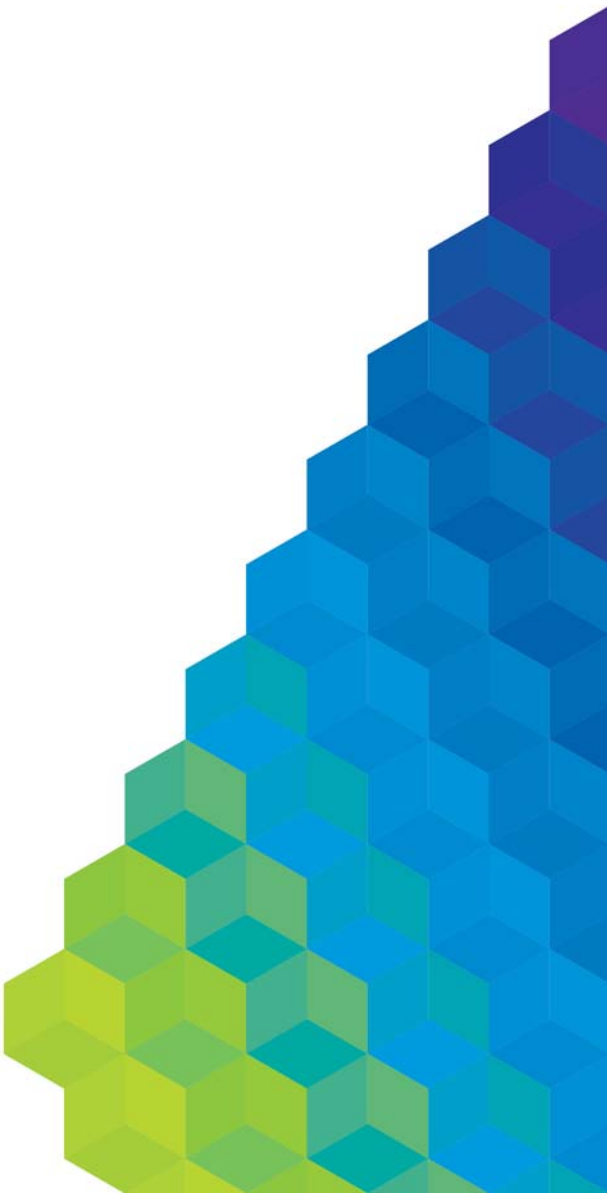
Demand Management Case Study

Electric Vehicle to Grid Trial



1. Project overview

With electric vehicle use expected to increase, AusNet Services collaborated with the CSIRO to examine the potential for electric vehicles to provide active support to the electricity network during peak demand periods.

This concept, known as 'Vehicle to Grid' (V2G), involves the controlled export of energy from the vehicle's battery back into the grid. V2G enables electric vehicles to provide a service to electricity networks while plugged in and otherwise not being used.

During the trial, which was undertaken over the summer of 2013/14, a V2G capable electric vehicle successfully reduced the evening peak demand of the house at which it was parked. For most areas of AusNet Services' electricity distribution network, peak demand occurs during summer evenings, mainly due to the impact of residential air conditioning.

The trial proved in concept that V2G electric vehicles are a potential future method of helping manage network demand peaks. This may reduce the need for network augmentation and allow AusNet Services provide a more efficient, reliable and lower cost electricity supply to consumers.

The Vehicle to Grid Trial has helped AusNet Services prepare for the predicted uptake of electric vehicles and understand the benefits of future V2G operation.

2. Project scope

AusNet Services previously collaborated with the CSIRO to convert three Toyota Prius hybrid vehicles to plug-in hybrid electric vehicles by installing larger lithium-ion batteries and related control software. Each battery pack could hold 11.8kWh of electricity, which is similar to the daily consumption of a small family household. These three vehicles were operated under a trial to investigate the impact on the electricity network of charging electric vehicles under real-world conditions.

For the Vehicle to Grid trial, the CSIRO upgraded one of these vehicles to V2G capability, where it could be programmed to either charge from the network, or discharge to the network.

