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COMMUNITY ENGAGEMENT REPORT

Learning gained from engaging with and supporting community groups

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RIIO NIC NETWORK INNOVATION COMPETITION

Report Title	:	Learning gained from engaging with and supporting Community Groups
Report Status	:	Draft
Project Ref	:	WPD/EN/NIC/02 - OpenLV
Date	:	XX.XX.XX

Document Control

	Name	Date
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Revision History

Date	Issue	Status
XX.XX.XX	X.X	STATUS
XX.XX.XX	X.X	STATUS

Contents

Table of abbreviations 5
1 Executive Summary 6
2 Overview and methodology 8
2.1 Overview 8
2.2 The community organisations 8
2.3 The web app 8
2.4 Capturing learning from the trials 9
3 Engagement of community organisations 9
3.1 Project selection 9
3.2 Substation selection and identification of feeders 10
4 Support for community organisations 11
4.1 Project planning 11
4.2 Project delivery 11
4.3 Web app development 12
4.4 Web app support 12
5 Achievements of the community trial projects 14
5.1 Bath and West Community Energy 14
5.2 Exeter Community Energy Ltd 14
5.3 Marshfield Energy Group 15
5.4 Owen Square Community Energy 16
5.5 Rooftop Housing Group Ltd 17
5.6 Tamar Energy Community 18
5.7 whg 18
5.8 Yealm Community Energy 18
6 OpenLV Community web app 19
6.1 Input from communities 19
6.2 Target audience 19
6.3 Accessing data 20
6.4 Data points 20
6.5 Features of the community web app 22
6.6 Examples of web app uses 22
6.7 Feedback on the web app 24
7 Benefits of the LV network data 26
7.1 Use cases 26
7.2 Benefits of engaging communities 29
7.3 Key findings around benefits of the LV data 31
7.4 Key benefits from engaging communities 31
8 Lessons learned and recommendations 32
8.1 Recruitment / engagement of community organisations 32
8.2 Key findings around recruitment 33
8.3 Delivery of projects 33
8.4 Key findings around delivery of projects 35
8.5 Development and use of the web app 35
8.6 Key findings around community web app 36

8.7 Recommendations for future projects.....37
9 Conclusions.....38
Appendix 1: Evaluation process.....39
Appendix 2: Analysis of Marshfield Village OpenLV data.....40

Table of abbreviations

API	Application Processing Interface
BWCE	Bath and West Community Energy
CSE	Centre for Sustainable Energy
CSV	Comma Separated Values
DSR	Demand Side Response
ECOE	Exeter Community Energy Ltd
FTP	File Transfer Protocol
JSON	JavaScript Object Notation
kWh	Kilowatt hour
LCT	Low Carbon Technology
LV	Low Voltage
OSCE	Owen Square Community Energy
REST	Representational State Transfer
Solar PV	Solar photovoltaic (PV) generation
TCE	Tamar Energy Community
TOUT	Time of Use Tariff
URL	Uniform Resource Locator (web address)
Wh	Watt hour
whg	Walsall housing group
WPD	Western Power Distribution
YCE	Yealm Community Energy

1 Executive Summary

This report reflects on learning gained from the OpenLV community trials, which were set up to determine whether Low Voltage (LV) substation electricity data could be provided to community organisations through the development of web based applications, test ways in which network data can be used, and examine local benefits resulting from access to data.

Seven active community groups and organisations across the WPD (Western Power Distribution) area participated in the project. The trials have clearly demonstrated that LV substation electricity data can be accessed by communities and that data can be used to support a range of activities resulting in local benefits. These include: using data to start conversations and improve householder understanding of local energy issues; encouraging uptake of low carbon technologies; modelling scenarios to make planning and development of energy projects more effective; and exploring opportunities for DSR (Demand Side Response) such as potential community aggregator income streams (from flexibility markets).

In order to provide access to the data, a community web app was developed, providing a range of functions which make it possible to access and work with LV substation data. The web app was used by all of the trial participants (to a greater or lesser extent) and additional features were added during the course of the project to enhance functionality.

Some key learning from the trials was captured. Expertise in electricity data, and understanding of how the data points could be used, was over estimated in initial stages of the project. A more limited set of substation monitoring data points might have been easier to work with, and additional training provision and support with data analysis would have helped to accelerate achievement of intended project outcomes.

In order to maximise possible impact of using the substation data, some community organisations would have benefited from help both with interpreting the data and also with developing a narrative to communicating findings, understandable to less 'technically-minded' people.

It's likely that the community organisations could have achieved greater impacts with more time and resource. Project timeframes and the voluntary nature of most of the community organisations participating in the trials limited the extent to which the data could be applied. Similarly, a more sophisticated web app (or a smart phone app), and the option to monitor multiple substations (in order to better reflect neighbourhood boundaries) may also have helped community organisations to achieve more with the data, but these would both have required significantly more funding.

In summary, there is clearly an appetite from community organisations to engage with energy data and there are definite benefits resulting from using LV data in local projects, with potential for further benefits to be realised in future.

2 Overview and methodology

2.1 Overview

The OpenLV Project was set up to trial and demonstrate an open, flexible software platform that could ultimately be deployed to every Low Voltage (LV) substation in Great Britain. Three key approaches were used to test the platform's ability to provide benefits to the network, customers, commercial entities and research organisations. Method 2 (the "community trials") concentrated on potential use of the OpenLV platform in providing data to customers or groups of customers in communities. The community trials set out to demonstrate how this could be promoted and achieved in practice, through active engagement of community organisations ("trial participants") and provision of direct access to LV network data via a secure third party hosted service (the "web app"). Ten LV-CAP™ substation monitoring units were made available to community organisations as part of the community trials.

2.2 The community organisations

Seven community organisations were selected to participate in the trials (see table 1 below). The Centre for Sustainable Energy (CSE) led on recruitment and provision of support to these organisations.

Community organisation	Location of trial
Bath and West Community Energy (BWCE)	Bear Flat, Bath
Exeter Community Energy Ltd (ECOE)	Topsham, near Exeter
Marshfield Energy Group	Marshfield Village, South Glos.
Owen Square Community Energy (OSCE)	Easton, Bristol
Rooftop Housing Group Ltd.	Bishop's Cleeve, Cheltenham
Tamar Energy Community (TCE)	Tavistock, Devon
whg (Housing Association)[1]	Walsall, Birmingham
Yealm Community Energy (YCE)	Newton Ferrers, Devon

Table 1: OpenLV community trial participants

2.3 The web app

In the original project concept it was anticipated that community organisations participating in the trials would develop their own software applications for deployment to the OpenLV platform, in order to provide access to the LV substation data. However, to overcome barriers identified around timeframes and resources, it was decided that CSE would develop a community web app for use by all the trial participants. The web app comprises an application deployed to the OpenLV platform (to collate 30 min data) and a web based portal accessing the 30 minute data from the Lucy Electric cloud server. This is explained more fully in section 4.3.

[1] Due to organisational changes, one organisation (whg) withdrew from the trial in 2019 and Yealm Community Energy took their place.

2.4 Capturing learning from the trials

This report looks at how the community trials were delivered, reviews achievements, and captures lessons learned from the project in order to:

- Encourage replication of community energy projects using LV network data
- Identify barriers and review learning generated by the community engagement and trial process to improve on delivery of projects in future
- Discuss benefits of providing community organisations with access to LV network data

The evaluation process used for the community trials is outlined in Appendix 1. This report summarises how each community trial project used the data to help achieve their aims. The report also brings together key learning outcomes and findings collated throughout the project. Various sources of data have fed into the report, including:

- Logic models developed with each group at the start of the project
- Monitoring data from regular updates between the community organisations and CSE
- Information provided for mid trial reports (compiled by Regen and separately available)
- Feedback collected in end point interviews with each community organisation
- Learning submitted and recorded throughout the project in reports and updates
- Feedback from CSE team via 'debrief' workshop held in October 2019
- Additional feedback from, and reports compiled by, individual participating groups (including Marshfield Energy Group, Tamar Energy Community, Bath and West Community Energy)

3 Engagement of community organisations

This section provides an overview of the pre-trial activity (including the selection of community organisations and identification of substations for deployment of monitoring units).

3.1 Project selection

An initial piece of work carried out by CSE in 2017 established that there was sufficient interest in OpenLV data for the trials to run. An expression of interest survey was sent to 447 individual contacts (with an established interest in community energy projects) and a further 9 umbrella groups. Separately, CSE promoted the OpenLV project to housing associations and parish councils, both by phone and by email. The National Housing Federation (representing housing associations) and ACRE (Action for Communities in Rural England, an umbrella body providing support services to rural community councils across England) both circulated details to their members. CSE staff also made calls and promoted the scheme via email to rural community councils in the WPD area, and the opportunity was circulated to parish councils CSE has previously worked with.

60 responses were received, demonstrating a strong interest from community organisations in accessing electricity network data. A wide range of proposed uses were suggested: 46 app concepts were identified, although the majority were based on accessing and interpreting real-time consumption data.

