2. The Demand for Electricity

The population of Vermont and the number of businesses that are located here are two of the primary determinants of the demand for electricity. GMP has just over 262,000 customers, 85 percent (223,000) of whom are residential. These residential customers represent 35 percent of GMP's electricity sales. The remaining 65 percent of GMP's sales come from just over 39,000 commercial and industrial customers. The following table shows that the number of GMP customers is expected to grow at an average of 0.45 percent per year over the next 20 years.

Table 2.1 Customer Forecast

Year	2015	2020	2025	2030	2035	CAGR
Residential	223,694	232,331	238,020	241,717	246,200	0.48%
C&I	39,091	40,072	40,702	41,105	41,586	0.31%
Total Customers	262,785	272,404	278,722	282,822	287,786	0.45%

2.1 Methodology & Major Assumptions

The sales forecast is based on regression models that relate monthly electricity sales to population projections, economic conditions, end-use energy intensity changes (consumption patterns), retail electricity prices and weather. The models were estimated using monthly billing data from January 2004 to March 2014. The major assumptions are listed in the following bullets.[1]

- Economic Growth & Population: The economic and population forecast is based on the Vermont state economic forecast from Moody's Analytics in October 2013, and was adjusted downward by Itron as described in Section 2 of the Load Forecast Report[2].

- End-Use Intensities & Energy Efficiency: The Energy Information Agency's (EIA) end-use intensity projections for New England form the foundation for the forecast. These projections are adjusted to reflect end-use saturations for Vermont, and for energy efficiency[3] using Scenario 2 from VEIC's 2014 Demand Resource Plan[4].

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[1] For a more in-depth discussion of the forecast methodology and assumptions, please refer to Itron's 2015 IRP Load Forecast Report, which is included in the Appendix.
[2] "GMP 2015 IRP Load Forecast Report", Itron, Aug. 2014, Section 2, Economic Drivers, Page 8
[3] "GMP 2015 IRP Load Forecast Report", Itron, Aug. 2014, Adjusting for State Efficiency Program Impacts, Page 13
[4] "EEU-2013-01 Demand Resources Plan Budget and Savings Recommendations" VEIC, April 2014

- Retail Electric Prices: Nominal retail electricity prices are assumed to grow at inflation. This means that a flat, real price of electricity was assumed in the sales forecast. A negative price elasticity was imposed on the forecast model as described in Itron's Load Forecast Report[5]. However, the Resource Plan (Chapter 7) does not adjust the load forecast in consort with assumed changes in the price of electricity.

- Weather: The forecast is based on actual heating and cooling degree days from 1994–2013, using a load-weighted average of Burlington and Rutland.[6]

2.2 GMP's Historical Sales

Over the past 23 years, the combined sales of GMP, CVPS, and Vermont Marble have been growing at a compound annual growth rate (CAGR) of 0.6 percent per year. The 1990s were a relatively high-growth decade with 1.4 percent annual growth, but growth turned slightly negative in the 2000s due to a combination of the 2001 and 2008 recessions and investment in energy efficiency. From 2010 to 2013, loads have been almost flat, declining by about 0.1 percent per year.

Table 2.2.1: Historical Sales by Decade (MWh)[7]

Year	Actual Sales (MWh)	Year	Actual Sales (MWh)	Year	Actual Sales (MWh)
1990	N/A	2000	4,363,150	2010	4,309,643
1991	3,779,818	2001	4,326,909	2011	4,278,648
1992	3,885,205	2002	4,347,148	2012	4,186,418
1993	3,860,954	2003	4,340,111	2013	4,295,605
1994	3,878,856	2004	4,428,459		
1995	3,931,647	2005	4,530,964		
1996	4,046,649	2006	4,464,741		
1997	4,115,765	2007	4,521,051		
1998	4,162,651	2008	4,437,592		
1999	4,284,046	2009	4,228,052		
CAGR '91-'99	**1.4%**	**CAGR '00-'09**	**-0.3%**	**CAGR '10-'13**	**-0.1%**

[5] "GMP 2015 IRP Load Forecast Report", Itron, Aug. 2014, Pages 10 & 61
[6] "GMP 2015 IRP Load Forecast Report", Itron, Aug. 2014, Page 10
[7] "kWh Sales & Revenue 1990-2013.xlsx", VT Dept. of Public Service

2.3 Energy Efficiency & Electrification Trends

In keeping with past practice, GMP and Itron worked with EVT, VELCO and the Vermont System Planning Committee (VSPC) to agree upon energy efficiency assumptions in our respective peak and energy forecasts. In general, there is alignment between GMP's IRP load forecast and the VSPC's statewide load forecast. For instance, Itron used the same economic growth, population, weather, and electricity price assumptions in both the VELCO and GMP forecast. The majority of the end-use intensity projections are also the same.

