WARMWORKS Scotland

Domestic Battery Storage Project

Dumfries and Galloway

Project Report

Contents

Acknowledgements

Warmworks is grateful for the support of a number of partners in making this project a reality. Firstly to SP Energy Networks (SPEN), who provided the funding for the project through their Green Economy Fund and gave regular input and much appreciated operational support throughout project delivery. We are also grateful to Dumfries and Galloway Housing Partnership (DGHP) and their team, who worked with their tenants as the end recipients of the battery storage units and proved to be a supportive and practical partner in delivery. The support and expertise of Citrus Energy and Cunninghame Housing Association also proved an invaluable element of our project delivery.

Finally, Warmworks is grateful to Changeworks for conducting independent monitoring and evaluation work at various stages of the project. This work has been instrumental in informing several areas of this report and a number of aspects are featured in more detail in the ‘Numbers and analysis’ section on page 16.

Background to the project

A paradigm shift

As we move towards the goal of becoming a zero carbon nation, the ways in which we generate, store and use energy are already changing at pace. After years of aspirational planning, experimental testing and devising targets that seemed a long way away, we now know that the technology, the will and the skills are in place to ensure the way in which we all interact with energy in the home will be very different by the end of this current decade.

Energy use in our homes will fundamentally shift away from the established norms because the new paradigm will be centred around greater flexibility, an increased use of storage to genuinely optimise renewable generation and, last but certainly not least, significant changes to behaviours and the way we interact with energy as a commodity.

We already know that Scotland has an established track record in renewable energy generation, both in terms of large scale technologies and also at household level. The Scottish Government has a target in place to develop this still further, with an aim for the equivalent of 50% of the energy for Scotland's heat, transport and electricity consumption to be supplied by renewable sources by 2030 – now under a decade away.

This focus on increased renewable generation naturally leads on to the incorporation of battery storage, both at the community level and at individual household level, particularly as the available technology continues to evolve and improve. For the first time, it's possible to see clear evidence – at the macro and micro levels – of integrated systems that are combining renewable generation with storage technology that is actively improving the flexibility of the network.

Coupled with the rapid rise that we're seeing in the installation of low carbon heat sources – such as heat pumps – we can see the individual pieces of the jigsaw puzzle becoming more established and generating more momentum in the mainstream of our homes, buildings and the wider popular consciousness.

Ensuring an inclusive, equitable transition

From Warmworks' perspective, our interest is in ensuring that this paradigm shift takes place in a way that is inclusive, equitable and brings about maximum benefit for those consumers who are in or at risk of fuel poverty; consumers that have historically been left behind or disadvantaged by shifts in market dynamics and product development. That's been the case despite the fact that fuel poor consumers actually have the most to gain from innovations, technologies and new approaches that can reduce bills and provide greater control over how energy is used.

As Managing Agent of the Scottish Government's flagship fuel poverty scheme, Warmer Homes Scotland, Warmworks has already helped more than 22,000 households across Scotland to save money on their energy bills and be warmer in their homes through the installation of mainstream energy efficiency improvements.

With the availability and efficiency of new technologies steadily increasing as described above, we saw an opportunity to use our knowledge and experience of working with our established, skilled and accredited supply chain of local installers to start to investigate how these technologies could be brought together in a way that lowered bills and tackled fuel poverty in a future-proof way.

Shaping the project itself

We started with the view that domestic battery storage was one of the least widely tested and least well understood elements of the technology mix described above. Our idea was to examine whether battery storage alone – when aligned to flexibility and the right tariff arrangements – could provide real world savings for homes that were in or at risk of fuel poverty.

That led us to focus our project on communities that were off-gas, looking at homes powered by electricity and/or existing renewable heat sources, as well as looking to target homes that were in communities that were more likely to be in need of more support.

The premise was that if the installation of a battery alone – alongside certain behaviour changes and optimised tariff arrangements – could generate a saving for these households, then the potential savings should only be greater if and when battery storage technology is included as part of a wider package of energy saving measures and interventions.

We also wanted to ascertain whether it was feasible, once a significant volume of batteries had been installed across the region, to bring the batteries together in a virtual power plant arrangement, which could in turn generate revenues from aggregation to supply grid flexibility services.