CSE then led the development and promotion of an open competition, shortlisting and interview process, with a recruitment drive throughout December 2017 and January 2018. Seven community organisations were selected to participate in the OpenLV community trials. The groups were chosen to ensure a spread of geographical locations and app ideas, with a range of selection criteria including project feasibility.

Each community organisation proposed uses for the OpenLV data in their project application. Ideas were refined with the groups during selection interviews, and further discussions about project design and use of data took place in post interview discussions, a web app development workshop, several webinars, and extensive emails and telephone conversations with representatives from the participating organisations throughout the trials.

3.2 Substation selection and identification of feeders

Ten LV-CAP™ units were available for the community trials. Part of the development process involved identification of substations which were suitable for installation of the units, and mapping the feeders which link households and buildings to specific substations. Identification of appropriate substations was initiated in the initial application process, but there were some complications to overcome. It was difficult identifying which substations provided which neighbourhoods, and most community organisations would have chosen to monitor multiple substations, but the cap on the total number of units available was a limitation. Many of the substations selected by the community organisations as their 'first choice' could not be monitored and because they were not accessible or not suitable for installation of the LV-CAP unit, so there was a lengthy process before the final set of substations was selected.

Feeder maps provided by EA Technology were used to help the community organisations select substations and identify target communities for their projects. The maps were also used to enable the community organisations to give specific names to the feeders being monitored for their substation (e.g. street names or local names for neighbourhoods) so that data from the LV-CAP unit would be more meaningful when shared within the community. Feeder maps proved useful in community engagement activities (for example, it was reported that allowing individuals to identify their home and see which feeder they are connected to was a good conversation starter).

4 Support for community organisations

4.1 Project planning

Alongside contributions to development of the web app, each group completed a 'logic model' using a template developed by Our Place[2] and adopted by CSE for use in the OpenLV community trials. The logic models set out inputs, activities, outputs, intended outcomes and impacts, and were developed to inform project plans and provide a means of measuring project achievements. The logic models are presented and described in more detail in the report "*Sharing LV network data with communities: Proposed uses of the data by Method 2 participants*". There was also considerable discussion with the participating groups around helping to shape project ideas, and there was anecdotal feedback at the time that the logic models were a useful tool for refining project ideas and helping to plan delivery.

Participating groups were also provided help in understanding how best to use LV data in their projects, including explaining technical limitations and possibilities, and exploring the data points and what they showed. For example, a key issue which emerged from these early discussions was a general misconception that the data showed local electricity consumption, rather than net demand. (This subsequently led to the addition of additional features to allow amalgamation of data points.) Another barrier encountered at the start of the project was that community organisations were not yet completely sure how they intended to use the data, so input into web app development could not be informed by project needs. This chicken-and-egg situation was to a certain extent unavoidable given the project timeframes.

During the end of project interviews with participating groups several stated that they had underestimated the amount of resource and time that would be needed to realistically deliver their projects and make best use of the data and the web app.

4.2 Project delivery

Trial participants were given a named point of contact at CSE. Organisations were offered support with project delivery and community engagement activity. In practice however, the community organisations that were recruited were very well embedded in their communities, with strong community engagement skills and a track record in working actively within their communities. Because of this, community engagement support provided to the groups was less in depth than anticipated, enabling more project time to be spent on app development work. Support that was provided for project delivery included:

- writing articles for local newsletters
- joint delivery of / provision of and resources for community engagement events
- planning community engagement strategies
- help with interpreting the data
- developing and printing publicity materials (e.g. leaflets).

[2] https://mycommunity.org.uk/wp-content/uploads/2016/09/Our-Place_Logic-Models-guide-June-152.pdf

A recurring theme in the feedback from the end of project interviews was that the participating organisations needed help to develop narratives so as to present the data in an understandable manner to less energy literate / and or less mathematically minded members of the community. This theme only really emerged towards the end of the trials as the organisations were getting to grips with the full range of features included in the web app. A learning point for any future work around use of LV data in local energy projects would be to dedicate some time to this early on in a project to improve success of community engagement activity.

4.3 Web app development

Early on in the project a number of barriers were identified that would affect the ability of community organisations to develop software to access substation data, namely: lack of software development expertise in most of the community organisations (to either write software or develop specifications for external developers); lack of funds to procure bespoke software development; and insufficient time for successful fundraising for software development within the timeframes of the trials.

However, there was significant crossover in the data points that trial participants wanted to access to facilitate their projects, and in the features they wanted to include in an app. A change of approach was therefore agreed, and CSE undertook to develop a single, customisable web app featuring a common set of core functions for all trial participants to use. This was the most cost effective way to provide each group with access to the data, a range of features to manipulate the data, and the ability to tailor functions and visualisations, whilst also avoiding replication of effort and meeting project timeframes.

In order to achieve this, CSE liaised with the community organisations to scope out requirements, and programmed a single application (the ‘m2 collation app’) which was successfully deployed to the LV-CAP units in August and September 2018. It accesses various data measurements from other applications running in the LV-CAP unit and collates the 1-minute information for each data point into 5 readings for each data point for every half hour:

- Minimum (i.e. lowest reading in the half hour)
- Maximum (i.e. highest reading in the half hour)
- Mean for the half hour period
- Number of readings in the half hour period
- Standard deviation

This information is communicated to the OpenLV Lucy Electric Cloud server. A web app, hosted on a separate server, receives messages from the Lucy Electric server, providing a ‘front end’ for community groups to access the collated half hourly data.

4.4 Web app support

The community trial participants were given access to a set of configurations in the web app where data, time periods and display options are set. In addition to core data from the LV-CAP sensors (temperature, voltage, power, energy etc.), the customised apps can also incorporate external data (carbon intensity data and local generation data) and user defined criteria (e.g. cost of electricity). Some data is extrapolated (e.g. by combining energy with a unit cost, or looking at associated carbon emissions for a given time period). The apps can also model different time of use tariffs and send alerts to individual members of the community when certain conditions are met (for example, carbon intensity reaches a set level).

The graphs, data tables and smileys that are set up by the participating community organisations are in the public domain, but configuration is password restricted to those organisations. (Smileys were developed as a function for avoiding graphs and communicating a simple message about current electricity use.)

Additional features requested by the community organisations were added during the project trials, to improve access to, and use of data, including: a function to estimate local (domestic) solar photovoltaic (PV) generation; a user controlled feature to amalgamate data from multiple sources; and a means of displaying a time of use tariff (‘Agile Octopus’) recently brought to market.

Support with the web app was offered in the form of troubleshooting technical issues, giving technical support, and providing training and guidance on using the app. Several webinars were held to demonstrate web app functions and answer questions about use of the app, followed up with support from CSE’s software developer for specific queries. Face to face web app tutorials were provided for two groups. Phone and email support was available throughout, and monthly updates to the groups helped to keep projects informed and engaged.

A comprehensive web app user guide was developed and updated during the project as new functions were added and improved and to include responses to frequently asked questions. The guidance included step by step instructions on use of every feature of the app, and descriptions of the main data points and how to use them.

Most groups accessed individual support to help identify which data points to use and how to configure them to achieve specific project needs. For example, Bath and West Community Energy (BWCE) wanted to be able to show the before and after impact of their domestic solar PV and batter installations on the substation, which was achieved by using imported local data and generating an equation using the amalgamated data function.

5 Achievements of the community trial projects

5.1 Bath and West Community Energy

Bath and West Community Energy (BWCE) are using OpenLV data as part of their Solar Streets project, which set out to install (and monitor) solar PV and batteries in 25 homes in the Bear Flat area of Bath. Their aim was to use the OpenLV data, integrated with the solar PV and battery data in the web app, to run some demand shifting campaigns with interested households and look at potential applications of the data in broadening uptake of Low Carbon Technology (LCT) and generating income through flexibility services.

BWCE commissioned Moixa for the rollout of their domestic solar PV and battery installations, successfully completed 16 battery and solar installs during the project, and were able to access data from the Moixa installations to display in the web app, making it possible to look at impact across the community. They also used the substation data to look at carbon intensity of local electricity demand (using regional estimated intensity for given times) and to look at community wide electricity use.

There were significant (unexpected) delays in firstly the contracting process, secondly in completing the installations and then in accessing the Moixa data so that it could be integrated into the web app. Because of this, at the time of writing there is insufficient data to be able to demonstrate impact of solar PV and battery installation on the substation load, or to use results in their first demand shifting campaign.

However BWCE found the data useful as an initial engagement tool and in raising people's awareness, and plan to use the data going forward to encourage community flexibility.

5.2 Exeter Community Energy Ltd

Exeter Community Energy (ECOE) aimed to engage with the Open LV project by developing a smart phone app for their local community using the Open LV data (in particular, energy use data, cost, and carbon intensity).

Householders could engage with substation data by using the smart phone app, which would show energy use at the substation level, local energy generation and National Grid carbon intensity, and send them alerts to encourage them to change their energy behaviours. The concept was based on an assumption that by enabling people to see when local renewable energy is being generated they would chose to use energy at times of day associated with lower carbon intensity.

