This study is part of ongoing work to model the impacts of new technologies on household load profiles. These load profiles will then be used to model changes in power flows due to these new technologies as well as the effects on network assets.

Three technologies are examined in this study:
1. Solar photovoltaic generation
2. Electric vehicles
3. Home battery energy storage systems

**PV Generation**

As at 31 March 2016 New Zealand has an installed PV Capacity of 36.774 MW which equates to 7.9 Watts per capita.

The common belief that PV makes no contribution to the reduction of peak loads was put to the test using data from 2015. An example of PV causing a reduction in daily peak is below.

Analysis was run for the entirety of 2015 across a number of networks in New Zealand. It is shown that PV does have the ability to reduce the daily peak on a number of days across the year. The case of real interest is the annual peak, which in the case of some electricity distribution businesses would have been reduced by PV generation. The mean reduction to the daily peaks for 2015 and reduction to the single peak load of the year, for varying levels of PV, is shown in the tables below.

**Electric Vehicles**

Electric vehicles (EVs) have the potential to create huge changes in demand, not only increasing peak daily demand, but also providing enough demand to shift the daily peak temporarily.

EV charging load has been modelled under a variety of scenarios. If 100% of the light vehicle fleet were to be electric vehicles with a charging start time normally distributed around 6pm, with a standard deviation of two hours, the peak load on Orion’s network would be increased by 62%.

It is clear that opportunities exist to manage the charging of EVs through the low load periods of night. Modelling a more realistic EV uptake (10% of the light vehicle fleet being EVs) and shifting the mean charging start time to 11pm causes a mean increase in daily peak of less than 1%.

The effect on a sample day’s load profile is shown below.

**Home Energy Battery Storage**

Home energy battery storage systems offer the potential to flatten household load profiles, reduce system peaks, and minimise reverse power flows due to high levels of distributed generation during periods of low load. Management of these systems requires decision making on both when to charge, and when to discharge, the batteries.

The most notable fact of initial modelling is the effect of load shape on peak reduction ability as demonstrated below. For sharp peaky loads, as in the graph on the left, the peak reduction ability is constrained by discharge rate. In the graph on the right, with a flatter peak of longer duration, the peak reduction is constrained by energy storage volume. Future work will consider different charging control methodologies.