RP2002

RESIDENTIAL ELECTRICITY DEMAND FORECASTING WITH BATTERIES

Research Question

In the future there will be an increased uptake of solar and battery systems in the residential sector, driven by falling battery costs and increasing electricity tariffs. The increased uptake means that we need new methods to forecast electricity demand when considering these technologies. This research couple's electricity demand forecasting with an optimally controlled solar and battery system to quantify, emissions reduction, peak energy use reduction and lifetime cost impacts.

Figure 1: Zero Emissions Home with rooftop solar PV and solar hot water.

Methodology

This research has developed a demand forecast model that implements an adaptive boost regression tree algorithm to forecast electricity energy demand based on historic smart meter and survey data. A mixed integer linear programing optimisation model has been implemented to investigate the impacts of solar and battery storage on demand. This technique is able to simulate the operation of a battery controller and also select the optimally, lowest cost, system capacity to meet an emissions reduction constraint (i.e. 50% reduction). The innovation in this research is to draw on forecasts to identify optimal battery configurations and to understand the wider impact of battery technologies on residential precincts. A scenario has been investigated to analyse the net present value (NPV) energy costs and system design required to achieve a 50% emissions reduction in the precinct.

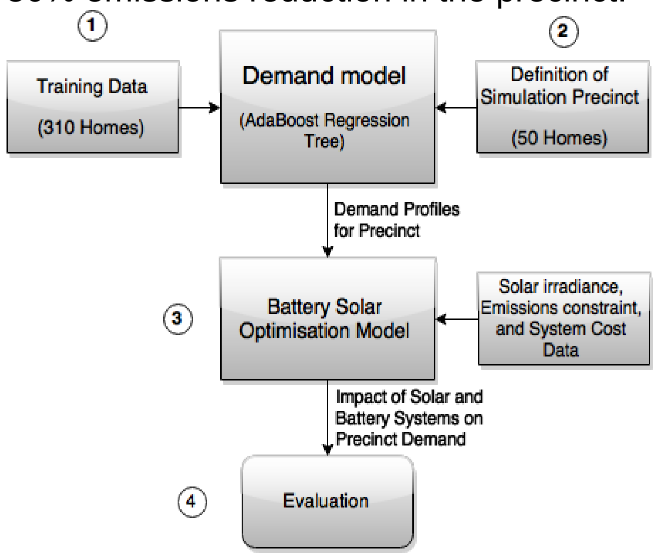

Figure 2 – Model process flow.

Results

Figure 3 shows the aggregated precinct demand for the week where the yearly peak event occurred. The blue line shows the reduction in demand considering an optimised solar and battery system installed, this shows a reduction in the peak event by 70%.Figure 4 shows the aggregated operation of the system for this week.

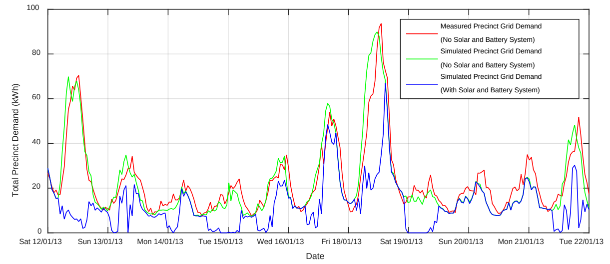

Figure 3: Peak demand week, for 50 home precinct showing comparison between measured, simulated demand, and battery-solar reduced demand.

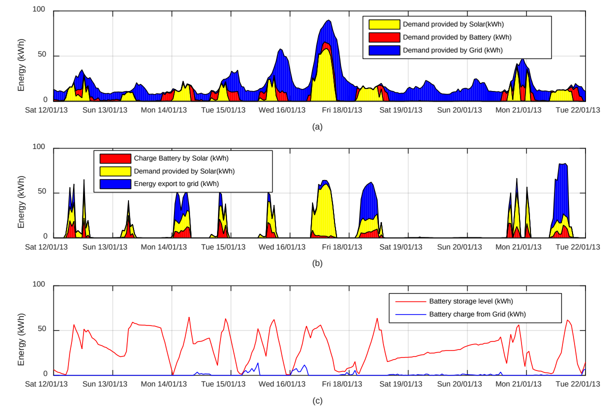

Figure 4: Operation of the the system (a) Energy mix to supply the demand (b) Solar supply usage (c) Energy stored in the battery and energy supplied to the battery from the grid.

Figure 5 shows the system solar and battery capacities defined for every home in the precinct. It can be seen that the unique way people use energy has an impact on the system design.

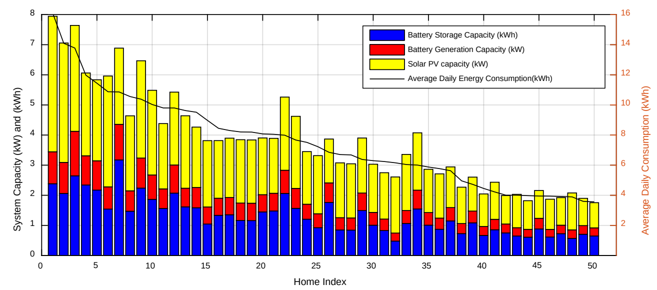

Figure 5 System capacities to achieve a 50% reduction in emissions.

Figure 6 shows the cost of the 50% emission reduction scenario compared to the NPV energy costs for the 25 year lifetime, including grid export income; for most customers this is very similar.

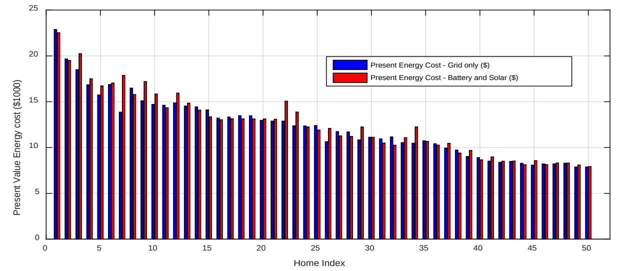

Figure 6: Consider including a graph to help explain your research.

Conclusions

A two-stage approach has been implemented that simulates the hourly demand for a residential home for one year. The approach applies an Optimisation model to define the impact of a battery and solar system on grid demand forecast, energy costs and greenhouse gas emissions.

Anticipated impacts

This work will allow for optimum sizing of solar and battery systems, and for an analysis of precinct emissions reductions, infrastructure requirements and grid impacts.

Batteries can reduce both CO2 emissions and the costs of energy!

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