Working with app developer Q bots who gave around £10,000 of in-kind funding, ECOE developed a prototype smart phone app. They held a focus group to test this app, which showed that the app needed further development to reach the high standard of smart phone apps which most people are now used to. Q bots were unable to offer any further development time as in-kind support and ECOE were unable to raise the funds that were needed in time to complete development of the phone app before the end of the OpenLV project trials.

Because of this, the development of the phone app is currently unable to progress. However, graphs from the Open LV app were presented at the latest ECOE annual general meeting and there has been a high level of interest in the data from their members. ECOE commented that if they were able to access data from several substations across Exeter, this may help them to identify areas that are less constrained at the substation level and aid future planning of future rooftop solar generation projects.

The ECOE project demonstrates two key learning points from the project, one about linking substation data with neighbourhoods, and the other about the (huge) resource required to develop bespoke phone apps (as opposed to web apps).

5.3 Marshfield Energy Group

Marshfield Energy Group applied to the trials in order to access data for the whole village to provide an evidence base for a village-wide sustainability strategy, and identify feasible and effective energy projects to pursue in future. The village is served by four substations, all of which were monitored through the project, in a unique opportunity to develop an accurate picture of electricity demand across an entire community.

They were principally interested in the 'raw' data rather than the visualisations generated by the web app, and wanted to look at the impact of the expected increase in electric vehicle (EV) use, potential energy storage solutions, potential for additional community scale renewable energy installations. A key driver was the number of power outages experienced in the village and the possibility that interrogating the data might help to identify (and address) causes, and build a stronger relationship with WPD.

A group of volunteers recruited as part of the project has used the data to record power outages, and look at correlations with the feeder level data. Data tables were generated in the web app and exported to Excel for manipulation (including production of graphs to display at a village event). Data has also been shared with students from the University of Bath for further analysis.

The group was particularly interested in capturing active Energy data (for each feeder of all four substations), oil temperature (for each substation), voltage readings, and renewable energy generation in the village (solar array on the community centre, school wind turbine, and domestic PV). This would be used for:

- Comparisons of electricity use, for example on different feeders (related to housing types) and for seasonal comparisons
- Visualisations of daily/weekly profiles of electricity use patterns
- Analysis of the effect of electric vehicles, electric cooking and heating transition on peak loads on the substations
- Sizing batteries in order to be able to meet a large proportion of the village's electricity demand through solar PV and batteries

Issues with loss of data have been a barrier to collating a full year of data for the whole village so in depth analysis of the data will be carried out beyond the end of the trials. However some patterns of electricity use on different feeders have already been generated, and the group has begun initial investigations looking at the impact of electric vehicle rollout.

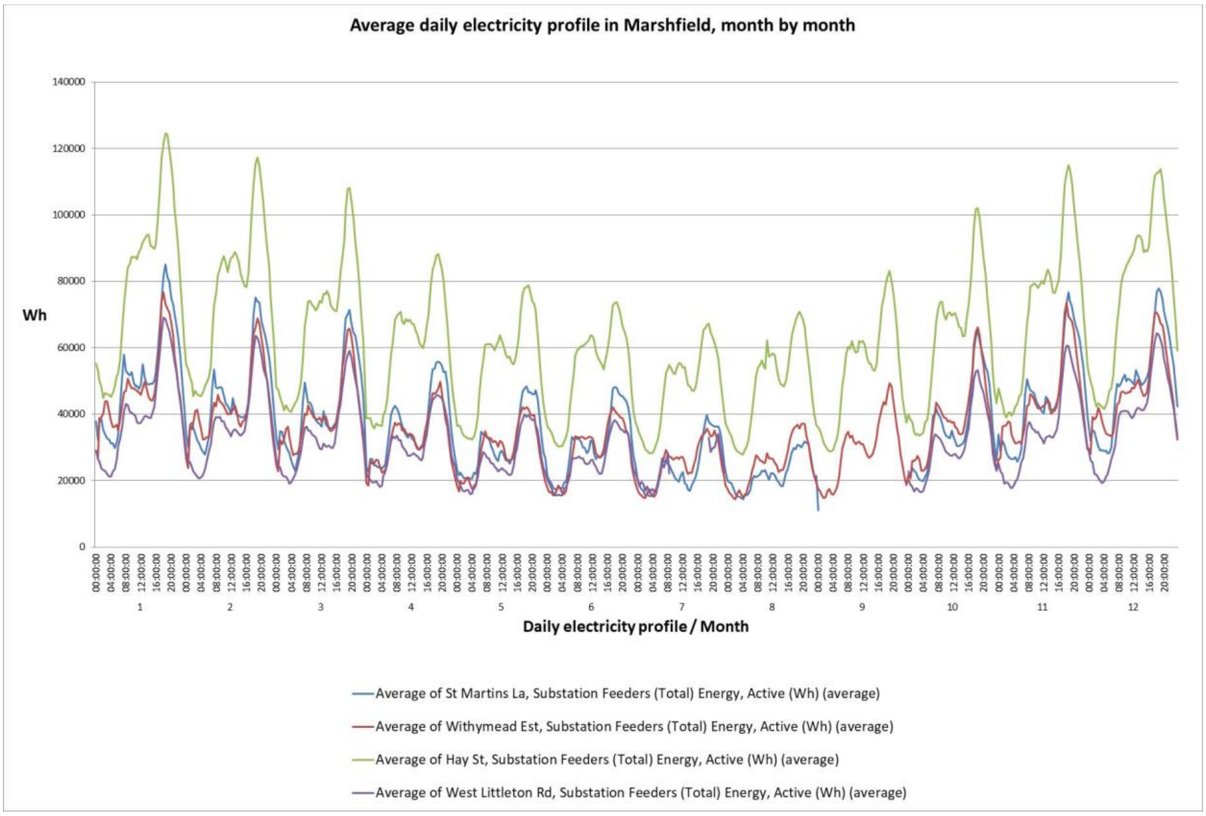

Figure 2: Daily electricity profile (month by month) for Marshfield village

With respect to the problem of outages, the group has used OpenLV data to try to correlate electricity use data profiles with recorded outages (with no discernible pattern), and to inspect each substation for number of records, making it possible to see if outages were across all substations or localised. Access to and an automated interrogation of 1 minute data would have been useful for more in depth analysis of the outages, but that was outside the scope of this project. However, during the project WPD responded directly to correspondence from the group and provided explanations for the power outages (chiefly attributable to wildlife colliding with the overhead lines coming into the village).

5.4 Owen Square Community Energy

Owen Square Community Energy (OSCE) set out to use the OpenLV data to examine the operation and function of the local substation, understand how much low-carbon generation the substation could support, and develop models (based on historical data) to look at the viability of a microgrid and to increase network capacity for installation of low carbon technologies in properties connected to the local substation. One proposed model was to help optimise the match between solar PV and heat pump installations, making it possible for households to flex their demand in such a way that losses in the low voltage network could be minimised. The intention was to then use this modelling to plan (and recruit householders for) a local roll-out of community batteries and domestic heat and solar PV systems.

A degree of modelling and analysis has been achieved, but lack of funding for more in depth feasibility studies and to cover capital outlays for proposed installations means that installation of low carbon technologies at community or household level has not yet been possible.

OSCE were interested in all of the OpenLV substation monitoring data (including phase angle data and reactive energy data which most other groups did not have a use for). They used the RESTful[3] API (Application Processing Interface) to download and work with JSON[4] files (from the community web app), and have found the data useful in supporting their funding applications (some of which are still pending). They've also recruited some university students to analyse the OpenLV data for financial modelling and to help build a business case for OSCE's decarbonised heat projects, which will hopefully support successful funding applications in future.

5.5 Rooftop Housing Group Ltd.

Rooftop Housing have been using OpenLV data to look into energy use in the Bishops Cleeve area of Cheltenham. Rooftop wanted to use the data to give residents in the trial area access to their community's real-time electricity demand, encourage them to think about their energy use, and catalyse behaviour change. They were also interested in the data because they are undertaking modernisation of their housing stock and wanted to investigate potential impact of investments in energy efficiency, smart appliances and renewable technology.

Rooftop used the data to create graphs showing real time energy use in Bishops Cleeve. They had hoped to use these graphs as the basis for community engagement and held one event early in the project, however, they found engagement more difficult than anticipated and had some staffing turnover which disrupted the project. The data was shared with colleagues in the housing association to show patterns in energy use, and knowledge gained from the data has already been used to inform business decisions being made about housing stock improvements. The most useful data for Rooftop was the active energy information and the carbon intensity data, as they are interested in improving their environmental impact as an organisation.

Rooftop are keen to communicate more clearly to their residents that environmental issues are important to them and that they want to help residents reduce their carbon footprints. They believe the data could be a valuable tool in a robust community engagement strategy, to work with residents towards their vision to be a sustainable housing association. Although they didn't carry out as much community engagement as they had hoped to during this project, they found the data valuable and gained knowledge and the skills and organisational resource needed to interpret and make better use of the data in future.