With existing Distribution Network Operators (DNOs) – such as SP Energy Networks (SPEN) and Scottish and Southern Electricity Networks (SSEN) – already publicly committed to increasing flexibility on the grid as they transition to become Distribution System Operators (DSOs), we felt that gaining an indication as to how aggregation revenues could work for fuel poor homes could be an important learning point as the storage market develops and the grid changes.

In mid-2019, we approached Dumfries and Galloway Housing Partnership (DGHP) and worked with them to develop an outline project plan to test this approach with tenants in their area.

> Dumfries and Galloway Housing Partnership is Scotland's second largest social landlord with more than 10,000 affordable homes across Dumfries and Galloway.

Funding and project outline

Once the plan was in place, we submitted a bid to SP Energy Networks' Green Economy Fund to secure capital funding to meet the cost of installing battery storage. That bid was based on a project that would:

- Install up to 150 batteries in homes off the gas grid in the Dumfries and Galloway region
- Following the installation of the battery, optimise tariff arrangements for tenants to try and secure energy bill savings that would tackle the risk of fuel poverty
- Work with tenants to optimise their behaviours to get the most value out of their tariff arrangements, for example from time-of-use tariffs
- Investigate the potential for future flexibility services once the batteries had been installed and a virtual power plant had been established – for example through aggregation and half-hourly trading

This project commenced in December 2019 and was completed at the end of March 2021. No-one foresaw the impact of a global pandemic in the middle of our delivery, but our delivery partners and SPEN as our funder showed patience and flexibility as we were able to work the project through to its conclusion.

As the following pages will hopefully demonstrate, we believe the project was successful in its aim to bring valuable learning and insights that should have a significant impact for fuel poor customers in future schemes and policy design. The task ahead is to engage stakeholders across the board as we look ahead not only to the task of scaling and accelerating the rollout of the technology that we need, but also the way in which we bring customers from all parts of society with us on the journey to a just transition and a zero carbon future.

Ross Armstrong

Managing Director, Warmworks

The project in numbers

423

the number of households engaged as part of this project

205

the number of households referred for free and impartial tariff advice, which includes those who did not get a battery installed due to their homes not meeting the technical requirements

83%

the highest reported monthly bill saving in % terms for an individual customer who had a battery installed[1]

133

the total number of batteries installed

the percentage of households that had a battery installed that are not on the gas network

13,000 KM²

the area covered by the network of batteries that has been installed across Dumfries and Galloway

the total power capacity in the batteries installed

[1]This saving was taken on a 'snapshot in time' basis, comparing that household's energy bill in May 2020 to the same month a year earlier in 2019. The nature of the comparison will be influenced by a number of factors, such as changing energy usage patterns and shifting Agile tariff pricing during the height of COVID restrictions.

Project delivery

Identifying the right tenants

Our first task was to identify the right mix of candidate households and communities within DGHP's portfolio of properties. This meant working with DGHP to find homes that were off the gas grid and likely to be struggling to pay energy bills. We then worked with our partner organisation, Changeworks, to carry out a more detailed exercise – using their bespoke fuel poverty mapping tool – that helped to more precisely target areas most likely to be in or at risk of fuel poverty.

Securing funding

When the list of tenants and properties was agreed with DGHP, we applied to SPEN's Green Economy Fund to provide the investment required to deliver the project in the way that it was designed. Securing this funding meant that none of the tenants included in the project would have to pay anything towards the cost of having batteries installed.

The £20m Green Economy Fund was established in 2018 to support the Scottish Government's ambitious energy strategy and the UK's drive to a low-carbon economy.

Engaging tenants

Once the funding was in place and we had established a list of tenants that would meet the project criteria, we worked with DGHP in the local community to raise awareness of the project and encourage target households to take part. We then wrote to all candidate households and arranged an initial survey visit.