Fig.1: A plug-in hybrid electric vehicle was upgraded to Vehicle to Grid capability

The maximum discharge rate of the vehicle back into the grid was 1.1kW. This rate is similar to the power consumption of a medium sized air conditioner. The V2G electric vehicle was connected to a customer's home in a similar fashion to a solar PV system.

The V2G project involved installing additional cabling, control systems and safety systems in the car, as well as a grid-connect inverter and remote monitoring systems in the customer's home parking space.

3. Project implementation

Across the summer of 2013/14 the V2G electric vehicle was driven as a daily commuter and was plugged in each evening when the customer returned home.

The following chart shows the customer's household load profile across a typical summer day. The dashed line shows the effect of V2G export from the vehicle. In this example, the vehicle returns home and is plugged in at 5:45pm. It then exports power to the household for a little over two hours at a rate of 1.1kW. This can be seen to significantly reduce the customer's evening peak demand.

It should be noted that this customer has solar power installed and exports energy to the grid. This is why consumption falls below zero during the middle of the day.

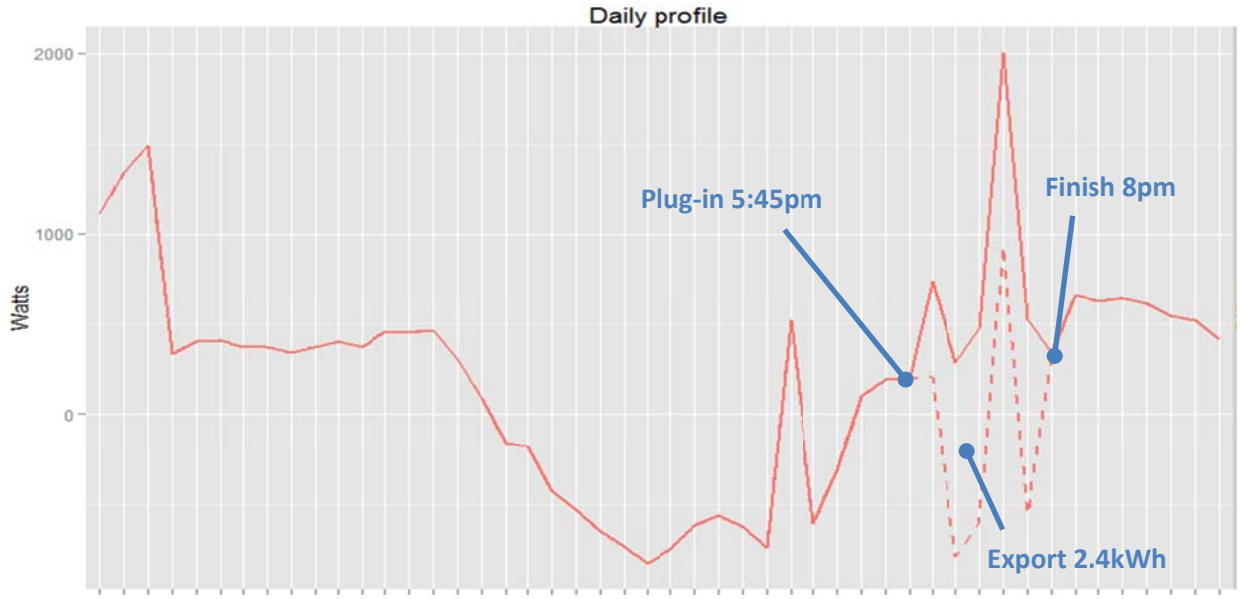


Fig.2: Effect on customer load profile of Vehicle to Grid operation on a summer day

In a normal day's use, after the customer's 33km commute home, the battery in the car had enough remaining charge to export an average of 1.9kWh of energy back into the household. This was sufficient to offset the customer's evening peak load for around two hours.

Once the battery was depleted, or evening peak time had elapsed, the control system would delay charging until the overnight off-peak period. The vehicle's battery would then charge to full capacity in order to be ready for the next day.

One aim of the trial was to determine how reliably the vehicle could support the network at peak demand times when being used in real-world conditions. The degree to which the vehicle could do

this way found to vary significantly from day to day, depending on the distance it was driven and the time of returning home and plugging in.

