Electrifying Journey

As awareness of the urgent need to reduce our carbon footprint continues to grow, more and more people are taking the initiative to make changes in their lives to move towards a greener future. Being a bit of an early adopter and realising the threat of climate change was growing, I embarked on such a journey to electrify my home back in 2016.

The first step I took in 2016 was to order an electric car. However, this was not going to arrive until 2019 so I had to be patient. The second step was to install 5 kWp of solar PV cells on my roof in December 2018. It was a significant investment, but one that has paid off in the long run as I have seen a dramatic reduction in my electricity bills.

In addition to the solar panels, in January 2019 I also installed a 10 kWh Sonnen battery in my garage. This allowed me to store some of the excess energy generated by the solar panels during the day for use at night.

This had an immediate effect on my power bills.

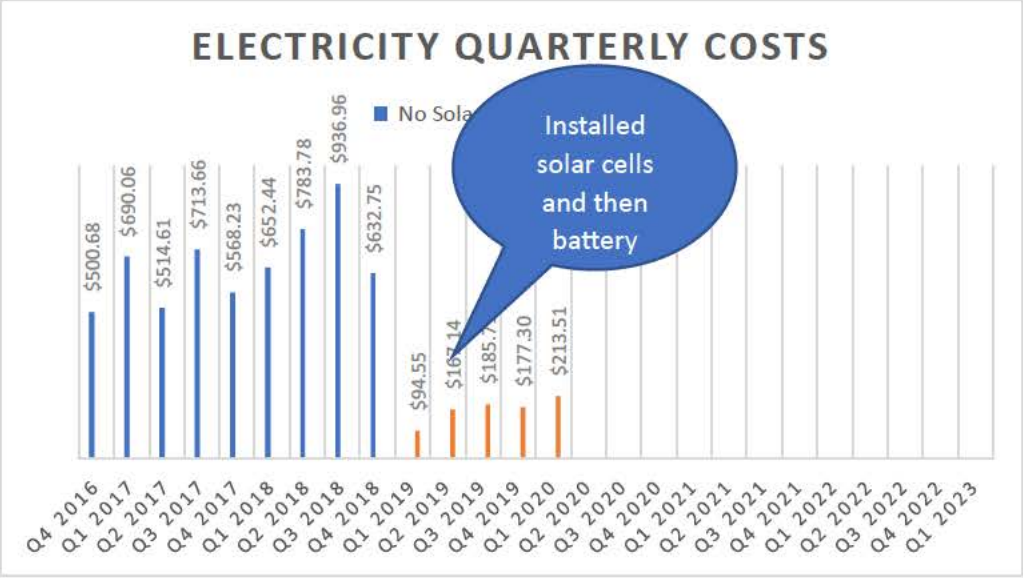

Figure 1 Change in costs after installing solar cells and battery.

That same year my EV arrived further electrifying my home. It was a big decision purchasing this car, but one that was in line with my commitment to reducing my carbon footprint. The car is a fully electric vehicle or battery electric vehicle (BEV). There weren't many EVs on the roads in 2019 so I was able to take advantage of the free destination chargers that existed in shopping

centres and other locations. I was lucky in that three out of four shopping centres closest to my home had free destination chargers[1] available. Also, there was a free NRMA fast charger only 9 km away and Tesla super chargers only 4 km away although they are expensive, so I only tend to use them when on a road trip.

It was convenient to use destination chargers as charging at home would drain the home battery completely. The home battery capacity is 10 kWh (9 usable) while the car battery is 75 kWh and the maximum output of my solar cells is 5 kW at the peak of the best summer day (kWp). So, the car is an order of magnitude larger than the energy system for the house meaning that the charging the car would depend largely on the grid despite the solar system.

To help manage various household appliances, including lights, alarm system, pool pump, air conditioning, and more, I also installed a home automation system called Home Assistant. This system allows me to control all my devices from a single app on my phone, computer, or consoles positioned in my home. This makes it easy to monitor and manage my energy usage.

By using Home Assistant to monitor energy flows, it is possible to identify areas where energy is being wasted or consumed inefficiently and you can adjust and improve overall energy efficiency.

