Residential Rate Calculator

Efficiency Vermont R&D Project: GHG Reduction

September 2022

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Executive Summary

Few Vermont ratepayers are aware of the many residential electricity rates available to them. Nearly all residential customers default to a Flat Rate Plan and pay the same price for electricity at all times of the day throughout the year. Only a small subset of residential customers are able to evaluate utility rates carefully enough to opt for and benefit from non-standard residential rates.

This project created and tested a web-based Residential Rate Calculator to assess whether alternative electricity rates can lower the cost of electricity for a given account based on historical electricity consumption. Using customer data, the calculator identified scenarios where alternative rates lowered costs immediately, with no behavior changes on the part of the customer. In other cases, the calculator demonstrated that alternative rates could provide economic benefits to customers who are willing to make small behavioral changes.

The Residential Rate Calculator may be useful to distribution utilities in evaluating rate plans. While Flat Rate Plans are simple to administer, variable rate plans can support grid management. It is easier for distribution utilities to manage electrical load when it is relatively consistent than when there are great fluctuations. Well-designed rate structures can encourage customers to consume electricity at times when overall demand is lower and thereby flatten a utility's daily load shape. This is especially true for loads such as electric vehicle charging which can be flexed to grow at times convenient to the distribution utility and alleviate periods of peak demand. Distribution utilities could use the Residential Rate Calculator to test new rate scenarios against customer consumption data.

Introduction

Vermont has seventeen distribution utilities as shown in Figure 1 and nearly all offer multiple rate structures to customers. Because alternative rate structures are more complicated than flat rates, the potential exists for ratepayers to face higher electricity costs if they do not completely understand the alternative rate structure. Distribution utilities rarely publicize their alternative rates or mention them to new customers, and informed customers are encouraged to discuss rate plans with their utility representative.