Selecting the right product

We needed to ensure that the battery storage units that would be used for the project were able to meet all of our needs and provide the right level of insight as to the potential for this technology in this market. We carried out a full market assessment exercise on that basis and selected the Tesla Powerwall II product, details of which are shown below:

- Capacity: 13.5KWh
- Works in the event of a power outage: Yes
- Allows aggregation and flexibility services: Yes
- Can be fitted internally within the property or housed externally if required: Yes
- Can be operated and monitored remotely: Yes

Surveys and EPCs

The initial survey visit gave us the opportunity to talk to tenants about their current energy use, electricity meter setup and tariff arrangements, as well as to investigate how and where batteries would be sited in their home (this could be inside or outside the property given our selection of the Tesla product).

Meters and tariffs

We quickly learned that switching customers to smart meters would open up a range of tariff and energy supply options that could lead to greater savings when battery storage units were installed.

We worked with Citrus Energy, an independent organisation focused on supporting consumers to switch to the best energy deal, to get households switched to the optimal meter, supplier and tariff for them once the battery was installed. As shown later in this report, this wasn't always possible given the challenges on the energy supplier side, but savings were still made, even for those customers who weren't able to change their metering or tariff arrangements.

Project delivery

Installation

We only used our accredited installers from within our existing network and we supported them in becoming Tesla-accredited installation partners. We ensured that the right level of training, onboarding and customer communication were in place to ensure this element of the process met our quality standards.

We engaged with DGHP's local Housing Officers throughout the installation process to ensure additional support was available at the point of installation for particularly vulnerable households.

Once batteries were installed and commissioned, we configured the units to ensure they were optimised and aligned with the tenant's tariff, in terms of setting the correct charging times and ensuring householders were very clear on how the technology would work.

Inspection

We carried out an independent inspection of every battery installation and double checked that each unit was correctly configured and aligned to the relevant tariff arrangements. We used this opportunity to provide further advice and support to all customers in order to ensure they were happy with the technology and its operation.

Lastly, for any customers that had received a battery storage unit but had not yet engaged with Citrus Energy to optimise their energy supply arrangements, we provided further advice on the importance of completing this final step.

Monitoring

Changeworks was appointed to carry out the monitoring and evaluation work at all stages of the pilot. This involved gathering data relating to bills and tariffs and carrying out regular qualitative surveys throughout the project, to evaluate householder perceptions and behavioural changes. A breakdown of the monitoring work is presented on page 16 below.

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Customer case studies

The stories of the tenants who took part in the project are the most important testament to its impact. This section sets out in detail how several project participants found the end-to-end experience of having this future-facing technology installed and shares their initial feedback about the process and the equipment. As part of their wider project evaluation remit, Changeworks also completed questionnaires with a number of tenants and the results of that analysis are detailed later in this report.

Name: **Mrs L**

Location: **Castle Douglas**

Date of installation: **September 2020**

Mrs L, a tenant of Dumfries and Galloway Housing Partnership, was identified as being able to receive battery storage technology under the Domestic Battery Storage Project. Mrs L was really interested in the technology and the potential benefits and decided to enquire further about it.

"I got a letter with some leaflets, which had all the information I needed, even explaining what the installation included. I also did all my own research too and had lots of questions, but I got in touch with Warmworks and they took me through all the information and gave me a few web links to look at. They also told me that if I had any further questions, I could call at any time and that it was no problem at all. That was really good."

Warmworks then arranged for a surveyor to attend Mrs L's property to confirm her home was suitable to receive the technology.

"This went very well. The surveyor came and looked at the practicalities of the actual installation and whether my home was suitable. He also explained where the technology would go and spent some time talking to me about the benefits of it and how it would all work. He went into a bit of detail on energy tariffs and how important being on the right one was."

The surveyor confirmed to Mrs L that her home was suitable to receive the technology and she was delighted that she was able to take part in the project.

In order to maximise the benefits of the battery storage technology, Mrs L's home was fitted with a smart meter. This was to ensure that once the battery was installed, she could benefit from the latest smart energy tariffs. It also had the added benefit of providing a mechanism for the battery to be used as an electricity store that charges when electricity prices are very low, thus helping to reduce the cost of electricity used to heat and power the home.

