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Analyzing Utility Rates
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Older versions obsolete

In my time installing grid-tied solar electric systems I have frequently had to ponder the impact utility rates have on the sizing of equipment and advise clients on selecting rate plans. This paper will explain some of the concepts and ramifications of these rate plans and explain some strategies for modelling these rate plans in a spreadsheet tool.

Why put a lot of thought into utility rates? At first glance this commodity that is priced at cents per unit seems not worthy of expending a lot of time or thought. However solar equipment is expensive. Once installed the equipment works silently day after day and the value gained becomes significant. If you are being compensated for your power at a few cents less hour after hour than you might under a more beneficial rate, that adds up to a lot of money not in your pocket.

I live and work in territory that is predominantly served by Pacific Gas and Electric. I cannot speak directly to rate structures in other utility regions but I imagine the questions are similar.

I do know that PG&E electric rates are mind-numbingly complicated and getting more so. There are tiered rats, Time of Use rates and combinations of the two. Time periods become so convoluted that any given day of the year can have 3 rates applied to different hours over a greater number of periods in just that one day.

The entirety of this discussion is based on Net Electrical Metering (NEM). This is a near zero-sum proposition wherein the electricity generated by means of solar panels is of little value unless you consume this electricity. If you generate excess electricity you will receive pennies per kilowatt/hour (kWh) in return.

To maximize benefit from investing in grid-tied solar (wherein you connect solar generated AC power to utility offered AC power) in an NEM environment, you must consumer every dollars' worth of energy you create. You are not required to consume the energy in the same moment it is created, but you must consume it in specific time period. That period starts and ends on the anniversary of the day you were approved to connect your system to the grid.

In an NEM contract your energy flow has three directions. Remember these Flow categories because they apply to many considerations:

1. From the grid into your lights or appliances (known as loads).
2. From your solar into your loads.
3. From your solar back into the grid.

If the sun is *not* shining and you are using energy you are in Flow category 1. If the sun is shining and you are consuming you are in Flow 2--some of the energy you produce will flow into your loads. If you are generating more energy than you are consuming then you are in Flow 2 and 3--some of your home-brew energy operates your appliances and some goes back into the grid. It is rare that a modern home is at any point not using any electricity, so it is unlikely you would find yourself solely in Flow 3.

Under Flow 1, the amount you pay for energy is determined by your rate plan. That value may vary widely for different seasons or even different times of the day. This is exemplified by a Time of Use rate plan (TOU). In a Tiered plan that value may increase as you consume more energy.

At the end of the year you compare the dollar value of energy you "imported" from the grid (Flow 1) to the value you exported to the grid (Flow 3). This end of the year reconciliation is called "True-up."

If you bought more energy than you sold, you owe the utility money. If you have not been keeping track of this it may be an unpleasant surprise. If you sold more than you bought you may be eligible for a cash reimbursement, but it will be at a fraction of the rate you pay for electricity.

During the course of that year, you trade energy credits back and forth with the utility. You may buy some power at night and then sell it back during the day. You may buy more in the winter and sell more in the summer. Accounts are kept but no money need be exchanged until the end of the True-up period. If you don't use those credits at the end of the True-up period you are paid a pittance for them. This is not to say the excess energy is wasted—it flows into the grid and powers your neighbor's appliances.

PG&E charges a service fee to provide a meter and service. There are other miscellaneous charges and credits we will ignore in this discussion and in the models.

When electricity costs more during some hours of the day (TOU rates), or in different amounts (Tiered), understanding the value of the energy you create becomes complicated. Under this scenario you are no longer exchanging kilowatt hours-- you are trading dollars.

In Flow 1 you pay an amount determined by the rate plan. In flow category 2, you are avoiding the purchase of some electricity so the value of the energy you produce is the amount you are saving. In flow category 3 the value of the energy exported becomes a dollar value credit on your account. The question is how much value is associated with the Flow 3 energy? We need to look into that a little further.