Additionally, by understanding energy flows in real-time, it is possible to make more informed decisions about how to use energy throughout the day.

For example, it may be possible to schedule certain appliances to run during times when energy is being generated by solar panels, or to charge an electric vehicle when excess energy is available.

After a year or so I started looking into Virtual Power Plants (VPP). VPPs are plans from electricity companies where they take over your battery and charge and discharge the battery to take advantage of the wholesale market price fluctuations.

The wholesale market is usually not something retail customers have access to. Retail customers are usually protected from the wholesale market by agreeing to a single flat tariff or set of off peak, shoulder, and peak tariffs.

[1] Destination chargers are slow AC or alternating current chargers that have a capacity of up to 22 kW and depend on an electric cars internal inverter to convert AC electricity to the DC electricity needed to charge batteries.

I decided to go with the Sonnen Flat VPP. This was provided by the company that sold me the battery. The details of this VPP plan were:

- $49 per month
- 7500 kWh or energy per year.
- Energy consumed over this 7500 kWh charged at 45 c/kWh
- Feed-in tariff of 8 c/kWh

What all this meant was that I would only have to pay $49 a month if I could stay under the 7500 kWh and any consumption over the yearly 7500 kWh be paid at the end of the year. I was always over a little bit as can be seen in the chart below.

The result from this plan is shown in this graph:

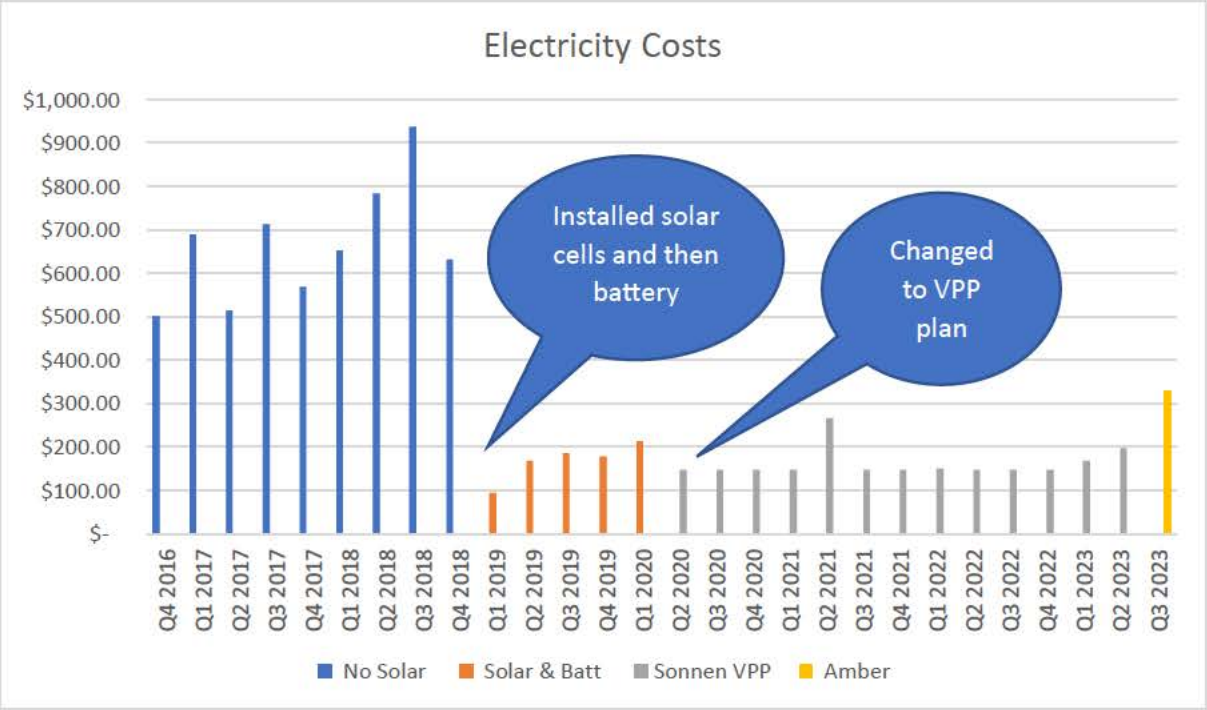

Figure 2 VPP further reduces electricity costs.