However, the VELCO/VSPC forecasting schedule was on a different timeline than GMP's IRP, and it is our understanding that the assumptions for electric vehicles, air source heat pumps, and solar net metering differ somewhat. As a result, the following sections describe in more detail how GMP dealt with these three electrification trends within its IRP forecast.

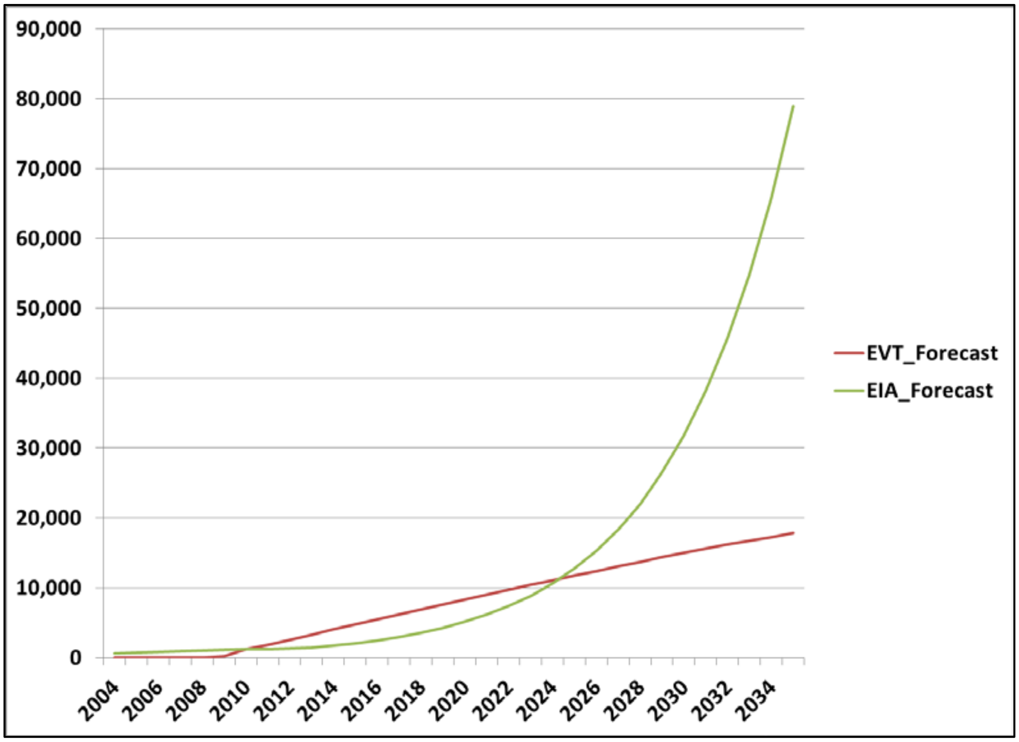
Air Source Heat Pumps

According to the US Energy Information Administration (EIA), air source heat pumps (ASHPs) are displacing natural gas in Heating, Ventilation and Air Conditioning (HVAC) applications in every region except the Northeast[8]. However, energy efficiency programs in all six New England states have been providing rebates to promote cold-climate ASHP adoption. In addition, GMP is offering its customers a lease to defray the up-front cost of installing a heat pump. As a result, we believe that the Northeast is simply lagging the national trend, and is not likely to represent an exception to it. Furthermore, the high cost and market penetration of heating oil as a source of heating energy in the Northeast points to even stronger heat pump penetration.

GMP collaborated with EVT, Itron and the VSPC to adopt a common market penetration trend for ASHPs in Vermont. The following figure shows the difference between EIA's heat pump forecast for New England and EVT's forecast of heat pump market penetration. EIA assumes linear growth over the next 10 years, and used a near-zero base of existing units, while EVT assumes 20 percent annual compound growth using a base of about 2,000 existing heat pump units[9], which is grounded in its regional market intelligence and relationships with in-state heat pump installers. Interestingly, both the EIA and EVT forecasts result in the same level of market penetration in 10 years; about 5 percent or 12,000 homes in 2024. After this point, EVT's forecast continues its exponential growth while EIA's forecast continues at a linear pace.