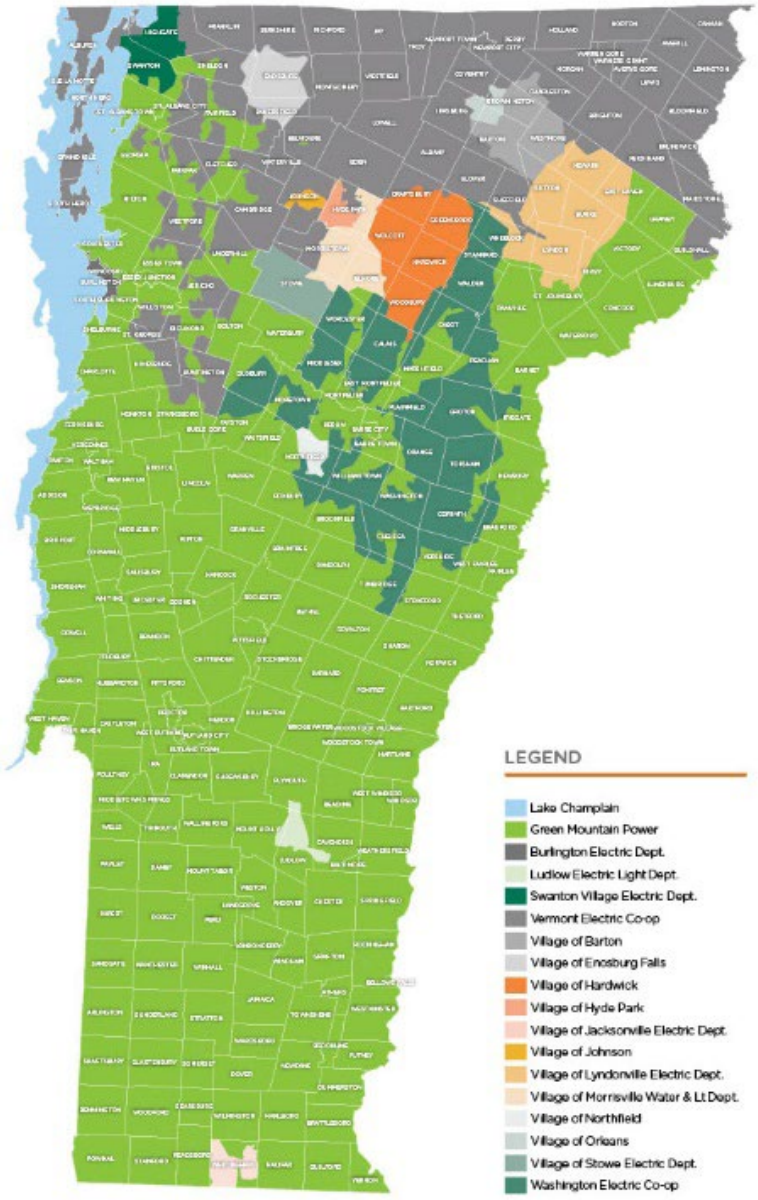

Figure 1: Vermont Distribution Utility Territories

For this study, Efficiency Vermont analyzed energy consumption data to compare electric costs on a flat rate plan with electric costs on other alternative rate structures. The comparison allowed Efficiency Vermont to identify scenarios where alternative rates reduced the cost of electricity for a customer without behavior modifications as well as scenarios where small behavior changes could lower electricity costs.

Efficiency Vermont focused the analysis on the largest utility in the state, Green Mountain Power (GMP) which serves more than 260,000 customers. GMP offers eleven different rates along with several 'riders' or 'add-ons'. Despite the multitude of rates available, an overwhelming majority[1] of GMP's customers are enrolled in the standard flat rate structure.

The analysis focused on rates that meter all end-uses and did not estimate riders or add-ons as those can be difficult to calculate. For example, to make an accurate savings calculation on GMP's water

[1] A GMP representative estimated that 99% of their residential customers use the standard flat rate.

heater rate, the hot water usage in each account must be disaggregated.

The Residential Rate Calculator

To analyze actual electricity usage, the study team created a computer program which accepts advanced meter infrastructure (AMI) energy data as input and returns a cost of electricity as an output. The output data disaggregates the total electricity cost by rate—standard rate, peak rate, super-peak rate—and by fee—energy efficiency charge, demand fee, and daily connection fee—to make it possible to compare alternative rate structures.

For distribution utilities supporting customers in rate analysis, this calculator can assist with two principal questions:

1. Is there another rate that the customer can switch to and expect to see a lower bill without behavioral changes?
2. Is there a rate that the customer could switch to and, with slight behavioral changes, see a lower bill?

The tool can also support distribution utilities in running batch AMI data analysis to identify households that would benefit from an alternative rate or to test the impact of a potential rate structure, and simultaneously ensure the utility that it will be appropriately compensated for peak-energy usage. Utilities expressed interest in the development of the calculator and provided information for the rates analyzed with the tool.

Types of Rates

GMP's variety of residential rates and rate structures and high number of residential customers provided an ideal case study for testing the calculator. The study team evaluated scenarios under the following GMP rates:

- GMP-01 Flat Rate: Nearly all GMP customers are on this rate. All new customers are put on this rate unless they specifically request a different one. The rate's greatest benefit is that it is simple and there are no unexpected fees. Every unit of energy costs the same amount regardless of demand, time-of-day, season, or grid status.
- GMP-06 Flat Rate: Similar to GMP-01, every unit of energy costs the same regardless of demand, time-of-day, season, or grid status, but the fees differ slightly from GMP-01.
- GMP-08 Demand Rate: Rewards the consumer who tends to have minimal fluctuations in their energy consumption, i.e., a customer who usually has a flat load shape. Customers with high consumption at some times and low consumption at other times will be penalized by higher rates on more of their energy and also by a demand fee that is proportional to their highest consumption during the billing period.