[3] RESTful API, or REST API, is based on representational state transfer (REST), an approach to data communication which can be used over nearly any protocol, but which usually takes advantage of HTTP when used for web APIs. REST provides flexibility, has the ability to return different data formats, and does not require developers to install libraries or additional software.

[4] JavaScript Object Notation is an open-standard file format that uses text to transmit data objects. It is a common data format and has a diverse range of applications (including serving as replacement for XML in AJAX systems) and can easily be converted to .xml files.

5.6 Tamar Energy Community

Tamar Energy Community (TEC) have been using Open LV data as part of their project 'The Power in Your Hands' to engage their community in energy issues and influence their energy behaviour. Using the data and the graphs displayed on the Open LV app they set up 'Eco clubs' at the local junior school to teach school children about energy efficiency and carbon emissions. By engaging first with the primary school TEC managed to build better brand recognition in their local area which enabled them to engage with the wider community more easily. They have now set up an online householder's survey and are knocking on doors in the substation area and starting to speak to people about time of use tariffs, distributed energy resources and what they can do to impact the energy system.

TEC are also using the data to carry out their own data analysis to help WPD understand where inefficiencies may be occurring in the local grid and have been developing a smart phone app which is currently live on TEC website.

TEC have found having access to their local substation data extremely interesting and useful for engaging their local community. They commented that they do not think the project would have been able to achieve similar results without access to the data and are very motivated to continue using the data in their future work.

5.7 whg

Whg housing association was selected to participate in the trials to use the OpenLV data for two main purposes. Firstly, to support behavior change campaigns, driven by volunteer energy champions. These campaigns looked at topics such as understanding fuel bills, tariff switching and flagging up when peak and off peak tariffs are in operation. Secondly, whg used the trail to inform the roll out of an electric heating retrofit project. There was particular interest in this project because an entire tower block was being monitored, where electricity was the primary power source both for appliances and also for heating. There were clear opportunities for replication and for sharing learning. Unfortunately due to organisational difficulties the company withdrew from the trial.

5.8 Yealm Community Energy

Yealm Community Energy (YCE) was a late arrival into the Method 2 trials, replacing whg. Their aim was to use OpenLV data to engage local people in local energy issues through messaging on substation behaviour, local energy consumption, local generation and carbon intensity. By putting energy data loggers into homes of residents who volunteer they planned to help people understand the link between domestic electricity use, substation activity and local renewable generation.

They planned to integrate solar generation data from the Newton Downs Solar Farm onto the community web app, alongside information from individual household data loggers (although there have been delays in accessing this data and integrating it with the web app). Generally, YCE have used the data to give general talks about electricity systems to their community and to highlight the impacts changes to the system (from low carbon technologies) may have on DNOs.

6 OpenLV Community web app

6.1 Input from communities

In order to meet the needs of all the participating groups, community organisations selected for the trials were asked from the outset (i.e. in the applications, interviews and follow up discussions) about the data they wanted to access and how they intended to use it (including via a web app). Following selection of successful groups further discussions about functions to be included in a web app took place. An initial app development workshop and ongoing conversations helped to finalise the specification. Several more open webinars and one-to-one discussions with the organisations about their individual requirements followed, both during early stages of development and once live data was available to view in the prototype web app.

Improvements were made to the web app, and new releases deployed throughout the trials, based on input from the trial participants. Once the prototype web app was live, and for each subsequent release, user guidance documentation was updated and circulated, and several more webinars were held to run through web app functions. Technical support available during the trials to help organisations to understand and make best use of the data.

It had been anticipated that there would be at least a one month period before the web app was finalised during which community organisations would be able to test the web app within their communities and provide feedback for improvements based on the way it was received. In practice however, issues with data access, time limitations (including delays across most of the groups with starting planned project delivery, and group members having insufficient time to fully familiarise themselves with the web app) meant that there was little exposure before the start of the trials to any individuals outside of the core members of the participating community groups.

In retrospect it's clear that most of the community organisations would have found it easier to explain their requirements for using a web app to access data if the prototype web app had been developed ahead of the recruitment stage, or if there were example projects based on access to substation data already up and running.

6.2 Target audience

The community web app interface can be viewed at **https://openlv-cse.uk/**. It is accessible to members of the public, but it was intended primarily for use by the community groups engaged in the trials (rather than as a public offering, which would have entailed far greater development costs).

Community organisations are, however, able to set up graphs and visualisations and embed them in their own websites (they will automatically update every half hour with the most recent data) with explanations that are most relevant to the energy project they are intended to support, and the community organisation's understanding of the best way to present information to the local population. Similarly, functions such as alerts and tariff modelling were designed for community organisations to log in and set up, and where appropriate to interpret or contextualise for local audiences.

The intention was that a level of interpretation and explanations about what the data shows would be provided by the community organisations in public facing communications. However, most of the organisations involved in the trials did not feel they had sufficient expertise to act as 'translators' of the information and it was clear in the end of trial interviews both that individual members of the groups had not found enough time to familiarise themselves with all of the features of the app. They felt they needed more help with understanding the data and creating a narrative around it in order to use the data for more effective community engagement.

6.3 Accessing data

The community web app provides access to the 30 minute data via a set of functions (described in more detail below) which make it possible to visualise and manipulate the substation data, external data (e.g. local generation data), and aggregated data (e.g. tariff modelling) for time periods specified by the user. By creating data tables within the web app, data can also be exported to other software (e.g. as .csv files to Excel). Community groups were also provided with instructions for accessing data as JSON files through an API, although this feature has only been used by two groups to date.

EA Technology agreed to give the trial participants access to spreadsheets containing the 1-minute data (i.e. the LV-CAP sensor data, not the additional datasets such as carbon intensity and local renewable energy generation incorporated into the community web app). These spreadsheets were viewed by at least three of the seven groups, but the spreadsheet format was not found to be very accessible because of the volume of data and the (very large) number of separate spreadsheets.

6.4 Data points

All the measurement points monitored in the substations fitted with LV-CAP units were incorporated into the community web app, and additional data was amalgamated via external APIs or (for one trial participant) an FTP (File Transfer Protocol) process. A huge amount of data is accessible through the web app but there are a handful of data points that have been used most in the community trials, outlined below.

Key data points used in the community trials	
Active energy	Active energy (Wh) (referred to as "Energy Active" in the LV-CAP monitoring) shows the net amount of electricity being used, and has been one of the most useful substation monitoring measurements used by trial participants.
Carbon intensity	Using the active energy data point, the web app measures the carbon intensity (gCO_2) of energy being used from the grid at a given time, and shows for every Wh used, the estimated amount of grams of CO_2 created. The carbon intensity data uses National Grid regional and national averages.
Electricity cost	The web app multiplies active energy by a unit rate for electricity set by the user to show electricity cost (£). This provides a means of estimating spending on electricity at substation or feeder level (which can then be turned into an average household spend in a given community).
Active power	Active power ("Power, Active") (W) is the power being used, or the *rate of energy transfer at a moment in time (Voltage x Current).* The web app can display average power as well as the maximum power in any given half hour period.
Current	The average current (A) value for a substation shows the transformer load. It includes both active and reactive power. When combined with a temperature graph, this is a useful indicator of whether substations are being overloaded, so this was seen as an important measure for several of the participating groups who wanted to determine whether the substation had capacity to take on extra load. The max current (A) value for a substation or feeder is also (in theory) useful to see if the substation or feeder protection (fuses or circuit breakers) is likely to trip turning off the supply. In practice it has been difficult for community trial participants to gauge substation health from the OpenLV measurements.
Substation temperature	Substation temperature (°C) measurements are recorded by the LV-CAP sensors and can be displayed in the web app as a crude indicator of when the substation is under pressure. Several community organisations looked at the records for the temperature of the oil inside and outside the transformer to see if there were any periods when the substation seemed to be under particular stress, but no obvious problems were noticed.
Renewable energy generation	The ability to display local renewable energy generation data in the web app was developed for four of the trial projects. Marshfield Energy Group are able to view electricity generation from a solar array on a community building, a small wind turbine at the school, and estimated domestic solar PV generation on roofs across the village. BWCE can view data from solar PV and battery installations, and YCE and TEC can see output from large solar arrays close to the substations being monitored.

6.5 Features of the community web app

The web app user guidance contains a full explanation of all the features of the web app and how to use them, and is available as a separate document. The main functions are:

- Access substation monitoring data (from LV-CAP units)
- Estimate grid carbon intensity data
- View renewable energy generation data (from an actual installation)
- Estimate local solar PV generation
- Generate line graphs, bar graphs and smileys to visualise data
- Embed graphs in local websites using iframe
- Set up and model different electricity tariffs
- Send alerts when certain substation conditions are met
- Amalgamate data from multiple sources
- Generate data tables to display or export data (e.g. as .csv files), or access JSON data files via API

The web app provides a way of seeing 'real time' (to the end of the last half hour) data as well as historical data, in graphs, data tables or as smileys. It can show substation monitoring data, data from external sources (e.g. grid carbon intensity data, local renewable energy generation, dynamic electricity charging rates), and amalgamations of both. It can also export data for use in other software, and can be used to embed visuals (also 'real time') in external websites. Finally, a handful of additional features developed for trial participants to support local community energy project delivery include the ability to send alerts, model electricity tariffs, and estimate domestic solar generation.