[8] "Excluding Northeast, NatGas Losing Market Share for Heating", Natural Gas Intelligence, Sept. 25, 2014
[9] "Heat Pump Penetration for DRP, 20 Year Projection", Efficiency Vermont, 2013

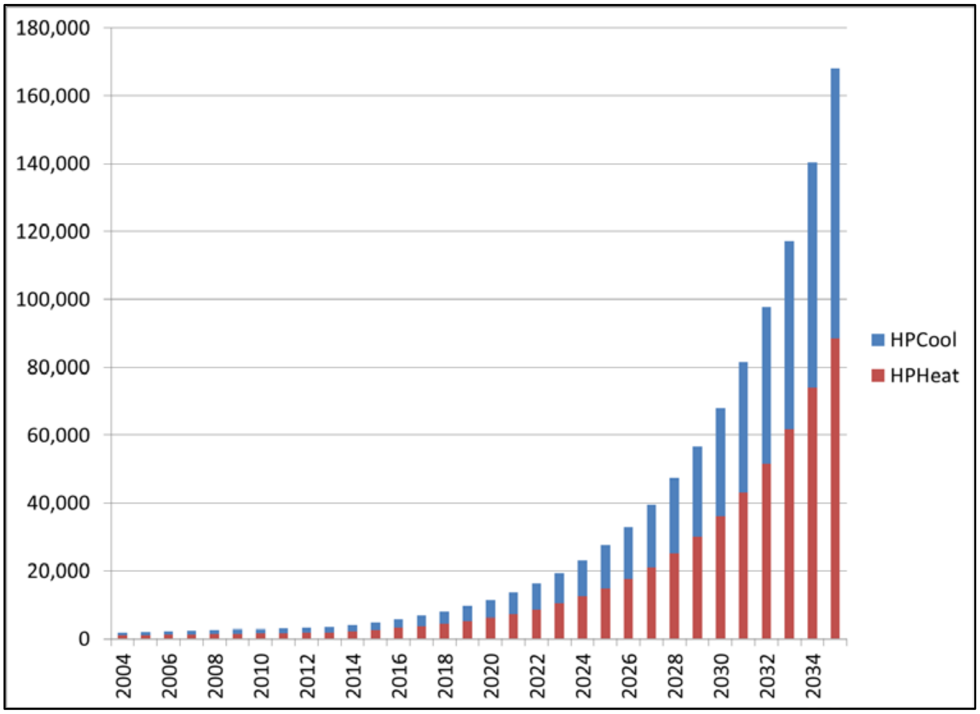
Figure 2.3.1 Heat Pump Market Penetration Comparison



After considering this information, GMP directed Itron to use the EVT penetration forecast for three reasons. First, it is consistent with the best information that is available from EVT, and is incorporated into the Scenario 2 of the DRP. Second, the first 10 years of the forecast align well with GMP's own lease program expectations. Third, the cost advantage of heat pumps over heating-oil-based systems is so large (i.e, payback so short) that the economics suggest significant market penetration is likely. Finally, it is prudent to anticipate potentially large, long-term changes like these in planning processes. This is especially true when three more IRP planning cycles will be complete before the EVT and EIA forecasts of market penetration begin to diverge.

The following figure shows the impact of EVT's forecast of heat pump market penetration on GMP's electric sales in the summer and winter months. For heating end uses, electric sales for heat pump operation in 2024 are projected to be about 12,000 MWh, which is less than 0.3 percent of total electric sales. At the end of the forecast period in 2035, heat pumps sales are expected to be about 90,000 MWh, or 2 percent of electric sales. The consumption in electric usage from heat pumps for cooling is projected to be nearly as large as that for heating. In 2014, heat pump electric consumption for cooling is projected at about 9,000 MWh, and in 2035 it is projected at about 80,000 MWh.

Figure 2.3.2 GMP Heat Pump Energy Consumption (MWh/Yr)



Electric Vehicles

The Vermont Department of Transportation (VTrans) published its Electric Vehicle Charging Plan in July 2013, which included multiple outlooks for EV penetration in Vermont. GMP consulted with VEIC, which co-authored the VTrans report, to gain its insight into which outlook was most plausible in the eyes of policymakers and planners. As a result of these conversations, it was felt that the Vermont Air Pollution Control Division's (APCD) outlooks represented a reasonable low and medium outlook. For planning purposes, the Comprehensive Energy Plan (CEP) goal of 515,000 EVs by 2050 was considered the high case.

