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OPENLV

OPENING UP THE SMART GRID

SDRC 4

Learning Generated from the OpenLV Project trials by Method 2.

ea technology

RIIO NIC NETWORK INNOVATION COMPETITION

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Contents

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Glossary

Term	Definition
API	Application Programming Interface
BWCE	Bath and West Community Energy
CSE	Centre for Sustainable Energy
DNO	Distribution Network Operator
DSO	Distribution System Operator
DTR	Dynamic Thermal Rating
ECOE	Exeter Community Energy
FAT	Factory Acceptance Testing
LCT	Low Carbon Technology
LV	Low Voltage
LV-CAP™	Low Voltage Common Application Platform
NIC	Network Innovation Competition
NOP	Normally Open Point
OSCE	Owen Square Community Energy
PV	Photovoltaics
RTTR	Real Time Thermal Rating
SAVE	Solent Achieving Value from Energy Efficiency [project]
SDRC	Successful Delivery Reward Criterion
TEC	Tamar Energy Community
Tx	Transformer
UPS	Uninterruptible Power Supply
WPD	Western Power Distribution
YCE	Yealm Community Energy

Executive Summary

Background

The OpenLV Project trials an innovative new open access platform that was developed by EA Technology.

The OpenLV platform

- **Enables Open Data**
- **Hardware and Software agnostic**
- **Decentralised analysis and control**

Uniquely, the OpenLV platform provides a substation monitoring and operating system (EA Technology's LV-CAP™) that has been designed to be hardware agnostic and, in a Method analogous to a smartphone, to be able to host multiple apps. The trial system allows hosted apps to share monitored data and each other's outputs. LV-CAP™ was designed so that calculations and decisions can be made locally, speeding up reaction times and reducing the amount of data that needs to be sent to central aggregation servers. It provides a secure environment for the maintenance and management of apps, while continuing to ensure the security of the electricity network.

The OpenLV trial

This trial opened access to 100 Million data points from 80 substations.

The OpenLV Project is seeking to prove the technology and assess how it enables benefits to the DNO (Distribution Network Operator), community groups, business's and academia. The trial was organised to:

- Investigate the benefits of decentralised analysis and LV network automation through **Method** 1 of the trial
- Investigate how OpenLV enables community action through **Method 2** of the trial
- Investigate how OpenLV creates new opportunities for business and Academia through **Method 3** of the trial

Further information on the overall project can be found in the Full Bid Submission, which is available on the OpenLV Project website [1].

Report Purpose

In this report we present the results and learning from Method 1, Method 2 and Method 3 of the trial. Subsequent reports will analyse the opportunities and benefits of implementing the platform into business as usual.

Key Findings

Within this report we outline the following key findings from Method 2 that investigated the effect of the OpenLV platform upon community groups.

The key learnings from this part of this trial are discussed in the next bullet points:

- The opportunity to use local data to better inform themselves about their effect on the electricity system was a popular offering to communities as demonstrated by the fact that the applications to formally participate in the trial were greater than the number of substation platforms that were available for installation.
- It was initially envisioned that individual communities would develop their own apps and pioneer their own data use cases. At an early stage it became apparent to the project that community groups are not able to commit their expertise on the same basis as commercial organisations and that few of them have access to software developers or the resources with which to manage a software development project. Applying for funding to develop apps would be a long and potential fruitless exercise that would leave participant groups little time to engage their communities with the app and project data. To mitigate this issue a single app was created to serve all the use cases that community groups participating in the project expressed an interest in.
- Interviews with community groups provided evidence for how each group specifically used data from the app to create value. The general perspective was that the ability to discuss their energy use at the network level was transformative. Communities also commented upon the usability and transparency of this data, providing insights such as:
    - Few of the community groups included electrical engineers. This means that network information and data need to be presented in a manner that allows easy interpretation. It would be helpful for communities to be able to do this without having to delve in the engineering complexity of the problem.
    - Several of the community groups valued the insights provided by the data as it enabled them to avoid guessing games as to what capacity was truly available in the network.
- Having access to this data did enable community groups to develop local energy strategies and apply for funding.

To summarise, Method 2 demonstrated that sharing local substation data with community organisations was a strong engagement tool for DNO’s to deploy, the benefits of which extend beyond the networks sector.