Eventually access to destination chargers started to become difficult and I started to depend on home charging more and more. This was because more and more people in Sydney were buying EVs and the demands on destination chargers was growing. It was becoming increasingly difficult to get access to them.

The VPP plan I was on did not allow for a cost-effective EV charging tariff. The VPP had one flat rate and a high rate at that if I exceeded the 7500 kWh PA and charging an EV would exceed this figure by a lot.

So, the next step in this journey was to move to an electricity supplier that catered for EV charging. There are a number of plans that allowed cheap and even free EV charging at certain periods of the day. I reviewed a number of them, analysing their plans with 12 months of my data. However, they all seemed to be more expensive than the Sonnen VPP with just the regular usage pattern from my data without adding EV charging.

I then discovered Amber Electric who make the wholesale electricity market available to customers. They charge $15 a month for this service and provide an energy management system called smartshift that controls your battery and inverter remotely. They do this to performing an arbitrage service in the wholesale market on your behalf.

The theory was that I would be able to take advantage of the highs and lows of the electricity market and buy and sell electricity using my battery and charge my car at cheap periods of the day.

However, after signing up with amber electric, I discovered that they couldn't support sonnen battery because sonnen see them as competition. So, I had to implement my own arbitrage system. I used a Home Assistant add-on called EMHASS to do this.

EMHASS takes a 24 hour forecast of solar energy, supply tariff, feed-in tariff and previous day's consumption patterns to produce a 24 hour forecast plan to control your battery charging and discharging and control deferrable loads such as pool pump, hot water system, car charging and air-conditioning etc. It manipulates the battery flows and deferrable loads to make best use of the market price fluctuations (basically a computer arbitrage system). I've set mys system to recalculate this plan every 60 seconds taking into account any changes in the forecast data being fed into it.