Speaking about having her smart meter fitted, Mrs L remarked how: ***"I got it put in before the battery was installed and I got lots of help from Octopus. I had been told by my previous supplier that I couldn't receive a smart meter because of a signal issue but it turned out not to be a problem. Citrus Energy (Citrus) also provided advice on switching my energy tariff to make sure I was getting the best deal. The guy at Citrus gave me information on when to use certain appliances and how the battery would work with the right tariff to help make my bills cheaper."***

Shortly after the smart meter was installed, Warmworks appointed one of its local sub-contractors, City Technical Services Ltd (City Technical), to carry out the work and a technical survey was arranged to go into more detail about the installation. The installation date was then set.

On the morning of the installation, the team from City Technical arrived early and got to work straight away to install the battery storage technology.

"The installers arrived for the installation and they just got on with it and I was happy with that. Apart from the battery being on the wall, you would think that nobody had been here. There was no sign of debris from the wall, not even a wire. I was asked beforehand to move some of my plants to accommodate the installation, but the team even put these back for me afterwards."

Once the installation was complete, a Warmworks inspector visited Mrs L's home to ensure everything was installed correctly and to the highest standards.

"A chap came back and did a final check that took half an hour. He checked everything and made sure it was all ok."

When asked if she has seen a difference in her fuel bills, Mrs L said:

"In January this year, I was in over £200 credit and I paid my January bill from that. I am checking my smart meter all the time; a Sunday ends the week on the smart meter and it gives you an overall cost for the previous seven days. In one week, I had used just under £15 for the week. I am easily saving £45-50 a month and the fact I am in credit, it's jaw dropping, it really is."

Speaking about her overall experience of the project, Mrs L said:

"Well I don't mean to be overly dramatic but it has been life changing for me. Before this opportunity came along, I was having problems and now I'm much better off. My bills before were £125 per month and now it's down to £75. It's like winning the lottery, totally life changing. Especially when you get old; I am 62 and still working. I feel the cold more and I have health issues, which can cause me problems. I also work in social care and don't make a lot of money. I can't stress any more how much of a difference this battery has made to me."

Everything went really well with the switching. I actually just got a bill in today and we are sitting £500 in credit, which is amazing! I could reduce my payments but I'm happy to continue being in credit for more peace of mind.

Name: **Mrs C**

Location: **Kirkcudbright**

Date of installation: **November 2020**

Mrs C, a tenant of Dumfries and Galloway Housing Partnership, was identified as being able to receive battery storage technology under the Domestic Battery Storage Project. Mrs C thought the project sounded really good, particularly the potential to save money on bills and provide resilience in the event of a power cut, as her husband had just started home dialysis.

"It sounded really good to be honest. We had just moved into a new house a few years ago due to my disability and when we came here we had a prepayment meter and they wanted £200 to take it out. This project helped us out with that. I was also pleased to hear about the potential for cheaper electricity and the fact that the battery would kick in if we had a power cut – this was a bonus as my husband has just started on home dialysis as well. It was a win-win all around for us."

After expressing interest in the project, Warmworks arranged for a surveyor to attend Mrs C's property to confirm her home was suitable to receive the technology.

"This was brilliant. The surveyor was really good and friendly. He chatted away and he actually ended up going to a few family members of ours as well as we told them about the project too."

The surveyor confirmed that Mrs C's home was suitable to receive the technology and she was delighted that she was able to take part in the project.

In order to maximise the benefits of the battery storage technology, Mrs C's home was fitted with a smart meter. This was to ensure that once the battery was installed, she could benefit from the latest smart energy tariffs. It also had the added benefit of providing a mechanism for the battery to be used as an electricity store that charges when electricity prices are very low, thus helping to reduce the cost of electricity used to heat and power the home.

Speaking about having her smart meter fitted, Mrs C remarked how: ***"It was installed before the (battery) installation and to be honest, it went perfectly."***

Shortly after the smart meter was installed, Warmworks appointed one of its sub-contractors, Everwarm, to carry out the work and a technical survey was arranged to go into more detail about the installation. The installation date was then set.

On the morning of the installation, the team from Everwarm arrived early and got to work straight away to install the battery storage technology.