6.6 Examples of web app uses

The web app has been used in different way by different trial projects. Just a few examples of how it can be applied are outlined below.

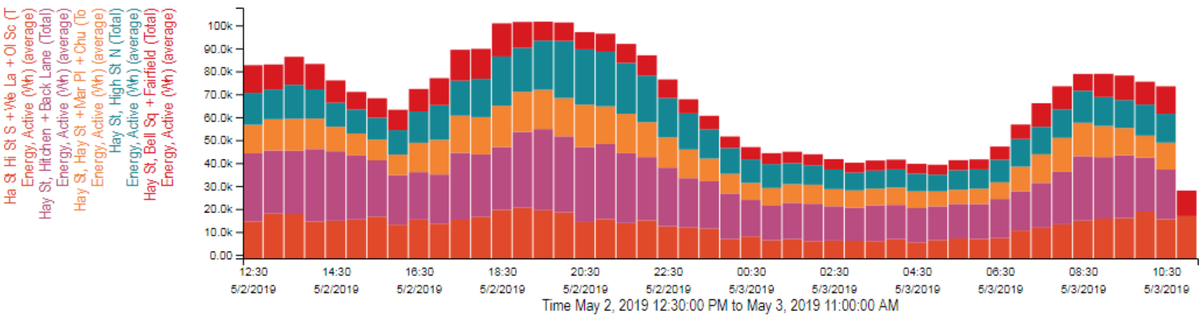

Figure 2: stacked bar chart showing active energy on different feeders

The web app can help to visualise electricity use across a community by setting up a **stacked bar chart** (an example is shown in figure 2) that shows active energy as individual feeder values and the substation total. (This can also be done for phases and feeder totals, and for substations and community totals.) This is a useful way of highlighting streets that may have particularly low or high consumption and generating discussions about the likely reasons for that.

Electricity use / cost / carbon intensity (or all three, to show that there are subtle differences in the daily patterns) can be displayed for a particular feeder, in order to focus energy reduction initiatives on a particular street (or streets) in an area. See Figure 3 for an example.

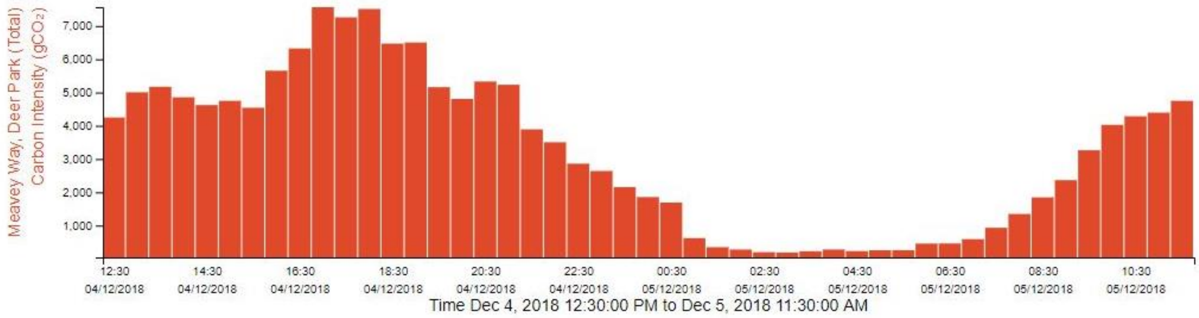

Figure 3: simple bar chart showing carbon intensity

Similarly, a feature developed for the web app was the ability to set up **smileys** for a more accessible display of current electricity use (intended for use with behaviour change campaigns or in situations where graphs would not be meaningful). Rooftop Housing Association specifically requested this feature for engaging with their tenants. Smileys can be used to compare (for example) carbon intensity for the most recent half hour period compared with an average over a given timeframe to give an indication of whether or not now is a good time to switch appliances on or off.

The web app can be used to set up **alerts** to a specific set of people when certain conditions (related to any of the data that can be viewed in the web app) are met. For example, as part of a behaviour change campaign the web app can be set up to alert a group of residents when the combined energy used by households on a particular feeder exceeds a certain value (in Watt hours), or when the temperature of the transformer on a substation exceeds a set temperature. Part of the alert configuration is shown in figure 4. Creating a **Reverse Alert Count** graph provides a way for community groups to record how many local people actively responded to alert messages generated in the web app.

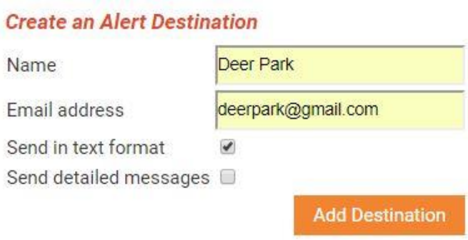

Figure 4: Configuring alerts from the web app

6.7 Feedback on the web app

In the end of project interviews, community organisations were asked about how they used the web app to access substation data, and elements of the web app that they had found most and least useful. Participating organisations were asked to rate the usefulness of some key features of the web app on a scale of 1 to 5 (where 1 meant 'not at all' and 5 meant 'a lot'), although not all groups provided ratings.

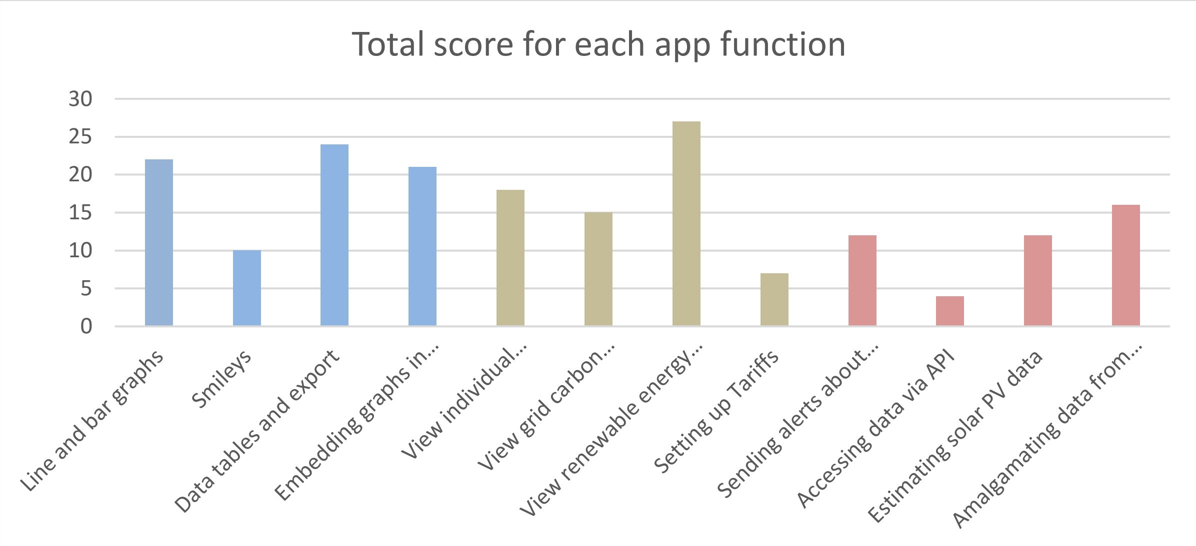

Figure 5: Scores on usefulness of different features of the web app

Overall the most useful functions that had been accessed were: being able to view renewable energy data; generating data tables and exporting data; plotting substation data as line and bar graphs; embedding graphs in local websites. The 'least useful' functions (in that their total score across all the groups was the lowest) were reported as being the API for accessing JSON data files via a URL (web address), the tariff modelling, and smileys. However these features were each only requested at the outset by one or two organisations.

TEC and BWCE found the carbon intensity data useful but would both have liked to have been able to see carbon intensity at a more local level than the national and regional data that is currently available. Marshfield found that being able to see a count of records for helping to monitor outages was useful.

The graphs were one of the features that almost all the groups used and reported as being useful. BWCE commented that they found the graphs hard to configure and that the web app graphs were not very engaging without explanations because the data is very technical and what's being shown is not immediately obvious to the layperson. Several groups (including BWCE and YCE) liked the premise of having the data displayed in a more user friendly way but were not convinced that the smileys were meaningful enough because they over simplify the data. Smileys were included because they were specifically requested by the housing associations as they felt their tenants would find graphs hard to engage with.

Several groups (including BWCE and TEC) embedded graphs in their own websites. However one group decided not to use i-frames for this because of an additional cost from their domain provider.

The alert function was not used much during the trials, in part because so many of the projects took quite a long time to get going. BWCE would have liked to have changed the language to make the alerts less technical and more conversational, and for the 'reverse alerts' would have liked to have had the option to set up a number of different actions for people in their community to report back on. YCE thought the alert function would have greater value in future, for example when there are more electric vehicles and switching away from peak times of electricity use becomes more critical.