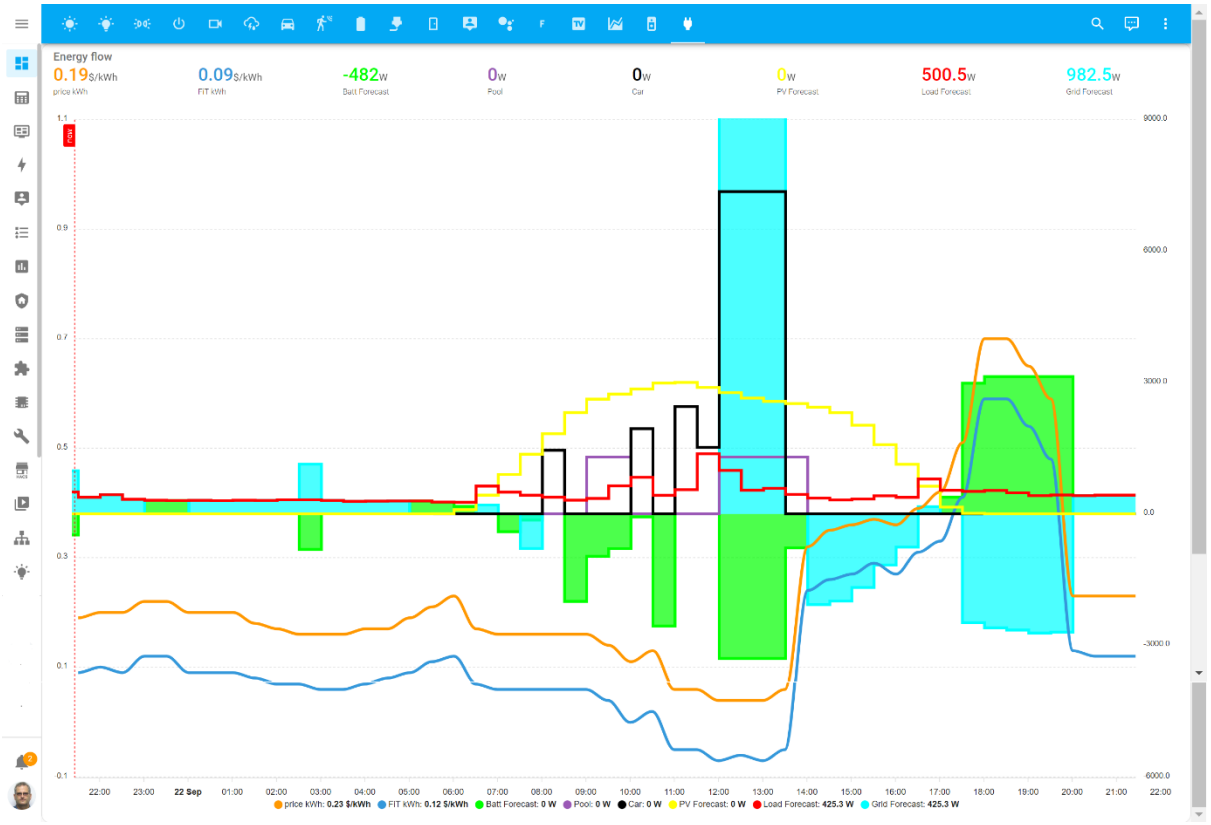

Figure 3 Supply and Feed-in tariff, solar, battery, pool pump, car charging loads, and grid forecast for next 24 hours.

Now I can charge the car in the middle of the day when the grid is overpowered with green energy and the price is very low or even negative.

It took three months to understand smartshift wouldn't work for me and discover EMHASS, understand the complex integration and configuration required. So, I've only just started to get the results I was looking for. I'm now into negative territory.

