THE ECONOMIC VIABILITY OF RESIDENTIAL BATTERY STORAGE: THE INFLUENCE OF LOAD PROFILE, TARIFF STRUCTURE AND BATTERY COST
Extended Abstract

Thomas S. Brinsmead, CSIRO, +61249606143, thomas.brinsmead@csiro.au
Luke J. Reedman, CSIRO, +61249606057, luke.reedman@csiro.au

Overview

It has been a key assumption of electricity system design that electricity is too costly to store but must be available when needed by the load. Recent reductions in the cost of batteries have prompted revisiting the economic viability of electricity storage. This paper analyses the economic case for storage from the perspective of a residential customer.

The economic viability of energy storage placed in residential premises is affected by a number of factors: annual consumption and load profile; the tariff structure of the customer; the presence or absence of on-site generation (e.g., solar photovoltaic); the feed-in tariff for on-site generation and its terms of payment (i.e. net or gross metering); the upfront and on-going costs of the energy storage system; expected life of the energy storage system; operational performance of the energy storage system (e.g., depth of discharge and round-trip efficiency); and expectations of future retail electricity prices.

The analysis in the paper explores several tariff structures, load sizes, and whether a customer has solar photovoltaic (PV) or not. The payback period of battery storage is calculated as a measure of economic viability. Results are presented for each state of the National Electricity Market (NEM).

Methods

Changes in residential customers energy bill due to the availability of battery storage are calculated for various customer load profiles, under battery sizes and operational regimes suited to each of various tariff alternatives. Reductions in the energy bill are compared to the costs of installing batteries in order to determine economic viability.

For each tariff incentive type, a heuristic battery operational regime was selected. For the case where there is a time-of-use (TOU) tariff without PV, the battery is charged during off-peak hours until its maximum capacity is reached, and discharged during peak hours until its minimum capacity. For the case of a tariff with a capacity charge, a target peak is selected, and the battery charged up to its maximum whenever customer demand is below the target peak, and discharged so that the net demand meets the target peak whenever the customer gross demand exceeds that target. For the case of PV with gross metering and a flat import tariff, the battery is discharged whenever customer consumption exceeds PV production, to the minimum battery capacity, and charged whenever PV production exceeds customer consumption. For the case of a TOU tariff with PV, the operational heuristic is slightly more complicated. The battery is charged when PV production exceeds customer consumption and during off-peak times and discharged during peak times if customer consumption exceeds PV production

The relationship between battery scale and financial return is typically slowly declining per unit installed capacity and the particular scale that maximises financial returns is strongly dependent on the individual customer demand profile, which will vary from year to year. There is typically a broad range of battery sizes which result in an approximately similar net financial benefit to the customer. This makes it particularly difficult to calculate a preferred scale of battery to within a small range, even for the case of an individual customer focussed solely on financial considerations. In practice it is likely that both residential and small scale commercial customers will opt for one of a limited range of standard sizes offered by suppliers. A number of different scales of battery energy and power capacities were investigated, with size being selected on the basis of another heuristic whereby the amount of energy shifted per unit battery capacity starts to decline significantly. This corresponds to maximising an approximation of the financial benefit to cost ratio.

Given a particular customer load profile and tariff schedule, the heuristically selected battery sizing and operation regime allow a resulting modified customer load profile to be calculated, and hence the change in the customer's electricity bill. Comparison with the cost of battery installation allows a (simple or discounted) financial payback period to be calculated. Because both the battery size and operational management regime have been selected on a heuristic basis rather than being optimised, the result underestimates the best achievable economic returns.

Based on the number of factors that affect the economic viability of storage, six end-use cases were formed for residential customers. These cases assume different energy storage, solar PV and tariff combinations: These six end-use cases were examined for three different sizes of customers (small, medium, and large) and for all five states in the NEM.

Results

The payback period (average time to recover the investment costs of installing a stand-alone battery system or integrated rooftop PV system with battery storage) varies across NEM regions, as it relies on individual household demand, available tariffs, solar resources, all of which vary broadly across the NEM.

The results show that:

- There is greater value of storage when it is installed simultaneously within an integrated system with solar PV;
- For baseline battery costs and large size residential customers in most NEM states, the payback periods for newly installed storage and solar PV systems on a time-of-use (TOU) tariff decline over the projection period from 11-35 years in 2015 to 6-12 years by 2035;
- For baseline battery costs and large size residential customers in most NEM states, the payback periods for newly installed storage and solar PV systems on a flat tariff decline over the projection period from 9-12 years in 2015 to 4-6 years by 2035;
- For households without solar PV battery storage under TOU tariff pricing provides the most value to households, particularly in New South Wales;
- For baseline battery costs and large size customers in most NEM states, the payback periods for battery storage for households without PV on a TOU tariff decline over the projection period from 17-35 years in 2015 to 8-11 years by 2035;
- For households with solar PV already installed, battery storage does not provide significant additional benefits under flat tariff or TOU pricing;
- There is greater value of storage for households with large loads when compared to smaller customers;
- Battery storage under capacity pricing appears to be unviable for households based on the tariff structure that has been assumed;
- Lower battery costs in the future reduces the payback period by between 4-5 years for most time periods if battery systems are installed under TOU pricing.

Conclusions

The results presented in this paper showed that the economic viability of battery storage placed in residential premises is sensitive to a number of factors. In general, viability was greatest for large consumption households in all end-use cases that were explored. Installation of an integrated solar PV and battery storage system was the most economic case, with the battery-only cases showing greater variability in the results.