"This all went smoothly, very lovely lads and everything was brilliant. It did not take long at all really, there was a delay due to COVID-19 restrictions, but everything moved along nicely."

As part of the process, Mrs C also switched her tariff to ensure she was on the right one to save money.

"Everything went really well with the switching. I actually just got a bill in today and we are sitting £500 in credit, which is amazing! I could reduce my payments but I'm happy to continue being in credit for more peace of mind."

When asked if she has seen a difference in her fuel bills, Mrs C said:

"Well, we are saving a lot and we are not worrying about having to get over the town to get money for the meter. We can check all the details from the smart meter."

Speaking about her overall experience of the project, Mrs C said:

"It was brilliant! The installers were amazing and I had a great laugh with them! If anyone was thinking of having this technology installed, I would say just go ahead, don't hesitate. Just listen to the advice, everyone that I spoke to was amazing!"

Customer case studies

Name: **Mr J**

Location: **Dumfries**

Date of installation: **September 2020**

Mr J, a tenant of Dumfries and Galloway Housing Partnership, was identified as being able to receive battery storage technology under the Domestic Battery Storage Project. Mr J was really keen to take part and was especially pleased to hear that one of the aims of the project was to make energy bills more manageable.

"I received a letter and leaflet through the door about the project and I thought it sounded like a good idea. I was especially interested in how it might save me money on my fuel bills."

Mr J got in touch with Warmworks to find out more information about the project and express his interest. Warmworks then arranged for a survey to be carried out on his home to assess its suitability for the project.

"The survey was fine and the Warmworks surveyor explained everything to me in detail."

The surveyor confirmed to Mr J that his home was suitable to receive the technology and Mr J was delighted that he was able to take part in the project.

In order to maximise the benefits of the battery storage technology, Mr J's home was fitted with a smart meter. This was to ensure that once the battery was installed, he could benefit from a smart time-of-use energy tariff. That tariff provided a mechanism for the battery to be used as an electricity store that charges when electricity prices are very low, thus helping to reduce the cost of electricity used to heat and power the home.

Speaking about having his smart meter fitted, Mr J remarked how: ***"Everything is up and running smoothly and I got help from Citrus Energy to switch my energy tariff to make sure I was getting the best deal. At the beginning, I was worried about the disruption of it all, but it's been minimal. Absolutely brilliant!"***

Shortly after the smart meter was installed, Warmworks appointed one of its registered sub-contractors, City Technical Services Ltd (City Technical), to carry out the work and a technical survey was arranged to go into more detail about the installation. The installation date was then set.

On the morning of the installation, the team from City Technical arrived early and got to work straight away to install the battery storage unit.

"The work took a bit longer to get started due to COVID-19 restrictions, but once it started, it only took a single day! They told us when they'd be finished, and they were a lot quicker than I thought they would be. I was surprised how quickly it was all installed.

The folk that came out were really professional and it was completed to a high standard - they were super quick and just really friendly folk.

There was no cleaning to do afterwards. I absolutely cannot fault them at all."

Once the installation was complete, a Warmworks inspector visited Mr J's home to ensure everything was installed correctly and to the highest standards.

Mr J has already seen a big difference in his fuel bills: ***"It has definitely taken a big chunk off our normal bills and what we would usually spend. I can't wait to see what this saving comes out at over a year."***

Speaking about his overall experience of the project, Mr J said:

"Everyone was spot on; it was absolutely brilliant. The opportunity just fell into our lap and I'm so glad it did. It's made a good bit of difference to our lives, and I am very happy and proud to be part of it."

Numbers and analysis

A key aim of this project was to monitor and evaluate its impact on householders in order to gain a greater understanding of the current and potential future benefits of the battery units.

Warmworks appointed Changeworks to carry out independent monitoring and evaluation work for the project. The highlights from their findings have been included below. Changeworks' monitoring and evaluation consisted of quantitative data analyses (taken from battery usage and related consumption data), pre-installation interviews and surveys and post-installation surveys, carried out with a proportion of householders.

Householder and property characteristics

Respondents were asked a series of questions to give some background information about their occupancy and the properties where the installations were taking place.