With the exception of YCE (who can't report back on this feature yet because third party delays meant that data from their solar farm was only made available at the end of the trials), all of the organisations displaying renewable energy data fed back on the usefulness of being able to show local generation alongside the substation monitoring data.

Several groups found that there was too much data that they did not know how to use. (This was as a result of developing a web app fit for multiple groups with different needs and providing access to all the data for all the participating organisations.)

Individual members of two different groups felt that the web app had not met their expectations, as they wanted something that was more user friendly and presented data in a different way (although in both these cases the individuals who commented had joined the group after the main app development work had been carried out and so had been unable to feed in opinions at the relevant stage in the project). In a project spanning a longer time period and with a significantly higher software development budget, this might not have come up as an issue. However other groups noted that the additional and ongoing technical support available was valued, and the improvements that were made (and additional features that were added) helped to make it more user friendly and meet their project needs.

It was striking that most of the community organisations remarked that they had not had time to explore all features of the app, but still intended to use the app to explore the information and the opportunities for local action.

7 Benefits of the LV network data

7.1 Use cases

Regen, supported by CSE, have put forward three main use cases for the ways in which LV network data can provide benefits to communities. Firstly, as a as a tool to aid community engagement and improve understanding of energy. Secondly, as planning tool, using 'transparent' data to identify the best local opportunities for decarbonisation plans, or improve the design / effectiveness of existing initiatives. Finally, as way of facilitating community level flexibility, in order to generate income. Specific examples of how the trial projects used the data for these three scenarios are outlined in the table in 7.1.4 below.

7.1.1 Engagement

OpenLV provides a means of both measuring and visualising electricity data, at a local level that people can relate to. It offers a unique opportunity to engage individuals in a community with a concept that tends to be quite intangible in our society. This helps to achieve outcomes linked to increasing understanding of energy and behaviour change around energy use by groups of individuals. Most of the trial participant groups had a strong element of community engagement in their planned activities.

7.1.2 Transparency

The trial participants also showed how data made available through the OpenLV project can be used to accelerate the decarbonisation of communities, facilitating the installation of more low carbon technologies (both at domestic and community scale), in particular the electrification of heat, power and transport. Data can be used (for example) to determine options that are feasible, to help to decide how to prioritise which energy projects to take forwards, and to model potential for future projects. Analysis of the data for Marshfield village, for example, quantifies the number of solar PV arrays and electric vehicles that could be added to the LV network in the village within the existing (estimated) network capacity (see Appendix 2).

7.1.3 Flexibility

Finally, the data can be used to facilitate community scale flexibility, manipulating or collectively changing (e.g. through alerts or remote switching) times of electricity use or storage across a community, in order to capture value from flexibility services.

7.1.4 Examples of how OpenLV data was used

Community benefit	Examples of intended outcomes	How OpenLV data was used to facilitate local projects
1. Community engagement tool for community organisations looking to engage individuals and households around energy. The data makes it easier to discuss differences between local electricity network and national network and needs; helps to engage people as part of a group initiative; and builds trust in the community organisation because they are able to present locally relevant and accurate information about local electricity use.	• Increasing understanding of energy issues (and improving acceptance of smart meters and other LCTs) • Changing energy use behaviour (household) (reducing total demand / shifting peaks)	• TEC reported that OpenLV data was a catalyst and the school workshops they delivered (very successfully) would not have been possible without the OpenLV project. The data helped to improve children's understanding of energy issues, and because of the workshops the group had a greater presence in the community. • YCE and Marshfield both used data to print posters for public events, displaying total energy use on different feeders / substations within a community, to begin conversations about electricity use. • BWCE and TEC embedded substation electricity visualisations in their community websites, to help increase local understanding of issues. • BWCE experimented with using alerts to encourage residents to change their electricity use patterns as part of their campaign 'Turn Down the Juice in June'. • TEC plan to develop their own smart phone app, using the collated 30 minute data to present different visualisations of the data supporting behaviour change campaigns. • YCE will use the data in publicity for their next share offer and to initiate conversations locally. They feel the data helps to build reputation and shows that they have a strong understanding of the local situation. • ECOE had hoped to be able to use substation data in a community wide engagement and behaviour change project including gamification ideas (e.g. competitions between streets) but unfortunately were not able to complete a phone app that was central to the idea.

Community benefit	Examples of intended outcomes	How OpenLV data was used to facilitate local projects
2. Transparency to help planning. The OpenLV units provide data previously only available to DNOs. The web app helps sophisticated users understand the layout and flows of electricity at a local level, aiding planning and improving efficiency of energy projects or new developments.	• Taking more control / starting up new community schemes, e.g. exploring Time of Use Tariffs (TOUTs) and flexibility services • Modelling different scenarios to see if there is potential for managing existing technology more efficiently • Planning for electric vehicles, microgrids, battery storage projects and take up of LCTs • Making most efficient use of existing network capacity (and indirectly reducing transmission losses)	• TEC, YCE and ECOE have started to use data to compare local electricity use with renewable energy generation over a given period of time, in order to encourage energy 'sustainability' of a specific area, and generate support for future renewable energy installations. • Rooftop have used the data to show average electricity costs to help with behaviour change initiatives, and will investigate possible time of use tariffs which could be accessed in future • Marshfield will use data in energy mapping for a neighbourhood, to use as the basis for planning future energy strategies (including potential for new renewable energy). • Marshfield have also begun to use data to assess the impact of electric vehicle rollout and implications for local charging • OSCE have begun to model data to explore the potential for a microgrid, and to see whether demand shifting would make it possible to move to more electrification of heat • BWCE would like to use the PV estimation tool to see where EV charging points could be installed
3. Facilitate community level flexibility. This could mean using substation data and manipulating or collectively changing (e.g. through alerts or remote switching) community electricity use/storage profiles in order to capture value from flexibility services across a community.	• Exploring opportunities for flexibility services • Increasing local RE generation (by demonstrating sufficient headroom)	• BWCE have installed solar PV and batteries in 16 local homes. Data is being monitored alongside substation data in order to determine substation impact, linked to future potential of selling aggregated flexibility services based on assets owned within a community.

7.2 Benefits of engaging communities

The OpenLV project has shown that there is scope for DNOs to provide access to data as a means of engaging with and supporting the activities of community organisations who want to accelerate smart grid rollout.

7.2.1 Trusted intermediaries

Community organisations are often well embedded in their localities, with members of the organisation often living locally and seen as trusted intermediaries by residents less willing to take the word of (for example) big businesses. The OpenLV data can improve this further, providing accurate, locally relevant data and opening up opportunities for conversations about electricity, low carbon transitions and local concerns. It's well accepted that communicating messages about energy is challenging, but it's easier to reach people through a local embedded community group.

7.2.2 Publicity

Relating to this, another benefit of working with community groups in this project has been the amount of additional publicity brought by groups, through attendance and presentations at events nationally; delivery of local meetings and events; sharing information through tweets, newsletters and local websites.

Figure 6: Tweet from Bath and West Community Energy, presenting at national event in October 2018

7.2.3 Uptake of LCTs

Engagement through community organisations obviously supports the delivery of projects at community scale, which can be more effective in bringing about change around uptake of LCTs than targeting schemes at individuals who can feel that their small contributions to carbon reduction are sometimes so small as to be worthless.

7.2.4 Social networks

New ideas and technologies tend to diffuse via social networks. Community projects can help to encourage neighbours to share low carbon behaviours and technologies that they have adopted. The link to substation data can provide a talking point and an opportunity to discuss some of the issues.

7.2.5 Local knowledge

The community groups also bring a different angle to the project in that they often have a fuller understanding of localised issues and are therefore able to interrogate localised data alongside local knowledge in a way which gives it more meaning.

7.2.6 Testbeds for new technologies

The community organisations brought a different angle to the project with innovative ideas for using the data, and bringing new questions and scenarios to the table. The community organisations also provided opportunities for the OpenLV trial as a whole for testing out the deployment of monitoring units in a range of different situations. For example:

- different substation locations and set ups (power supply, voltage, wiring, labelling, arrangement of busbar etc)
- size and type of community being supplied (for example, a mix of large housing and commercial buildings in Bath; a school and residential properties in Tavistock; housing association properties in Bishops Cleeve; the whole of the village of Marshfield; and a single street of Victorian terraced homes in Owen Square)
- different levels of understanding of the data within members of the community groups engaged with the trials, and within residents of their communities.

7.2.7 Sharing learning

There are opportunities for sharing learning between community organisations through projects like OpenLV, and improving effectiveness by avoiding too much 'reinventing the wheel'. Despite the differences in communities and geographical locations, many of the same barriers were encountered in the community trials. DNOs could use the network of engage organisations to disseminate key messages and to tap into the sorts of issues that are being raised at ground level.