- **GMP-09 Demand-Response / Critical Peak Rate:** Offers residential customers a slightly lower rate for their electricity throughout the year except during specific peak events periods. GMP identifies as many as ten such peak events in a year and provides customers with approximately twelve hours of notice. Electrical use during the peak-event periods is about four times more expensive than it is during non-peak periods.
- **GMP-11 Time-of-Use (TOU) Rate:** Offers a substantially lower rate for electricity during most hours in return for paying a premium during the window of 1:00 PM to 9:00 PM on weekdays. The daily connection fee is slightly higher for this plan.
- **GMP-13 Load Management Rate:** Offers a substantially lower rate for using electricity at the time of day most convenient for GMP—a contiguous 8-hour period specified by GMP between the hours of 10:00 PM and 08:00 AM.
- **GMP-14 Time-of-Use & Critical Peak:** Combines GMP-09: Critical Peak Rate and GMP-11: Time-of-Use Rate. Customers with flexible usage can benefit from a much lower off-peak rate, but pay significantly more during peak and critical peak periods.
- **GMP-22 Seasonal Time-of-Use:** Similar to GMP-11: Time-of-Use Rate, this rate offers a substantially lower rate for electricity during most hours in return for a premium price during an 8-hour window of peak usage. Unlike GMP-11, the window of peak hours changes seasonally.

Testing and Results

To test the calculator, the study team selected actual usage data from a typical residential account during 2021. The account reflected a customer with above-average electricity use throughout the year, and the study team analyzed electricity costs for this account under the eight GMP rate structures described above. Because the GMP-13 Load Management Rate[2] features a window of off-peak rates which changes based on decisions made by GMP, the analysis included both a Best-Case and a Worst-Case[3] estimate bringing the total number of scenarios to nine.

Figure 2 below shows the expected cost for each of the tested GMP rates. The GMP-09 Demand-Response Rate produced the lowest annual cost for electricity in the test scenario, lower than the default GMP-01 Flat Rate.

In addition to identifying the least cost option, the calculator's results also demonstrate the risk of adopting an alternate rate structure without fully understanding the implications. A customer on GMP-08 or GMP-13 who used more than 10-20% of their electricity during peak periods or

[2] Although this rate is designed to be specific to a sub-metered electric heating system, the study team applied it to the total energy usage for the account.
[3] Best-case and worst-case are used to express the range of possible costs that this particular rate could cost the customer. There is uncertainty in calculating this rate because it only says the peak period is "16 of 18 consecutive hours to be determined by the Company". The "Best-Case" scenario uses that 16-hour period that would result in lowest cost to the customer and the "Worst-Case" scenario is the 16-hour period that would result in the highest cost to the customer.

incurs large demand charges would incur significantly higher costs than they would on other rate plans. Changing to the wrong plan can double or even triple energy costs.