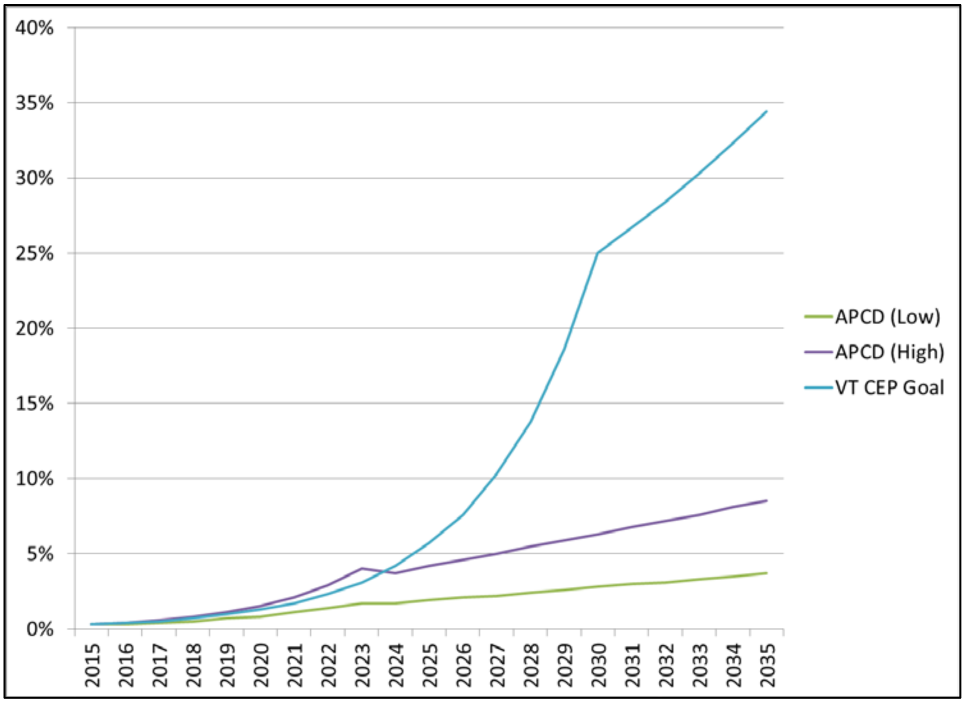
Table 2.3.1 Electric Vehicle Registration Outlooks for Vermont[10]

YYYY	APCD Low	APCD High	VT CEP Goal
2013	692	692	692
2023	10,000	23,000	
2030			143,000
2050			515,000

[10] Electric Vehicle Fueling Infrastructure Plan, VTrans, July 2013, Table 2.4, Page 20-21

Using extrapolated numbers from this table, GMP created the following market penetration curves for its service territory. Because EVs were not included in the Itron forecasting processes, GMP made assumptions about fuel efficiency and vehicle miles traveled per year, and then multiplied the MWh/Vehicle/Year by the number of EVs in the extrapolated curves. The resulting loads were then used to increase the Itron forecast for the low, mid and high cases.