The average measuring period was 140 days, which is **4.5 months**. On average, **52%** of the daily used electricity was consumed via the battery, meaning this was used at the off-peak tariff.

The heating systems in the properties where householders took part in qualitative surveys were mainly electric, with a majority of the respondents that were surveyed having air source heat pumps (15). The second most common type of system was electric storage heaters (4).

Most respondents (25 of the 27 surveyed, or 93%) live in households where someone is at home during the day, every day of the week. However, given the impact of the COVID-19 pandemic during the project period, this will have been the case for many households.

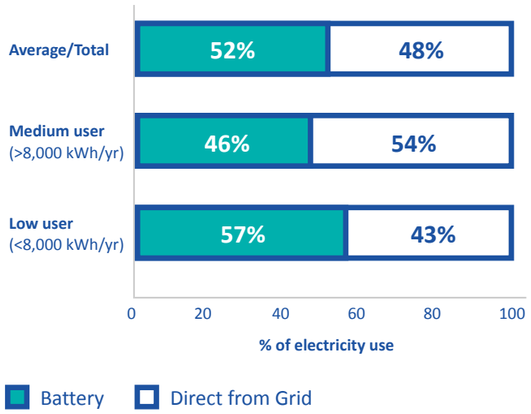
Estimated savings

There were 88 households with battery data for which a full set of installation dates and tariff switching (if applicable) was provided. Where it was clear for whatever reason (timing of commissioning of the installation, for example) that households were not discharging the battery at all, they were excluded. This was in order not to skew the estimated average savings for a household using the battery correctly.

Dual tariff households

The average measuring period was 140 days, which is 4.5 months. On average, 52% of the daily used electricity was consumed via the battery, meaning this was used at the off-peak tariff. The baseline electricity use data showed that before the battery installation, 41% of the electricity was consumed at off-peak tariff.

For households that had a lower overall energy use, this percentage was higher, and the average price per kWh consumed was lower. This difference can be explained by the battery having a limited capacity, with the result being that householders that used more electricity during the day – likely to be a higher proportion given COVID restrictions in place at the time – were more likely to use more against the peak tariff in absolute and relative terms.



Overall, if it is assumed that the electricity from the battery used during the day would have otherwise been imported against the peak tariff, the estimated savings from battery use with a dual tariff is **£208 per year** if we compare it to the baseline electricity use.

In addition to the savings from battery use and supplier switching, the households that switched suppliers on average saved a further **£8 per year** from the change in standing charges.

Smart time-of-use tariff households

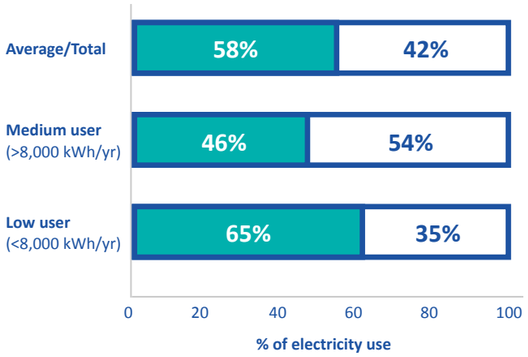
The average measuring period was 261 days, which is 8.5 months. On average, 58% of the daily used electricity was stored in the battery. For households that had a lower overall energy use, this percentage was higher, and the average price of kWh consumed was lower. The limited capacity of the battery can explain these differences. All households on the smart time-of-use tariff have 'Octopus' as their supplier, indicating the adoption of Octopus Energy's Agile Tariff.

The average baseline annual consumption provided at the beginning of the project for households on a smart time-of-use tariff that were previously on a dual tariff was 6,311 kWh/yr. The difference between their previous average dual tariff (15.01 p/kWh) and the smart time-of-use tariff (9.78 p/kWh) results in a saving of 5.23 p/kWh, which is **£331 per year** using the baseline consumption.

For households previously on a single tariff, the average costs per kWh were comparatively even lower than those previously on a dual tariff. The average baseline annual consumption for smart time-of-use households previously on a single tariff was 4,755 kWh/yr. The difference between their average single rate tariff (18.55 p/kWh) and the smart time-of-use tariff (9.37 p/kWh) would result in a saving of 9.18 p/kWh, which is **£436 per year** using the baseline consumption.