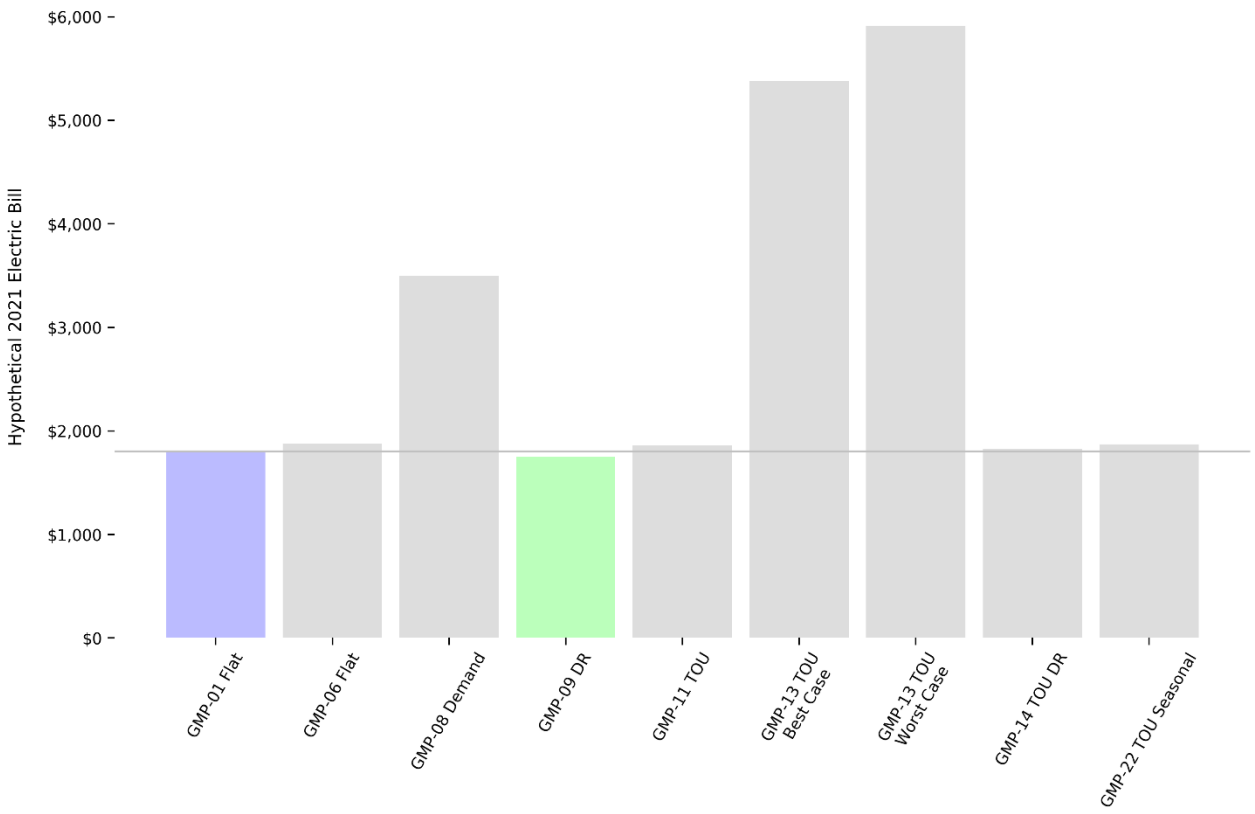

Figure 2. Example calculator results showing hypothetical energy costs for each of the nine residential rates available through GMP for the example customer. The "GMP-01 Flat" rate is highlighted in blue as the default rate that this and nearly all GMP customers are on. The "GMP-09 DR" rate is highlighted in green because for the analyzed year, 2021, this rate returned the lowest expected cost.

Determining the best rate

Clearly, the GMP-08 demand rate and the GMP-13 TOU rate, even under the Best-Case scenario, are inappropriate for the example user. Figure 3 compares differences among the remaining rates that the residential customer might reasonably consider. Without behavior change, the GMP-09 Demand-Response Critical Peak Rate is the least expensive option, saving the customer $60 per year (3.3%).