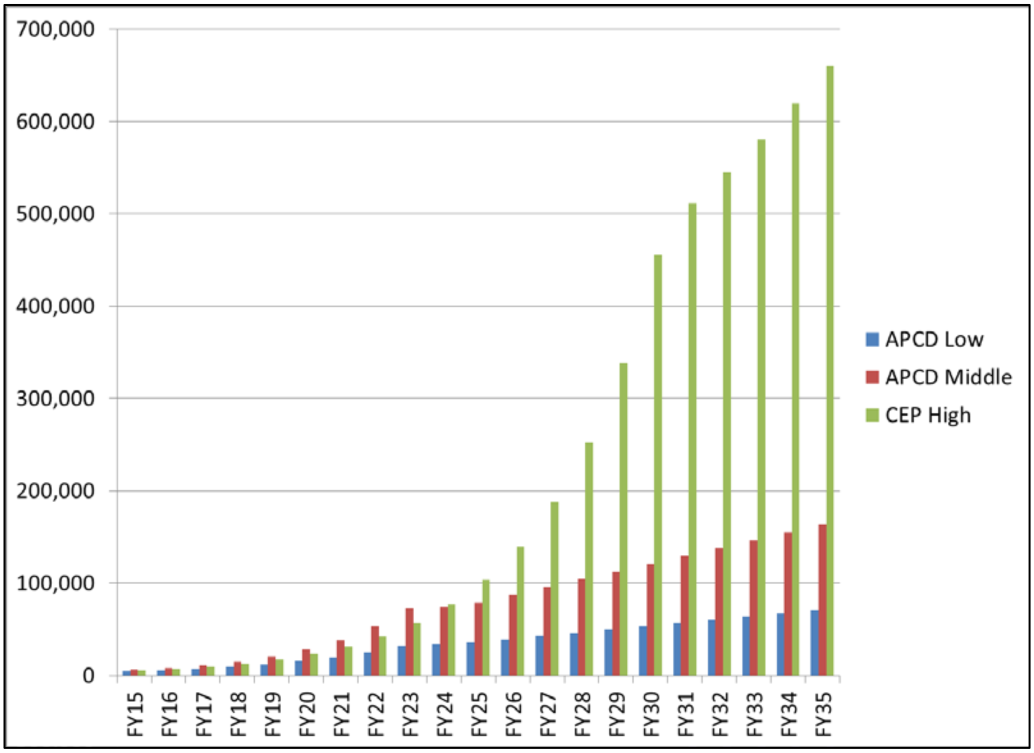
Figure 2.3.3 Electric Vehicle Market Penetration Outlooks for Vermont



The results show that both APCD forecasts result in small, single-digit market penetrations (2-4 percent) over 10 years, and 4 percent to 9 percent market penetration in 20 years. These penetration rates translate into less than 4 percent of electricity sales in 2035, which is both manageable and within the forecast's margin of error.

However, the CEP's goal penetration curve results in EVs being 35 percent of all registered vehicles and 15 percent of electricity sales in 2035. As a customer class, this would place EVs among GMP's largest customers. Interestingly, even this rate of fuel switching results in less than 1 percent/year compound annual growth in electric loads over the forecast period, which is both moderate and manageable. Nevertheless, GMP will continue to monitor the still-emerging penetration rate of electric vehicles so that it can plan accordingly.

Figure 2.3.4 GMP Electric Vehicle Electricity Sales (MWh/Yr)



Net Metering

Since Vermont's original net-metering law was enacted in 1998, it has been updated several times, most recently in Act 99 in 2014. Act 99 included a number of important changes, but for the purposes of load forecasting, the most significant change was to the cumulative capacity cap. This cap on the cumulative installed capacity of net-metered systems increased from 4 percent of a utility's peak demand to 15 percent. For GMP, the new cap represents about 115 MW of net-metered capacity.

To date, GMP has received 16 net-metered applications for 500-kW solar systems[11]. This represents 8 MW of new development, and if all of these projects are permitted and built, it would represent about a one-third increase in the installed base of net-metered capacity within GMP's service territory. In addition, a number of solar developers have indicated their intention to develop several hundred new group-net-metering projects within the service territory in the coming two to three years.

[11] Source: GMP's Net Metering Database, Query from K. Carrera, October 2014

It is too soon to determine if these development plans will result in completed projects. As a result, GMP directed Itron to continue using its 'simple payback' model to forecast the production from rooftop net-metered systems, and then developed an internal consensus view of the number of group-net-metered systems that will be built.

As the following table shows, GMP expects net-metered capacity to grow quickly over the remainder of this decade. The 15 percent cap is expected to be reached in 2021, primarily due to the addition of about 180 group-net-metered (500 kW) systems. This is about the same number of substations in GMP's service territory, and represents a substantial amount of new interconnection activity.

After 2021, one or two group-net-metered systems are added each year as demand growth creates available capacity below the 15 percent cap. Note that rooftop net-metering development is held constant after 2017. The rationale is that group net-metering will offer economies of scale that will leave little incentive for individual customers to own their own rooftop systems.