Projects delivered for the community trials have scope to be replicated elsewhere in future with access to local electricity data, although some elements of the projects could still be run in the absence of substation data (for example energy awareness activities in schools). However resource limitations are a barrier to voluntary projects delivered on the ground by community groups.

7.2.8 Attracting funding

In terms of fundraising, participating in the OpenLV project did not directly lead to any of the community organisations securing funding. However, being selected as a trial participant supported BWCE's application to funding for their solar PV and battery installations, and LV data accessed via the project was used in modelling for businesses cases put forward by OSCE for funding. With a longer trial period and more time to make better use of the data, other groups might have been able to use the data in funding applications, either to present local circumstances and the need for funding to address local issues, or to secure further funding to use the data itself within a project, or to secure investment in development projects (for example community scale renewable) shown by the data to be feasible.

7.3 Key findings around benefits of the LV data

Three main use cases were identified for the LV network data:

- as a as a tool to aid community engagement
- as planning tool, using data to identify new opportunities or improve the design of existing energy projects
- as way of facilitating community level flexibility (with potential to generate income).

7.4 Key benefits from engaging communities

- It's easier to reach people through a local embedded community group acting as a trusted intermediary.
- Community groups bring additional publicity to projects like OpenLV
- Projects operating across a community, as a collective endeavour, bring a different (and potentially more effective) approach to encouraging behaviour change and uptake of LCTs than targeting individuals.
- New ideas and technologies tend to diffuse through social networks, and the link to substation data can provide a talking point for discussions.
- Community based organisations may be better able to contextualise data and use local knowledge to give it more meaning.
- The community organisations provided opportunities for the OpenLV trial to test out the deployment of monitoring units in a range of different situations.
- There are opportunities for sharing learning between community organisations through projects like OpenLV, improving effectiveness and reducing duplication.
- Projects delivered for the community trials have scope to be replicated elsewhere in future with access to local electricity data.
- Some elements of the community trial projects could still be run in the absence of substation data.
- Access to data can help community organisations to attract capital funding.

8 Lessons learned and recommendations

Key elements of the project that worked well (or did not work well and could be improved in similar future projects) are discussed below, with key learning points summarised at the end of each section, and recommendations for future projects set out in section 8.4.

8.1 Recruitment / engagement of community organisations

The number of responses from community energy groups in pre-application stage demonstrated a high level of interest from communities in becoming part of a smarter grid and engaging with WPD. However, significant promotion of the project was needed to encourage applications from housing associations, and there was very little interest from parish councils (none applied to the trials). The technical nature of the project and the lack of funding to participate were seen as barriers to housing associations and parish councils, and to a lesser extent to community groups made up of volunteers already stretched with time commitments. Funding to participate might have improved outcomes. The timing of the recruitment phase may also have affected the number and type of applications that were received. With an extended recruitment period (and by avoiding the Christmas break), a greater number and wider range of organisations might have submitted applications.

Opportunities to engage more with DNOs was a motivator for groups applying to the trials. Several groups were keen to establish, or build on, a relationship with WPD. Feedback at the end of the project showed that organisations would have liked more interaction with WPD, including communications around their OpenLV projects and more broadly as an opportunity to discuss issues in their community and expected changes (for example with electrification of heat, and more people connecting electric vehicles to the network).

Having a Memorandum of Understanding with each community organisation, and a named point of contact at CSE worked well. Several groups fed back that ‘check ins’ by phone and email with CSE were useful, while others found it difficult to make time for regular catch up calls to feed back on project progress.

The selection of substations was more complicated than originally anticipated. There is often a disconnect between the houses and streets served by substations, and ‘real life’ neighbourhoods. There are also barriers around identifying which houses are connected to which substations, via which feeders. Network maps are (for good reason) not in the public domain, and the age of the infrastructure is such that connections are not always known without a physical check. ECOE and BWCE in particular had trouble matching substations with particular streets they wanted to monitor as part of their projects, and projects could have been initiated more efficiently with either a greater number of substations being monitored, or improved feeder maps. The feeder maps themselves were identified as a useful resource for community energy groups.

Given that the project was about sharing access to data, the lengthy datashare agreement was perceived as a deterrent to groups engaging in the trials, although subsequent guidance from WPD helped address concerns.

8.2 Key findings around recruitment

- There is a high level of interest from communities in using electricity data.
- The technical nature of the project and the lack of funding to participate were seen as barriers to housing associations and parish councils.
- The timing and timeframes of the recruitment period affected the total number of applications received.
- Opportunities to engage more with DNOs was a motivator for groups.
- MOUs and named person as the 'point of contact' at CSE worked well.
- Selection of substations was more complicated than originally anticipated.
- Neighbourhood boundaries do not generally match areas served by individual substations.
- Feeder maps were identified as a useful resource.
- Lengthy datashare agreement was perceived as a deterrent.

8.3 Delivery of projects

The project timeframes were an issue for most of the projects. Community development work takes time whatever the topic, but engaging with people around energy is notoriously difficult, and there were additional delays because many of the projects were pilots, participating organisations were unfunded, and there was no contractual relationship.

Logic models were a useful tool for refining project ideas and helping to plan delivery, although a period of only 9 months for the community trials meant it was difficult to deliver significant outcomes within the trial period. Many of the community organisations will continue to work on their projects beyond the end of the trials however, especially if there is continued access to data.

Four out of the seven trial projects were run by volunteers; two were led by individuals in paid jobs where the OpenLV project was additional to (rather than a core part of) their job roles, and only one project was led by a member of staff where the project was integrated with existing work. With the volunteer led projects (as with most community projects), the roles of individual members had to fit in around work, family, and other commitments (most of the groups are also running several other projects at the same time). At Rooftop there were also several staff changes) during the course of the trial, with gaps where there was no cover. This combination of factors meant that project development and delivery was often in fits and starts.

It became apparent early on in the trials that the community organisations engaged in the trial did not feel they needed significant community engagement support from CSE. This meant that support time could be made available for software development, making the realisation of a web app within the project timeframes possible. However limited time was then available to support groups with interpreting data and with the more technical aspects of community engagement (e.g. more intensive support with using the web app; putting together sets of graphs to particular to local situations; developing a narrative to explain the project and what the data was being used for). These factors, together with short project timeframes, and the fact that most groups did not have a very strong understanding of electrical engineering, placed limitations on opportunities to make the most of the data.

All the trial participants found it a challenge to engage members of their communities with substation data. TEC successfully set up weekly workshops in a school, Marshfield recruited local ‘energy monitors’ to act as intermediaries in the community, and BWCE and Rooftop both ran meetings and events to engage local residents. ECOE had planned to develop a phone app in order to make the topic more engaging by gameifing electricity use and encouraging competition between neighbours. Unfortunately they were not able to secure funding to complete development of the phone app.

One group (Marshfield) were more interested in the data itself than the functions of the web app, but there was limited capacity within the group to handle large data feeds in the format they were provided and difficulty understanding which data points were likely to be the most useful in data analysis to achieve the project aims.

Data losses from the LV-CAP units, due to issues with communications caused by poor mobile phone signals, firewalls and power outages, led to periodic loss of data. In most cases this was quickly rectified but in several cases (ECOE, OSCE and Marshfield) meant that there was no data for periods of a month or more. This made it difficult to carry out modelling, community engagement and data visualisations, and impacted on project delivery. In the early stages of the project when the web app was first launched data loss issues across all the projects led to some loss of enthusiasm in organisations keen to ‘get going’. There were further issues with access to data for two of the groups using the web app to display locally generated solar PV output data because of security and contract requirements and delays in communication with third parties.

The projects demonstrated the value of accessing LV electricity data both as ‘live’ (or in the case of the community web app, half hourly) data feeds (which can be used in projects aiming to reduce demand or shift peaks in electricity usage) and also as historical datasets (for example for modelling, or for looking at daily electricity profiles across a year).

Understanding of electricity data is not high amongst either community groups or the general public. The people (i.e. the members of the community organisations participating in the trials) who are the ‘translators’ of the data need to be able to understand what it shows. A recurring theme in the feedback from the end point interviews with participating groups was that communities accessing the data felt they needed some help in developing a narrative to present the data to people who are not particularly energy literate and who don’t generally engage with graphs and numbers. As one participant put it, in terms of encouraging take up of LCTs, “the data is not the driver”.

However, people who are good at engagement are not necessarily the same people that are good with data, and the two often need to be joined up. To engage individuals in communities with low carbon technologies and changing their behaviour around energy, concepts need to be relatable, understandable and ‘human’. For example, talking with neighbours about electricity bills (rather than graphs of active energy), or talking about the number of people on a street with electric vehicles and potential future constraints on charging points or times (as opposed to attempting to discuss peaks in electricity demand).

Some of these themes only really emerged towards the end of the trials as the organisations were getting to grips with the full range of features and data accessible via the web app. A learning point for any future work around use of LV data in local energy projects would be to dedicate some time to this early on in a project to improve success of community engagement activity.