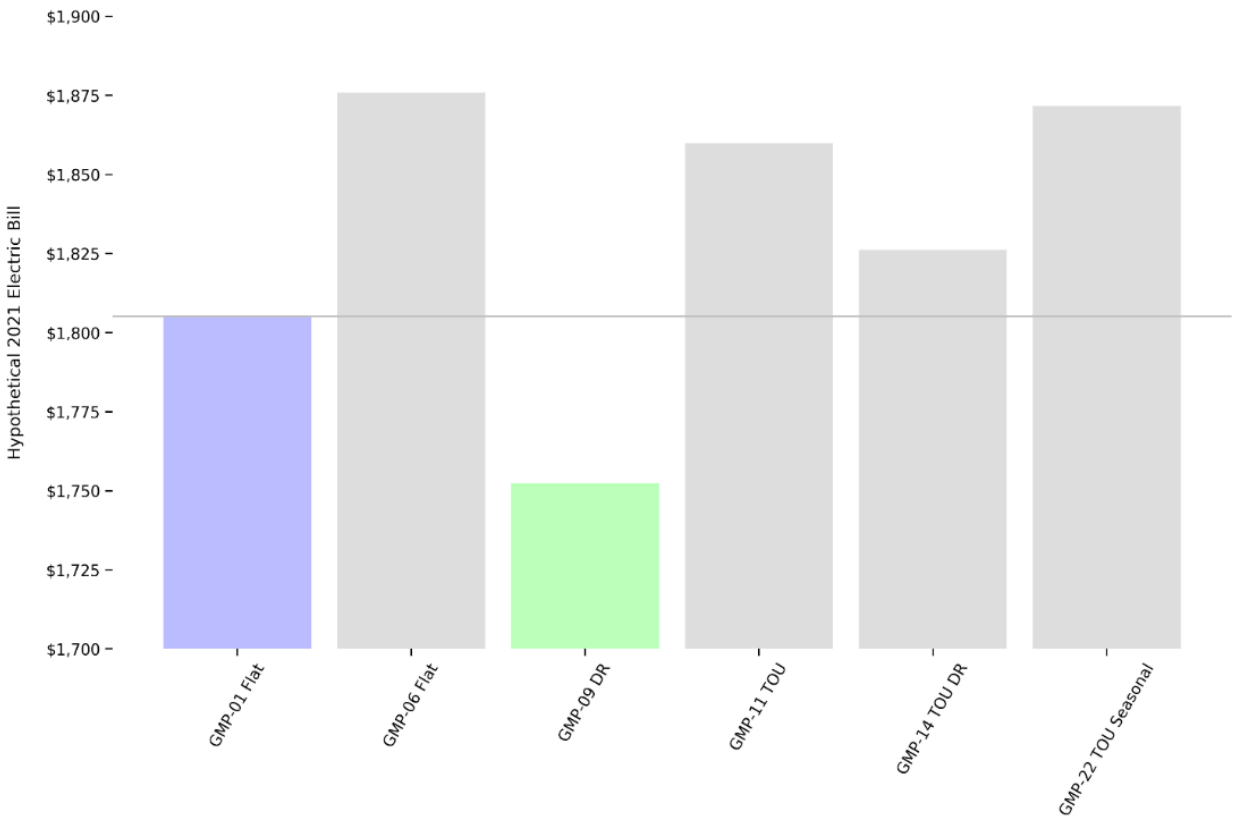

Figure 3. Rates worthy of consideration by the example customer. The scale and range of values along the y-axis have been changed to magnify differences among the rates.

Optimizing Rates with Behavioral Changes

The calculator also disaggregates total electricity costs according to category of fee, allowing users to identify the source of specific costs, as shown in Figure 4.