Table 2.3.2: GMP Net Metering Output Forecast (MWh/Year)

	RoofTop	Group	Total
2014	1,120	-	1,120
2015	7,977	5,453	13,430
2016	13,317	22,989	36,306
2017	13,574	42,652	56,225
2018	13,580	62,349	75,929
2019	13,583	82,059	95,642
2020	13,584	102,008	115,592
2021	**13,584**	**119,347**	**132,931**
2022	13,584	122,202	135,786
2023	13,584	122,747	136,331
2024	13,584	123,685	137,269
2025	13,584	124,119	137,703
2026	13,584	124,718	138,303
2027	13,584	125,921	139,505
2028	13,584	126,978	140,562
2029	13,584	127,951	141,535
2030	13,584	129,206	142,790
2031	13,584	131,065	144,649
2032	13,584	133,339	146,923
2033	13,584	135,614	149,199
2034	13,584	138,180	151,764

CEED Fund (Community Energy & Efficiency Development)

As part of the Order governing the merger of Central Vermont Public Service with Green Mountain Power, GMP was required to initiate a CEED Fund to invest approximately $21 million, primarily in electric and thermal measures for the benefit of customers. CEED Fund investments are allocated to legacy CVPS customers, and a total of $46 million in net societal benefits are anticipated.

Since June of 2012, approximately $13.8 million has been invested, providing net societal benefits of $16.9 million. Initial investments were primarily for thermal (e.g. weatherization) programs to maximize benefits for residential customers. The CEED program is expected to continue for several years before the fund commitment is achieved, with much of future investments focused on electric energy efficiency.

Figure 2.3.3 CEED Fund Cumulative Summary of Services[12]

Monthly Report: August 2014

	Totals			Thermal Efficiency[1]		Electric Efficiency	
Cumulative Summary of Services	All Services and Initiatives	Subtotal Thermal Efficiency Services	Subtotal Electric Efficiency Services	Business	Residential	Business	Residential
Program-to-Date Benefits and Costs							
Present Value of Societal Benefits	$ 30,659,067	$ 26,944,703	$ 3,714,365	$ 653,725	$ 26,290,978	$ 3,714,365	$ -
Present Value of Societal Costs (incl GMP)	$ 13,747,950	$ 12,247,592	$ 1,500,358	$ 297,148	$ 11,950,445	$ 1,500,358	$ -
Net Societal Benefits (NSB)	$ 16,911,117	$ 14,697,111	$ 2,214,006	$ 356,577	$ 14,340,534	$ 2,214,006	$ -
Present Value of GMP Costs	$ 13,825,599	$ 12,247,592	$ 1,578,007	$ 297,148	$ 11,950,445	$ 1,578,007	$ -
(NSB/GMP Cost) Ratio	1.22	1.20	1.40	1.20	1.20	1.40	-

Please note that the savings from CEED Fund investments are not subtracted from the load forecast because the majority of the spending to date has been on thermal efficiency. Furthermore, the future spending and resultant energy savings are small (<0.1 percent /year) in the context of GMP’s sales.

[12] “Cumulative Summary of Services”, Efficiency Vermont, August 2014

2.4 GMP's Future Loads

The 20-year system energy and demand forecasts are derived using a *bottom-up* approach. First, individual sales forecasts are developed for each of the residential, commercial, industrial, and street-lighting customer classes. These class-level forecasts are aggregated and adjusted for line losses to arrive at a forecast of system energy requirements or "loads." The system energy and peak demand forecasts are adjusted for the expected impact of investment in energy efficiency as well as the impact of net metering. Projected annual system energy and peak demand forecast are summarized in the following table.

Table 2.4.1 GMP's Peak and Energy Forecast, Including the Effects of Net Metering

Year	Energy (MWh)	Change	SumPeak (MW)	Change	WintPeak (MW)	Change
2014	4,494,169		771.9		706.2	
2015	4,488,960	-0.1%	780.6	1.1%	715.9	1.4%
2016	4,483,739	-0.1%	778.5	-0.3%	717.0	0.2%
2017	4,464,699	-0.4%	775.5	-0.4%	716.2	-0.1%
2018	4,447,383	-0.4%	772.0	-0.5%	715.3	-0.1%
2019	4,427,562	-0.4%	768.2	-0.5%	714.0	-0.2%
2020	4,393,013	-0.8%	764.9	-0.4%	712.1	-0.3%
2021	4,369,697	-0.5%	762.7	-0.3%	711.2	-0.1%
2022	4,376,701	0.2%	764.7	0.3%	711.0	0.0%
2023	4,387,968	0.3%	767.6	0.4%	711.1	0.0%
2024	4,405,194	0.4%	770.4	0.4%	711.4	0.0%
2025	4,410,340	0.1%	773.9	0.5%	711.3	0.0%
2026	4,425,444	0.3%	778.4	0.6%	711.7	0.1%
2027	4,443,293	0.4%	783.3	0.6%	712.4	0.1%
2028	4,470,556	0.6%	789.3	0.8%	713.8	0.2%
2029	4,487,071	0.4%	795.4	0.8%	714.8	0.1%
2030	4,503,114	0.4%	802.1	0.8%	715.9	0.2%
2031	4,520,854	0.4%	809.9	1.0%	717.5	0.2%
2032	4,550,667	0.7%	819.8	1.2%	719.9	0.3%
2033	4,574,631	0.5%	831.5	1.4%	722.4	0.3%
2034	4,606,453	0.7%	844.6	1.6%	725.7	0.5%
14-34 CAGR		**0.1%**		**0.4%**		**0.1%**
14-24 CAGR		**-0.2%**		**0.0%**		**0.1%**
24-34 CAGR		**0.4%**		**0.9%**		**0.2%**