Across the trial period, the available energy remaining for V2G export was found to range from 0.7kWh up to 5.5kWh, and the duration of V2G export was found to range from 40 minutes up to 5 hours. An electric vehicle with a larger battery would be able to support the network more consistently.

The following chart shows the average impact that the vehicle had on reducing the household's peak-time electricity consumption on both weekdays and weekends. The vehicle was successful in reducing the customer's peak, particularly on weekday evenings when the customer's peak loads naturally aligned with the time of returning home in the evening.

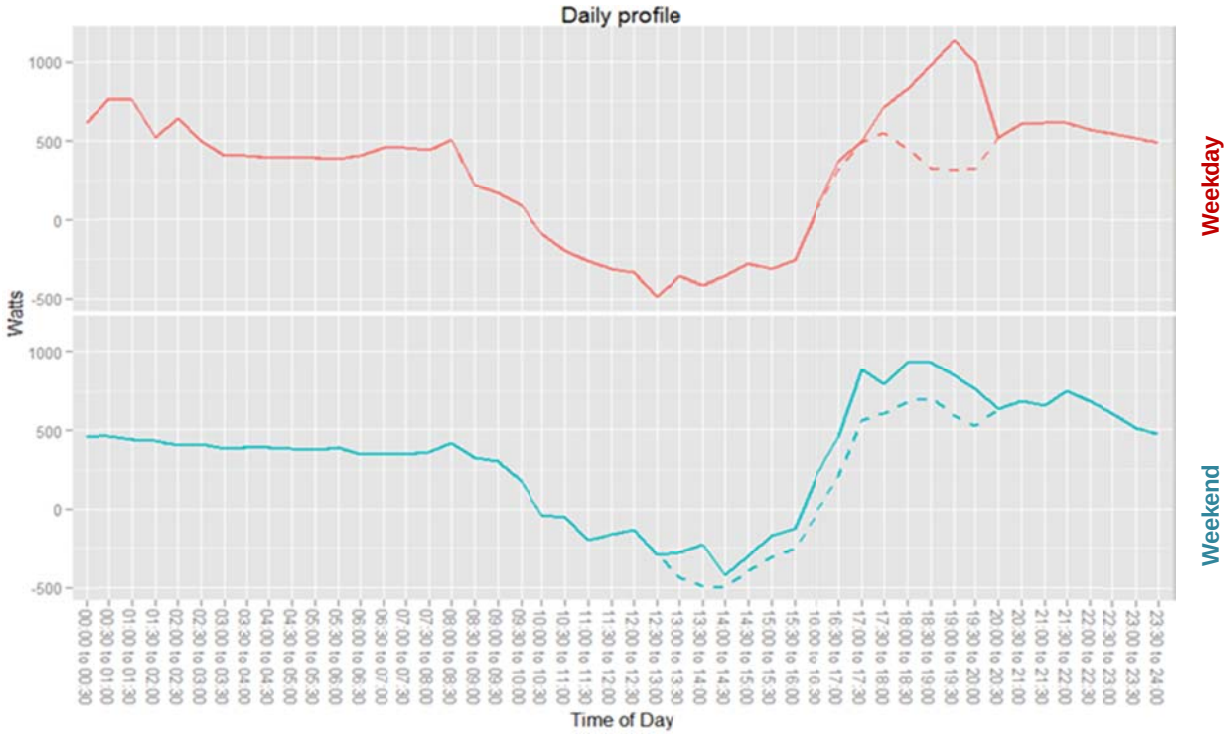


Fig.3: Average effect on customer load profile of Vehicle to Grid operation over summer

4. Benefits

The Electric Vehicle to Grid Trial has helped AusNet Services prepare for the expected uptake of electric vehicles, and better understand the benefits of future V2G operation in reducing network peak demand.

If electric vehicles become widely adopted and car manufacturers implement V2G capability, such vehicles may provide AusNet Services an opportunity to manage network peak demand more efficiently by reducing the need for new or upgraded infrastructure.

The lessons from the Electric Vehicle to Grid trial have also informed AusNet Services' ongoing investigations into stationary residential storage systems. Battery storage systems can be used to charge from excess solar power or off-peak power, then discharge at peak times, thereby reducing both the customer's electricity bill and network peak demand.