In addition to the savings from tariff switching and battery use, the households that switched to the smart time-of-use tariff on average saved **£25 per year** from the change in standing charges (21p per day on the smart time-of-use tariff).

Numbers and analysis



Single tariff households

Some households remained on single rate tariff at the time of the project's conclusion, partly due to the difficulties they experienced in switching energy supplier or getting a smart meter installed (see 'Householder experiences of switching' below).

Single tariff households are unlikely to make savings on their electricity bills through the battery, as they pay the same amount per kWh throughout the day. However, as a result of their engagement with the project, twelve households remained on a single rate tariff but switched electricity supplier to save money. When we combine savings achieved from these changes in price per unit and standing charge, they saved on average **£23 per year**.

Householder experiences of switching

The post-installation survey analysis showed that some households had experienced complications during the switching process. Therefore, interviewees were asked to provide further feedback. Around half of the interviewees had switched to the smart time-of-use tariff. A few householders experienced complications when switching, mostly due to errors made by the energy suppliers (i.e., erroneous meter readings). Some of these householders felt they were not able to understand what this tariff meant for them and felt a lack of accurate meter readings would impact their bills at a later date.

Total potential savings

Based on the data gathered in this project and applying it more broadly to the wider population, then **if the average consumption (including non-electrically heated homes) is standardised to 8,000 kWh a year**, adding a battery to a dual tariff could save **£290 per year**. Switching to a smart time-of-use tariff (such as the Octopus Energy 'Agile' Tariff) could then save a further **£388 per year**. This means that switching from a single tariff to a battery with a smart time-of-use tariff could result in the highest savings, **£679 per year**.

Applying the battery savings mentioned for those on dual and agile tariffs to all 133 households that received a battery would result in overall savings of just under **£43k per year** (£42,682)[2], assuming these households use their batteries in an optimal way.

Satisfaction

Around two thirds of survey respondents (65%; 17 out of 26) were satisfied or very satisfied with the information provided about the battery. However, when comparing the more favourable responses to the pre-installation survey, there is a clear reduction in satisfaction rates, where comparatively 96% (30 out of 31) of respondents were satisfied or very satisfied with the pre-installation process. This indicates that some respondents would have preferred more information to have been provided at the point of installation or immediately afterwards.

In addition, before the battery installation, 60% of respondents (18 out of 30) used extra heaters. Since the battery installation, 42% (11 out of 26) reported using extra heaters; one respondent used the extra heater in place of their central heating. Those who continue to use additional heaters now use them for slightly longer periods of time. However, these findings should be set in context against the fact that many households will have been isolating at home or operating under stringent COVID-19 restrictions during the period in question.

The findings above suggest that tenants would benefit from an increased level of follow up advice, and support on how to optimise the use of their central heating system, to reduce costs once a battery has been installed.

The findings opposite suggest that tenants would benefit from an increased level of follow up advice, and support on how to optimise the use of their central heating system, to reduce costs once a battery has been installed.

[2] Overall, 133 properties received a battery, of which 34 remained on a single tariff (therefore making no battery driven savings), 34 moved to a smart time-of-use tariff and 65 had a dual rate tariff such as Economy 7.

Recommendations and insights

The evidence presented in this report – both at the project level and the individual householder level, at the quantitative level and the individual case study level – demonstrates that domestic battery storage has an important role to play, not just in the adaptation of our energy grid and systems as they seek to support a zero carbon society, but also in the ongoing efforts to tackle fuel poverty and ensure that a just transition to zero carbon is a reality.

The key insights from the project are summarised in this section, taking the form of a ten point plan for future policy and scheme design as the rollout of this technology accelerates:

If batteries alone can do this, even with these challenges, then think about what they could do in an optimised package of energy-saving improvements.

Batteries alone can save money for certain householders: the project has demonstrated that for customers on dual tariffs and smart time-of-use tariffs, it's possible to make significant energy bill savings solely by installing a battery storage unit and optimising supply arrangements.