Note that almost all future net metering is modeled as group-net-metered (up to 500 kW) projects. The generation from these projects is recorded as purchased power (kWh and dollars), and is not causing the peak and energy forecast to decline as a result. If future net metering were accounted for like traditional rooftop projects, most of the generation would be reflected as reduced retail sales and revenue. Under this treatment, the 2034 load would be about the same as the load in 2014.

The annual growth rates in the energy forecast are significantly lower than the historical average. Over the entire 20-year forecast period, energy sales grow at an annual average of 0.1 percent, which is a fraction of the 23-year historical average of 0.6 percent. Over the first 10 years of the forecast, sales are expected to decline slightly due to a combination of ongoing investment in energy efficiency and a limited amount of additional rooftop net metering.

In the second decade of the forecast, investment in energy efficiency continues, but total net-metering penetration (individual and group) is held to 15 percent of peak loads. This enables increasing heat pump penetration to grow the load at an average of 0.4 percent per year, about 3/4 of the historical average of 0.6 percent per year.

Summer peak loads continue to be larger than the winter peak loads, and follow a similar pattern, declining in the first 10 years of the forecast before resuming a growth trend of 0.9 percent per year.

2.5 Comprehensive Energy Plan (CEP) Goal

The CEP recommends that Vermont set a goal to obtain 90 percent of its total energy from renewable sources by 2050[13]. Although this goal is outside of the planning horizon for this IRP, this section provides an estimate of what such a future would require in terms of new renewable resources.

The last year of the IRP sales forecast results in sales of about 4.5 million MWh in 2035. By applying the 10-year compound annual growth rate from the last 10 years of the IRP forecast, we arrive at an estimate of 4.86 million MWh of sales in 2050. This assumes the continuation of the existing trends within the end-use stock of energy-using devices. By adding in line losses, FY50 loads at the ISO level are about 5.1 million MWh, as shown in the following table.

Table 2.5.1: Extrapolation of GMP's Sales & Load Growth

	MWh
FY35 Sales	4,524,829
2025 - 2035 CAGR	0.5%
FY50 Sales	**4,866,690**
Line Losses	5.45%
FY50 Loads	**5,131,797**

Recall that heat pump penetration rates were following an exponential trend of 20 percent/year from 2015-2035, and that Itron called out this trend as the reason for why sales were growing faster in the last 10 years of the forecast. This is the rationale for using the CAGR from the last 10 years of the forecast period, and it presumes that heat pumps penetrate 90 percent of the housing stock by 2050 because of the exponential growth in the heat pump penetration rate.

To achieve the 90 percent total energy goal, 90 percent of the energy to power Vermont's registered vehicles would also have to come from renewable sources. For the purpose of this estimate, we assume that 90 percent of all vehicles are powered by electricity, which is a reasonable proxy for the 90 percent total energy goal with respect to transportation fuels. Therefore, assuming that electricity is the fuel of choice for this purpose, we can estimate the electrical energy that would be required to operate that many electric vehicles.

[13] "Vermont's Energy Future – 2011 Comprehensive Energy Plan", Vermont Department of Public Service, Dec. 2011

If we extrapolate the load forecast data on EVs and heat pumps that was used in the load forecast, we arrive at 1.8 million MWh of incremental load growth. This would be about 25 percent of total electricity requirements in 2050, and is likely an overestimate because technology will certainly increase the efficiency of both electric vehicles and other end uses between now and 2050.