Understanding TOU Rates:

Typically TOU rates allow the utility to charge more on summer afternoons and less at other times. This is justified by the law of supply and demand—the use of air conditioning on summer afternoons taxes electric utility production and distribution systems making energy a rarer and more valuable commodity on these increasingly hot summer afternoons.

Fortunately the sun is shining on our solar panels on summer afternoons. The energy you create on a summer afternoon is worth more per kWh than the energy you consume at night because as stated above, energy created is worth the same as energy purchased. This gives you a financial advantage--every night you are buying low and every afternoon you are selling high.

This is great unless the tables turn and you are a net-consumer on summer afternoons. Say you have a hot, muggy overcast day. There is reduced power generation from you solar panels but you are running the AC all afternoon consuming the expensive electricity. Now you are at a disadvantage.

In simple terms, it would be easy to advise someone to just avoid using power on summer afternoons to keep the sell-high advantage. But if you want to know more precisely when and how to do this and what the arithmetic is, it is not easy to give precise answers. Questions arise such as, when do I need to start conserving, how much do I need to conserve, what rate plan works best with this scenario, etc.

Even the definition of when the afternoon starts has been a moving target. It used to be that TOU peak rate periods started at 1:00 PM. Now for some rate plans they start at 5:00 PM. This means the solar customer loses 4 hours of production valued at the highest rate. This is bad if you are a net-producer during this period and good if you are a net-consumer.

Understanding Tiered Rates:

Tiered rate plans mean you pay more per kWh if you consume more kWh. There can be up to four tiers in a rate plan. These tiers are allocated per day but accounted for over a billing cycle. You are allowed to purchase a "baseline" amount of energy at the cheapest rate. The baseline quantity is based upon where you live, if you have electric heat and if it is summer versus winter. If you go over the baseline, the cost per kWh ratchets up. It may be that if you go over a second threshold the cost goes up again, and maybe that occurs a third or fourth time. The higher the tier the more each kWh costs. This can get very expensive.

Once you generate enough energy that you are exporting it back to the grid (Flow 3) the rate at which you are credited is not clear. If you export the baseline amount of energy it would seem logical to get credited at the lower, baseline rate. If you export more than the baseline amount it seems only fair you be compensated at the above baseline rate. I have not been able to confirm if this is the case. This issue should not be of much concern however, because with a properly sized system exporting energy above the baseline rate should be a very rare occurrence. I checked this against data I have accrued on my own home and found this to be the case.

Real life rate scenarios:

PG&E is in the habit of shuffling customers from rate plan to rate plan. In the early days of grid-tied connections when you entered into a NEM contract you kept the plan you were on. If you installed later on you were forced to go onto a TOU plan. There are now *tiered* TOU plans. Sometimes you are informed of the change in rate plan, sometimes it happens with little or no notice.

This proliferation in rate plans spawns the question, "Which plan is better?" This is a difficult question to answer with any precision. It brings up the question I started with, "What is the value of the electricity I am creating?" These questions can be answered by arithmetic models that take into account all of the variables involved.

Strategies for numeric analysis:

So how does one calculate the value of home-made electricity?

To calculate this you turn the cost of buying electricity upside down and assume the value of selling is the same as the cost of buying. These sounds easy, but remember the cost of buying varies due to a lot of factors. Here are the two scenarios:

TOU: You need to know how much energy your system is producing for every given hour of the year and what the cost of buying energy is at that hour. Now apply these values over each of the 8,760 hours in a year.

Tiered: You need to track the amount of and value of energy produced each day and over the course of a month. The moment you reach a tier threshold, start calculating at a different rate.

Tiered TOU: You have to combine the above strategies.

With the clever use of online tools and spreadsheets, this has been done. See this URL for more information on the subject.

Thanks for taking the time to read this paper. I hope I have explained this in a clear manner.

William Miller