Forward:

This forward to the report '***Distributed Storage and Solar Study: Final Report***' follows a roundtable discussion, in October 2019, by three of the reports authors (Paris Hadjiodysseos – Northern Powergrid, Siem van Limpt – Element Energy & Andy Heald – Energise Barnsley) on the report findings that follow.

The authors wished to discuss and capture the wider aspects of the project results, relevant to the changing low carbon domestic retail electricity market, aside from the impact to the network alone.

Project initiation was in 2017 when the residential domestic smart battery market was in its' infancy with only a small number of manufacturers and distributors in the UK, and only a few hundred installations, aside from trials and innovation projects.

The domestic smart battery marketplace in the UK has seen an increase in manufacturers and distributors, with new entrants and business models, since project inception.

However, it is fair to say that it is still a nascent industry, which potentially can offer suitable solutions to the foreseeable change to the electricity generation and distribution network, if capital costs of the batteries continue to fall, and market driven contracts reward those homes willing to host batteries to respond to a future flexible grid.

Market Analysis

The cost benefit analysis section of the report shows that domestic smart batteries can be competitive, especially as the capital costs reduces and revenue streams stack up.

The methodology and results from a study like ours would be 'super charged' if all homes were digitalised, with smart meters. With smart meters in homes, the batteries can be sized accordingly, therefore assist the network more effectively. The benefits would include the charging/discharging rate of the battery set by a threshold rate reliant on accurate digitalised smart data, which would in turn make the battery more efficient, and the network of batteries more efficient if aggregating demand and export per home. Alternatively, battery development would include inverters which no longer required a minimum threshold to operate.

Our study showed that idle batteries have no benefit to the network. A battery will be idle if the discharge threshold is too high for typical evening use in one dwelling, for example, or if the solar generation keeps the battery topped up, as demand is too low in the dwelling.

Open and available data could be used to the benefit the district system operator and homeowners allowing third parties/innovators to analyse the data and come up with suitable tiered business models.

Our study had a mixture of retired, family and night shift workers. A home with a low level of electricity consumption will not strongly increase their levels of PV generation self-consumption with a battery, but the night shift worker next door would be able to benefit from the extra generation in a digitalised aggregated market.

The study tested the degradation of the battery over the project lifetime and then calculated that after 10 years there should still be 80% of power charge left, which was viewed as a positive.

Community Analysis

Our community consisted of tenanted homes that already had the benefits of solar PV (2.9kWp average size installation). At the end of the project tenants commented that it did not make sense for solar to be installed without a battery fitted, as the tenants realised their increased benefit of using self-consumption of the solar generation via the battery, instead of it being spilt onto the grid. This benefit, when added to the initial solar savings, had a material impact on the reduction of their electricity bills.

Battery size and aesthetics for the tenants were acceptable as the battery was relatively small and a good fit in the outhouse of our bungalow properties. The battery was generally viewed as out of the way. A large battery that had to be fitted internally on the walls might not have been so favourably viewed.

Tenants accepted that the battery required 'piggy backing' on their broadband to communicate its data. Where tenants did not have broadband the project installed it. It should be noted that the monthly charge from broadband alone would erase any battery savings to the tenants.

Tenants did not show any reluctance to a third party controlling the battery and analysing the data.

Given the vast array of data, and calculated savings to the tenants, for a third party intermediary to accurately check the savings, metered data is essential, with no gaps in the data information because of communication problems. Any third party community aggregated model will require streamlined, accurate and efficient data flows in order to pass on the savings to tenants, post taking an administration fee.

Tenants could easily ask for the battery to be removed, if the savings per annum are not accurately portrayed to them in an easy to understand format. This is even more apparent if a new tenant moves into a home, with solar and a battery already installed. The first year electricity bill will contain the relative savings from the installed equipment, although the tenant will find it difficult to understand the absolute savings, as the first annual bill is the *de facto* amount for the home in that given year.

If the homes were electrically heated there would be more use and impact of the smart battery within the home, and the network. Using a smart battery for solar generation charge and discharge only, feels like it is not being used to its full capacity and impact.

Network Analysis

For the network there was a reduction in voltage even when the batteries were not being remotely controlled through a charge or discharge programme. This reduction to the network is 'free' to the network companies and can be significant if there is widespread distribution of residential smart batteries.

Batteries can help flatten the substation demand by shifting load, which will have a positive impact of low voltage losses. DNO compensation costs will also decrease with the benefit of predicted solar generation, which in turn will optimise a battery to benefit the low voltage network.

The modelling analysis shows that batteries can help with keeping the voltage along feeders within limit and batteries in the middle of the day help reduce voltage rise. Batteries in the evening help reduce the evening peak demand. The peak demand coincides with when people go home. If they have an EV they can plug it in to discharge and hence reduce the peak. Batteries can help reduce evening peak demand which can help with the uptake of EVs. This battery can be fixed (charge in the middle of the day from PV and discharge in the evening) or on wheels (i.e. V2G push back power to the grid). For our homes which did not have solar but had a battery fitted there was no economic benefit to the household, although the battery did help the network, especially if charged during the middle of the day to absorb the solar peak.

The study also found that if the batteries were forced to charge and discharge, there could be more than double the positive impact for DNOs on the network, particularly for households with low levels of demand as in these households the limited evening and overnight discharge will have an impact on the charging capability during the next day. This can have a particularly large impact in summer.

The demand patterns of the trial participants were very comparable to those in the CLNR dataset, even though we monitored only a small cluster. This gave us confidence in the DS3 dataset, as well as the other way around.

The trial highlighted the importance of the timings and rates of charging and discharging. In some cases it was shown that it could be preferable for the network if batteries would be forced to charge at a lower rate but for a longer period of time, as in summer the generation period turned out to be longer than the maximum charging period (when charging at the battery's maximum rate). On the other hand, in winter batteries did not need to be forced to operate in a certain way because generation was limited and evening peaks were fairly small.

Conclusion

Our innovation trial has hopefully given some insights into a future flexible domestic electricity market, where smart batteries are utilised to their maximum effect, benefiting consumers and the local network.

Part of the trial has successfully concluded that batteries can be retrofitted into homes, and perform to the manufacturers stated capabilities, whilst increasing the benefit of residential solar generation and aiding balancing the local low voltage network.

The speed of uptake of smart batteries with or without solar PV, or electric cars at home, will be rocket propelled when there is a clear understanding of accurate residential demand and export, through the digitalisation of our domestic residential electricity market, and local settlement. This can't happen fast enough to propel this market.