Table 2.5.2: Estimate of Incremental Load Growth from Electric Vehicles

	MWH/Unit/Yr	# Units in 2050	MWH/Yr
Electric Vehicles	4.44	394,979	1,753,707
		Line Losses	5.45%
		FY50 Incremental Loads	**1,849,238**

Adding the incremental load to the base load results in a total load of 6.9 million MWh in 2050, and 90 percent of this number is 6.28 million MWh. This is the amount of electrical energy that would need to be provided by renewable generators; hydro, solar or wind.

Table 2.5.3: Estimate of Total Load in 2050

Load	MWh in 2050
Base Load	5,131,797
Incremental Load	1,849,238
Total Load	**6,981,035**
90% of Total Load	**6,282,931**

The following table shows the amount of installed renewable capacity that would be required to serve such a load. As a standalone resource, it would take about 1,434 MW of hydroelectricity at a 50 percent capacity factor to meet this load. Similarly, 4,782 MW of solar or 2,049 MW of wind could meet this requirement on a standalone basis. In reality, a mix of resources would be built to meet the requirement, and the table shows what the mix would look like if it were divided in equal parts between hydro, solar and wind resources.

Table 2.5.4: Installed Renewable Capacity Requirements at 6.28 Million MWh/Yr

Technology	Cap. Factor	Equivalent Installed Capacity (MW)	% of Mix	Net MW
Hydro	50%	1,434	33%	478
Solar	15%	4,782	33%	1,592
Wind	35%	2,049	33%	682
Total				**2,752**

2.6 Conclusions for Resource Planning

One somewhat surprising observation that resulted from the load-forecasting process is how flat the forecast appears despite significant changes in the underlying stock of end-uses (heat pumps) and distributed generation (DG). In the context of net-metering and distributed generation, many participants in the process surmised that the load would drop significantly as a result, which would create concerns about revenue erosion and potential stranded costs. Conversely, other participants expected that heat pump and/or electric vehicle penetrations would cause loads to increase substantially, and create concerns about the need for new investment in generation and/or transmission resources.

What we learned from the forecasting process was not only that these two trends largely offset each other, but that the other demographic, economic, and end-use trends in the forecast model are in a collective state of near equilibrium. This result occurs despite making legitimate but fairly optimistic assumptions about heat pump, DG, and overall energy efficiency penetration rates. Nevertheless, it is a reasonable question to ask, "How much higher or lower could the forecast be?"

The historical trend in sales from Section 2.2 offers some context. The fastest growth rates occurred in the 1990s and were only 1.4 percent/year, while the fastest decline rates occurred in the 2000s and were only -0.3 percent/year. In our view, electric loads are unlikely to decline faster than they did during the 2000s, when two recessions (including The Great Recession) occurred in the context of substantial investments in energy efficiency that were made for the first time. Similarly, electric loads are unlikely to grow any faster than they did in the 1990s when the economy was growing strongly and investment in energy efficiency was still nascent. This rationale leads to the major conclusion in this chapter: sales are expected to be flat in the near-term, and will grow at less than 1 percent/year in the long term.

"This rationale leads to the major conclusion in this chapter; sales are expected to be flat in the near term, and will grow at less than 1%/year rates in the long-term."

What are the implications of this conclusion for resource planning? As the following chapters will illustrate, GMP's supply-side resources equate to roughly half of GMP's energy and capacity requirements in the long run. Because the expected growth/decline rates in loads are expected to be less than 1 percent, the 50 percent ratio of the size of the portfolio to GMP's energy requirements is expected to remain steady, and in any event, is not expected to come anywhere near the threshold where supply could exceed demand. As a result, the second conclusion of this chapter is that load growth/decline rates are not a constraint on the acquisition of, or a driver of the need for, new resources.

"…the second conclusion is that load growth/decline rates are not a constraint on the acquisition of, or a driver of the need for, new resources."

The third and final conclusion is that the potential growth impact of fuel switching to heat pumps and electric vehicles is manageable, and is not in the immediate three-year future for resource planning purposes. To arrive at this conclusion, we adopted legitimate but fairly optimistic assumptions about heat pump penetration rates (20 percent/year growth), and we formed a high load forecast case that puts EVs on a trend to hit 90 percent penetration in 2050. However, the combination of the heat pump penetration rate and the high-load-forecast (high EV penetration rate) still resulted in a sub 1 percent/year load growth rate, which served to reinforce the first two conclusions.

"…the combination of the heat pump penetration rate and the high load forecast (high EV penetration rate) still resulted in a sub-1%/year load growth rate, which served to reinforce the first two conclusions."