The right tariff and meter arrangements are a key factor: some customers were unable to access smart meters and smart time-of-use tariffs, due to an inability or an unwillingness on the part of their energy supplier to make the required changes to their arrangements. Without switching to a dual rate or smart time-of-use tariff the battery is effectively redundant. It is therefore important to provide the right levels of support and guidance to help tenants to make the necessary changes to their metering and tariff payment arrangements. It's clear that when tenants were able to make these changes in the context of this project, then the energy bill savings were significantly greater.

Batteries can have an impact on health as well as reducing energy bills: some tenants in the project used in-home medical apparatus (for example oxygen supply) and they derived immediate benefit from the battery unit's ability to supply their home in the event of a power outage. The potential use of battery storage units as a means of resilience in this way – especially when paired with smart meters – could have wider implications for their potential use in the health and social care sector.

Extra support, advice and behaviour adaptation are important at the householder level: not all householders on this project were able to adapt seamlessly to a smart time-of-use tariff, many required additional information and support to explain how the tariff works and how they could change their energy usage to optimise the benefits. Some householders still did not understand why this needed to be done and expressed frustration with what they saw as a volatility in the pricing of the tariff, even though over an annual period their bills would ultimately be lower. This indicates that higher levels of information and support will be necessary if this solution is to be scaled up in fuel poor homes in the future.

DNOs need to be encouraged to be enablers in making the transition possible in practical terms: Warmworks enjoyed an excellent operational relationship with the regional operational team in SPEN, the DNO in the area. Requests were handled quickly and pragmatically, enabling any network upgrades to be carried out seamlessly without disrupting project progress. It will be important to replicate this across all regions as the number of battery connection requests ramps up significantly in the coming years.

The smart meter rollout is not always able to keep pace with the solutions needed: some participants in the project were told that their homes were not suitable for a smart meter or their supplier was not willing to come to their area to switch them to a smart meter. Several participants had complex, legacy two-meter setups that were tied in to one particular supplier and were unable to switch over to a smart meter-driven solution. In turn, this prevented them from being able to benefit from combining a battery installation with a smart time-of-use tariff. Going forward, this has the potential to be a barrier for fuel poor households and could result in a systemic inequity as the pace of change increases.

The energy retail industry needs to be ready with the right tariffs, made accessible and available to all: some customers could not switch to smart time-of-use tariffs due to a lack of access to the internet and/or an email address. Other challenges were also evident for customers on prepayment meters. As this report notes, the smart time-of-use tariffs generated excellent savings when we were able to pair them with a battery, so the process can work – the key will be for the industry and the wider market to continue to develop these tariffs in a way that promotes greater accessibility, and reduces barriers to entry, for fuel poor homes.

The supply chain is there and willing to deliver: Warmworks used three of its existing network of registered sub-contractors to complete the installation of the battery units. All three companies were able to become Tesla-registered installers very quickly, drawing on their existing base of skilled electrical engineers and cross-training them to become battery installers. Had this project required double the number of battery units to be installed, this would have been achievable. The supply chain for battery installations certainly exists – the key will be growing this sustainably and effectively as the demand curve increases.

There is more to learn on aggregation and flexible services: at the time of writing, Warmworks is not yet in a position to share results to evidence that aggregating power within a virtual power plant can produce a revenue stream following the installation of battery units. This is still a developing market and not all of the required technological pathways have been established and proven at this stage. However, we are hopeful that our ongoing work with project partners will provide additional clarity on this within the next six to twelve months.

If batteries alone can do this, even with these challenges, then think about what they could do in an optimised package of energy-saving improvements: perhaps the most important insight from the project is that, if a battery unit – when aligned to optimised tariff arrangements for vulnerable tenants – can save households hundreds of pounds per year by itself, then the potential bill savings for fuel poor householders could be even more significant when batteries are installed at scale as part of a wider package of energy efficiency improvements; including for example heat pumps, heat batteries and solar PV generation. This offers the potential for decarbonised retrofit solutions that could bring the dual benefit of reducing energy bills for fuel poor households whilst also significantly reducing the carbon emissions used to stay warm.

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