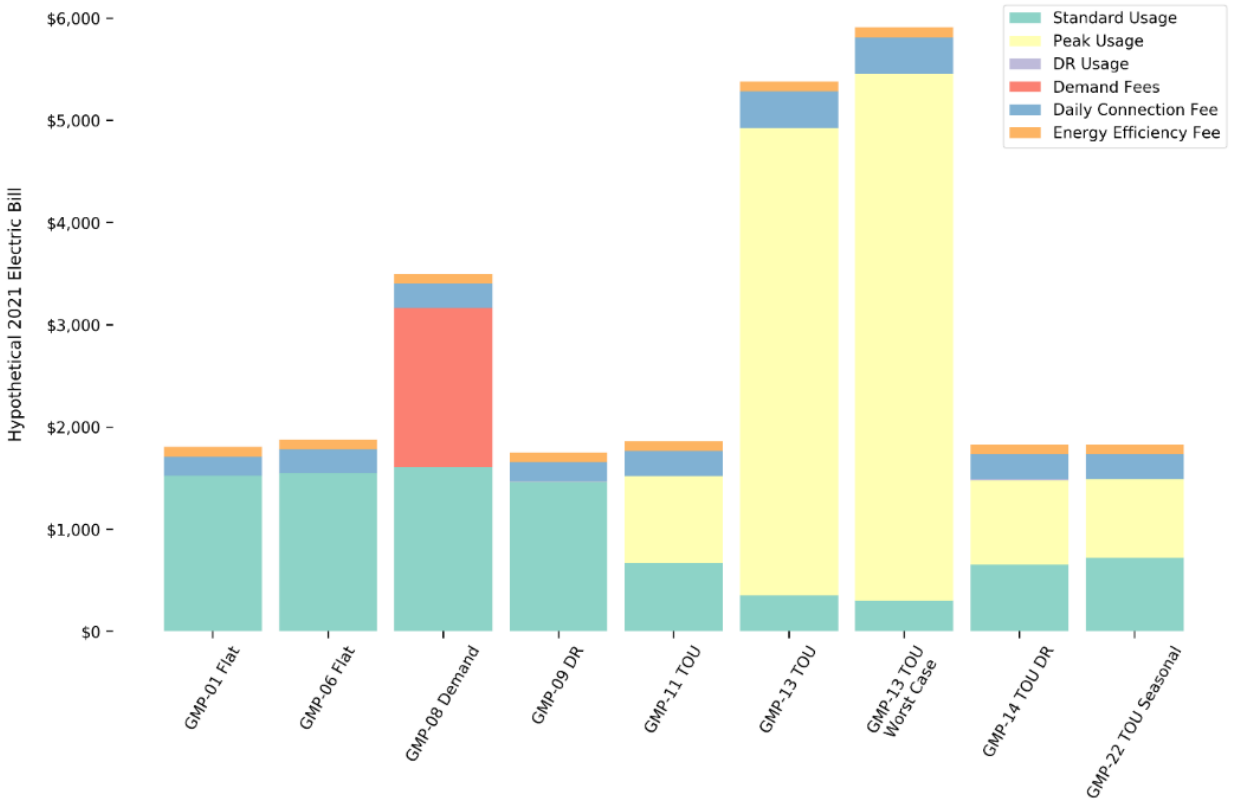

Figure 4. Cost breakdown of the example residential customer.

For the example customer, it's clear that what makes GMP-08 Demand Rate untenable as an option are the demand fees. But, because this ratepayer used nearly no electricity during the critical peak periods, any plan with a discounted rate during Demand Response and Critical Peaks would be worth considering.

Figure 4 suggests that the example customer could probably reduce their electricity costs without reducing consumption if they made small behavioral modifications and switched to a Time-of-Use Rate such as GMP-14 or GMP-22. With a some effort, it might be possible to shift a large amount of electricity usage from the peak periods defined by GMP-14 and GMP-22 to those plans' off-peak periods and save nearly a third on energy costs relative to the standard GMP-01 Flat Rate.

Precautions for Alternative Rate Structures

The results from the test scenario show the opportunities presented by alternative rate structures, and the risks. Before advising any residential customer to change plans based on the output from the calculator it is critical to consider the potential impact of Demand Rates, Time-of-Use Rates, and Demand Response or Critical Peak Rates.

Demand rates – While these rates can lower costs for ratepayers who have flat loadshapes, a single 15-minute period of high demand can cause enormous increases in cost both due to larger thresholds at high rates and demand fees. Depending on the rate, the demand fees due to a single high demand period could continue for up to 12 months.

Time-of-Use (TOU) rates – These rates commonly have "peak" and "off-peak" rates. "Peak" rates can be as much as four or five times higher than "off-peak" rates. A prospective TOU customer should be certain that they can curtail their usage during peak periods and limit the potential for consumption mistakes.

Demand Response or Critical Peak rates – These rates often have very high penalties for using electricity during specified periods. A customer should be willing to change their consumption with notice of 12 hours or less. During 2021, the sample year analyzed in this paper, GMP called for fewer Critical Peak periods than they were technically permitted by the terms of the Rate. If GMP decides to call for all 10 allowable Critical Peak periods in a future year, the savings seen by the hypothetical customer might disappear or even turn into a loss relative to the GMP-01 Flat Rate.

Future Work

If distribution utilities value the calculator, the study team can update it to be more user-friendly. Here's what work is needed to turn the calculator into a usable web application:

1. Refactor (re-writing) of existing code to make the calculator run faster and make the code more approachable and understandable for other programmers.
2. Attach the "back-end" to energy data so AMI data can be directly accessed by the application. Currently, it takes a .csv file of AMI data as input.
3. Develop an appealing "front-end" for the web application. A front-end involves writing html, css, and JavaScript code to give the calculator user-friendly interfaces to use like drop-down menus and text boxes.
4. Deployment on a remote computer server to do the calculation when called upon.

Distribution utilities could use the updated version of the calculator to estimate the impact of existing and potential rate structures, including rates designed to incentivize customers to reduce their energy use when the grid energy has higher carbon emissions, and increase their energy when the grid has excess renewable energy available.