8.4 Key findings around delivery of projects

- Community development work takes time.
- Logic models were a useful project management tool.
- Identified project support needs changed during the project.
- Data losses impacted on levels of engagement with the trials (e.g. Marshfield volunteers) and limited practical use of the data (e.g. OSCE).
- People within community organisations tend not to have strong electrical / technical expertise – or it sits with one or two individuals within an organisation or group.
- Understanding of electricity data is not high amongst the general public.
- In terms of encouraging take up of LCTs, “the data is not the driver”.

  Relatable narratives can help to explain the data and use it to maximise local impact.

8.5 Development and use of the web app

There was significant crossover between trial participants in terms of the data points they wanted to be able to access, and how they intended to use data. This meant that development of a single web app for use by all the groups was feasible, and could be delivered within the project timeframes. Despite the fact that the web app software took longer than expected to develop (there were delays with accessing data and some teething issues with the skeleton web app), a web app was developed for the project and facilitated access to LV substation data for the communities involved in the trials.

In initial conversations most community organisations were keen to retain access to all the data points being measured in the substations. However in end of trial feedback there was an acknowledgement that in fact not all the data was needed and a smaller dataset might have made the web app more user friendly. The data provided is, by its nature, very technical, which was a barrier to most of the individuals within the community organisations participating in the trials who were not electrical engineers. As one community group member put it “power phase-angles just don’t do it for me”.

Similarly, all organisations wanted to have access to all the functionality being developed, but within the timeframes of the trial, none of the community organisations had time to test out all of the functions that had been developed, and instead tended to concentrate on one or two functions that were most relevant to their projects. However, several groups still plan to access the web app features that they haven’t yet had time to make use of.

Due to the nature of the trials some of the community organisations had difficulty using the data to easily show what they wanted to show. As an example, it has been difficult for community trial participants to gauge substation health from the OpenLV measurements, as additional information and interpretation is needed from WPD. Another example was the misconception that the LV electricity data showed total electricity demand and generation on a given feeder or substation: LV substation data shows *net* flows of electricity, and large renewable energy assets are usually connected higher up the network, so it is hard to show a simplistic picture of energy in terms of "our use is 'x' and generation is 'y'".

Several organisations would have preferred to use a smart phone app to access the data and aid community engagement. Several groups also fed back that elements of the web app could have been made more user friendly (e.g. the alerts function). Improvements could have been made with more time and resource, including time for more intensive user testing. The issue of smart phone app development was raised and discussed during the recruitment phase of the project, and it was made clear that although there is often an expectation that individuals will be able to 'get the app' for any given activity, centralised development (by CSE) of a phone app or a very cost intensive web app would not be possible within the project budget constraints. A smart phone app would have necessitated significant additional fundraising. There is learning here around managing expectations for app development linked to budget availability.

Some of the most useful web app functions, as reported back in end of project interviews, were not about 'pure' substation data but where the web app provided a way of linking substation data with additional data sources (e.g. cost, carbon intensity, renewable energy generation) to give a more localised perspective. There were some unforeseen issues affecting the ability of one community organisation to use functionality such as cost of using i-frames.

Incorporating external data requested by participating organisations part way through the project led to delays in project delivery for BWCE and YCE because of issues with third parties providing access to data via APIs. A learning point here is around identifying all data sources at the start of development work, and building in some contingency time for delays of this kind.

8.6 Key findings around community web app

- A more limited set of data points would have met the needs of most trial participants and might have made the web app more user friendly.
- Few voluntary groups have the expertise and resources for complex software development work.
- With more resource, the web app could have been made more user friendly and features could have been improved.
- Training on the web app (webinars and 1:1 sessions) was valued, although some community organisations still found the web app difficult to use.
- More time was needed for trial participants to make use of the full range of web app functions.
- Expertise and understanding of the data points and how to use them was over estimated in the application phase of the project.
- Additional training and networking opportunities would have been useful to trial participants.

8.7 Recommendations for future projects

Based on the experiences and learning gained from the OpenLV community trials, these are recommendations for future iterations of the OpenLV project:

- Use case studies to recruit a wider range of organisations by showing range of potential benefit of accessing LV data.
- Consider time of year when planning recruitment, and allow sufficient time to allow community organisations to apply.
- Build in opportunities for more interaction with the DNO.
- Manage expectations around substation selection and build in more time for identifying and checking substation suitability.
- Develop a shorter and less daunting data share agreement.
- Ensure an MOU is in place, setting out roles and expectations for all parties.
- Build in more time for community trials (ideally several years as a minimum).
- Use logic models (or a similar tool) to help to refine project ideas and plan and evaluate project delivery.
- Because neighbourhoods do not generally correlate with substation maps, projects using LV substation data at community level may be better delivered either with specific streets or with access data from multiple substations.
- Develop robust community engagement strategies as part of any projects planning to use data in a similar way in future.
- Ensure time is made available for support with accessing and interpreting data where needed.
- Develop narratives to present opportunities arising from use of the data to improve success of community engagement activity.
- Build in more time for software development, including testing with users and incorporating external data.
- Allow longer timeframes for community groups to test out web app functions and make best use of data.
- Clarify at the start of the web app development process the formats that would be most useful for exporting data (to facilitate modelling and manipulation outside the web app).
- Provide training on web app at the start of project delivery, with regular refreshers and opportunities for users to share learning.

9 Conclusions

Work carried out under the community engagement trials has shown that it is possible to develop web based applications to provide community organisations and groups of customers with access to LV electricity data. It has also shown that there is scope for DNOs to provide access to data as a means of engaging with and supporting the activities of community organisations who want to accelerate a smart grid rollout.

Community organisations participating in these trials were well embedded in their localities, and seen by residents as trusted as trusted intermediaries. Although timeframes of the trials limited the extent to which project aims were achieved, the participating community organisations started to use contextualised data to engage with people around energy use behavior and encouraging take up of low carbon technologies.

Project achievements included use of the LV electricity data in school workshops, various public events, behavior change campaigns, and community websites to help improve understanding of energy issues and the need for change.

Key learning was around the length of time needed for community projects to achieve results; the value in using data as a conversation starter in local engagement activity; difficulties in communicating messages about energy and the need for a narrative to explain data; the level of resource needed to develop complex web (or phone) apps; and the potential of (and value from) using LV data in a range of contexts supporting low carbon transitions.

Appendix 1: Evaluation process

Steps in the evaluation process	Completion and review dates

1. Data collection plan
• Define measurables which will be used to demonstrate achievement of project aim and outcomes
  • develop logic model for each participating community organisation, setting out project activities, inputs, deliverables, and intended outcomes (CSE and trial participants)
  • discuss intended outcomes and identify one or two key outcomes for evaluation focus (Regen and trial participants)
  • set up data collection plan for each project, including information to be collected, how, when and by whom (CSE, Regen, trial participants)
	October 2018

2. Gather evidence, based primarily on: • Mid and end point interviews with the Method 2 trial participants (CSE, Regen, trial participants) • End of project focus groups (where possible) with members of the communities where the projects are taking place (CSE and trial participants) • Survey data using standardised questions to measure changes in behaviour and understanding (trial participants) • OpenLV data to measure changes in electricity usage patterns (CSE, Regen, trial participants)	December 2018 – September 2019 *including* Mid point interviews: March and June 2019 End point interviews and focus groups: October 2019
3. Analyse and report (CSE and Regen) • Evaluate data • Quantify achievements • Highlight key issues and lessons learned • Analysis of OpenLV network data (where appropriate) • Draw conclusions about success of Method 2 trial and achievements of individual projects	September – December 2019

Appendix 2: Analysis of Marshfield Village OpenLV data

OpenLV Your local electricity data

centre for sustainable energy

OpenLV data analysis

November 2019

Analysis of OpenLV data from the four substations being monitored in **Marshfield** gives some indicative figures to help with future plans to make the village more sustainable.

- It could be possible to install a further **138 5kWp solar PV installations** (depending on a number of provisos – i.e. if the existing PV and new PV are spread evenly across the phases; and if WPD agree).

- If this was all installed, the yield would be around **830MWh electricity per year** (including the already installed PV and Wind generation).

- On average, this would provide for about **16% of the EV charging demand** if EVs were used for all current journeys, or for 100% of travel by e-bike.

- **106 EV charge points could be installed** allowing 'charging on demand'. A greater number of charge points could be installed with management of charging times and by spreading charging points carefully across feeders.

- **Battery storage could be used to balance out peaks** in generation and demand, but may not be the most cost effective way to reduce carbon emissions. Battery storage would however reduce the number of solar PV arrays that can be installed (when it's discharging it takes up capacity that could be allocated to PV). It would also reduce the number of charge points that can be installed (when it's charging it's using the capacity that could be allocated for charge points).

- Switching residents to **time of use tariffs will help to reduce carbon emissions and electricity costs** (on average by £60 from a standard tariff, and by £95 from Economy 7. When electricity costs for the year 2018-19 are averaged across the whole village, average electricity costs per house are £558 for consumers on a standard tariff, £589 for those on a variable tariff (Economy 7), and £494 on a time of use tariff (calculated using Agile Octopus rates).