGs emissions by 30% from 1990 levels	3.22	1990	3.67	2013	'16-'25	-0.16[3]	N/A
Supporting Objectives for 2025 and 2030	1. Hold VMT/capita stable	11,402	2011	11,680	2015	'11-'30	0	69.5
	2. Reduce the share of SOV commute trips by 20%	79.5%	2011	80.7%	2015	'11-'30	-1.1%	0.3%
	3. Increase the share of bicycle/ pedestrian commute trips to 15.6%	7.2%	2011	7.1%	2015	'11-'30	0.4%	-.03%
	4. Increase state park-and-rides spaces to 3,426	1,142	2011	1,525	2017	'11-'30	120	64
	5. Increase annual transit ridership to 8.7 million trips	4.58	2011	4.71	2016	'11-'30	0.22	0.03
	6. Increase annual Vermont-based passenger-rail trips to 400,000	91,942	2011	92,422	2016	'11-'30	16,214	96
	7. Double the rail-freight tonnage in the state	6.6	2011	7.3	2014	'11-'30	0.35	0.23
	8. Increase electric vehicle registrations to 10% of fleet	0.0%	2011	0.3%	2016	'11-'25	0.7%	0.05%
	9. Increase renewably powered heavy duty vehicles to 10% of fleet	Since diesel vehicles can run on conventional diesel and biodiesel, this objective cannot be tracked without tracking biodiesel fuel sales						

[1] Rates of change are annual averages. Target rates are calculated for the period shown and indicate the average annual rate of change required to meet the CEP target. Rates of change for Objectives 2-3 are measured as the change in percent of total commute trips. Objective 8 is measured as the change in the percent of the total vehicle fleet.
[2] Units: Goal 1 - trillion Btu; Goal 3 - MMTCO2e; Obj. 5 - millions of riders; Obj. 7 - millions of tons
[3] Preliminary target rate of change assumes 2016 value is equal to the most recent value.

Vehicle Miles of Travel Trends

As shown by the figure below, per capita vehicle miles traveled (VMT) in Vermont has steadily decreased since 2009. However, according to the most recent data available VMT increased between 2014-2015. Recent fuel price trends may help to explain this increase.



Mode share and trends

Another factor that affects the energy consumed in the transportation sector are the mode shares, i.e. the method of transport that people choose. The more people choose less energy intensive forms of transportation such as carpooling, biking or walking, and riding public transit, the less energy will be consumed in the transportation sector. The table below shows that most people still choose to drive alone, with moderate increases in the percentage choosing to do so in the last few years.

Commuter Mode Share, 2009-2015[108]

Comparison of Commuter Mode Share (%) for Vermonters, 2009-2015

Commuting Modes	NHTS 2009	ACS (5-Year Estimates)						
		2009	2010	2011	2012	2013	2014	2015
Drive Alone	82.7%	79.3%	79.4%	79.5%	79.7%	80.1%	80.5%	80.7%
Carpool	11.7%	11.4%	11.3%	11.1%	11.0%	10.8%	10.4%	10.1%
Public Transportation	0.6%	1.0%	1.1%	1.2%	1.2%	1.3%	1.3%	1.3%
Walk	3.1%	6.6%	6.6%	6.4%	6.4%	6.1%	6.0%	6.2%
Bicycle	0.9%	0.6%	0.6%	0.8%	0.9%	0.9%	0.9%	0.9%
Taxi, Motorcycle, Other	0.1%	1.1%	1.0%	1.1%	1.0%	0.9%	0.9%	0.9%

[108] Vermont Agency of Transportation, *The 2017 Vermont Transportation Energy Profile,* September, 2017.