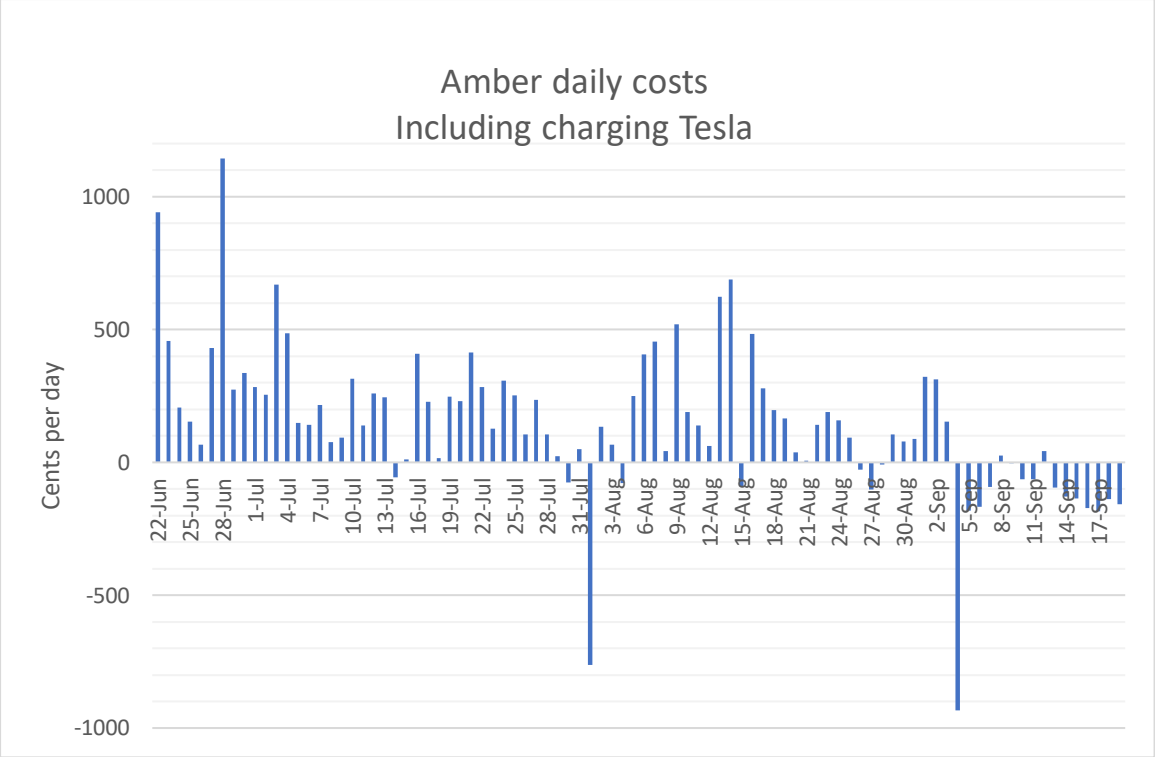

Figure 4 Daily electricty cost slowly reducing to negative as I improved EMHASS config.

The documentation for configuring EMHASS is located here.

Overall, my journey to electrify my home has been a rewarding one. While the initial investment was significant, I have seen significant savings in my energy bills over time and I have also greatly reduced my carbon footprint. I expect a ROI in less than 5 years. That's just an estimate.

I also replaced the under-floor ducted gas heating system with revers cycle air conditioning at the end of 2022 with the increase in cost of gas. This resulted in a flattening of gas bills down to the lower summer level all year round.

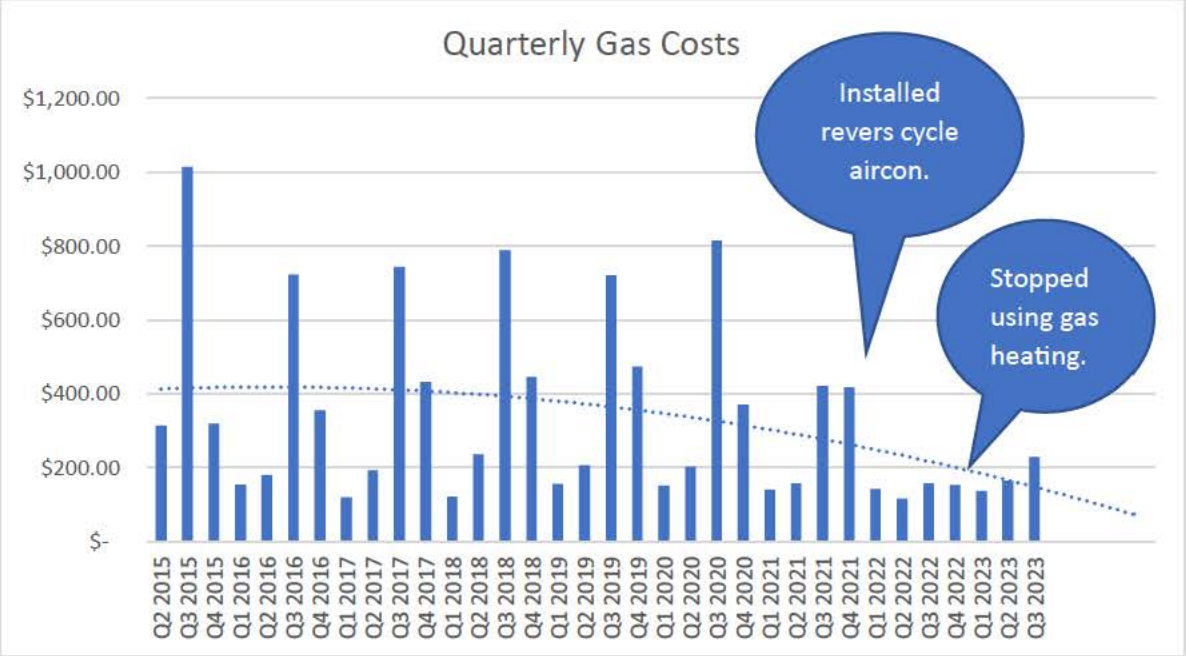

Figure 5 Change in costs after installing air conditioning

However, I still have to replace my gas cook top and gas hot water system and do away with gas consumption altogether, but this is proving difficult as I am now retired. I think the government should help people to achieve these steps as this is a powerful way to decarbonise.