1 Introduction

1.1 Project Background

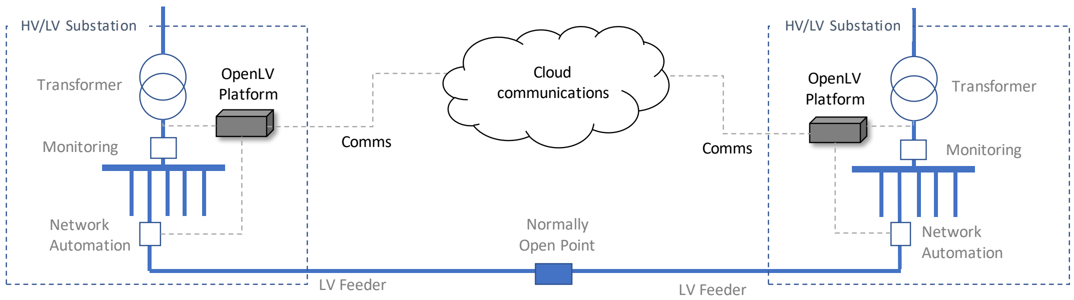
Great Britain has about 1,000,000 Low Voltage (LV) feeders; these have largely been designed and operated on a fit-and-forget basis for the last 100 years, but things are set to change. LV networks are expected to see radical change as we, as customers, alter our behaviour and requirements, stemming from the vehicles we drive, to the generation and storage devices we put onto and into our homes.

The technology to be trialled as part of the OpenLV Project provides a new, open and flexible solution that will not only provide the DNO, community groups and the wider industry with data from the LV network, but will also enable these groups to develop and deploy apps within LV substations through a common hardware platform. The OpenLV Project is seeking to prove the technology and assess how the provision of LV network data and the ability to develop and deploy apps can provide benefits to the DNO, community groups and the wider industry. These Methods used to achieve this objective are outlined below.

1.1.1 Method 1: Network Capacity Uplift

Figure 1 provides an overview of the systems architecture that will be deployed to complete Project trials for Method 1 – Network Capacity Uplift.

As part of the Project trials for Method 1, apps will be used to increase the capacity of existing LV assets through the application and implementation of Dynamic Thermal Rating of the LV Transformer and through meshing LV feeder(s) on the LV network.



What

- Check network capacity against thermal rating of transformer; when breached, close two radial circuits to mesh the LV network
- Deploy two proven techniques
  - 'Dynamic Thermal Ratings App' and
  - 'Network Meshing App'.
- Together with a 'Network Control App' to operate/configure the network

How

- Assess WPD's network to identify candidate circuits
- Deploy LV-CAP™ to 60 substations
- Monitor how the solution would operate over several months
- Install actuators on 5 circuits (2 ends each) to prove end-to-end control
- Assess and report on performance

Figure 1: Method 1 – Network Capacity Uplift

1.1.2 Method 2: Community Engagement

Figure 2 provides an overview of the systems architecture that will be deployed to complete Project trials for Method 2 – Community Engagement.

As part of the Project trials for Method 2, Community Groups will make use of the LV network data provided by the OpenLV Platform to provide benefits to Communities.

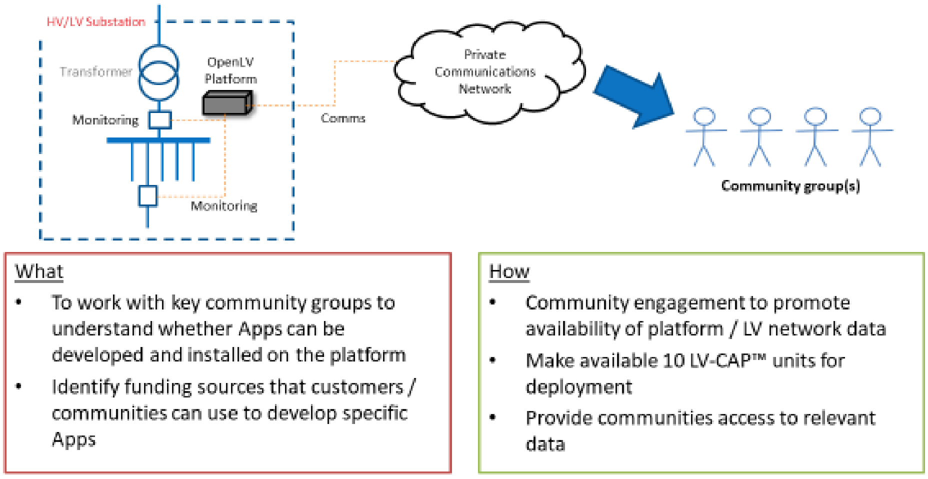


Figure 2: Method 2 – Community Engagement

1.1.3 Method 3: OpenLV Extensibility

Figure 3 provides an overview of the systems architecture that will be deployed to complete Project trials for Method 3 – OpenLV Extensibility.

As part of the Project trials for Method 3, the Wider Industry will either, make use of the LV network data provided by the OpenLV Platform, and/or develop and deploy 'apps' to provide benefits to: DSOs (Distribution System Operator), Platform Providers, 3rd Party Developers and Customers.

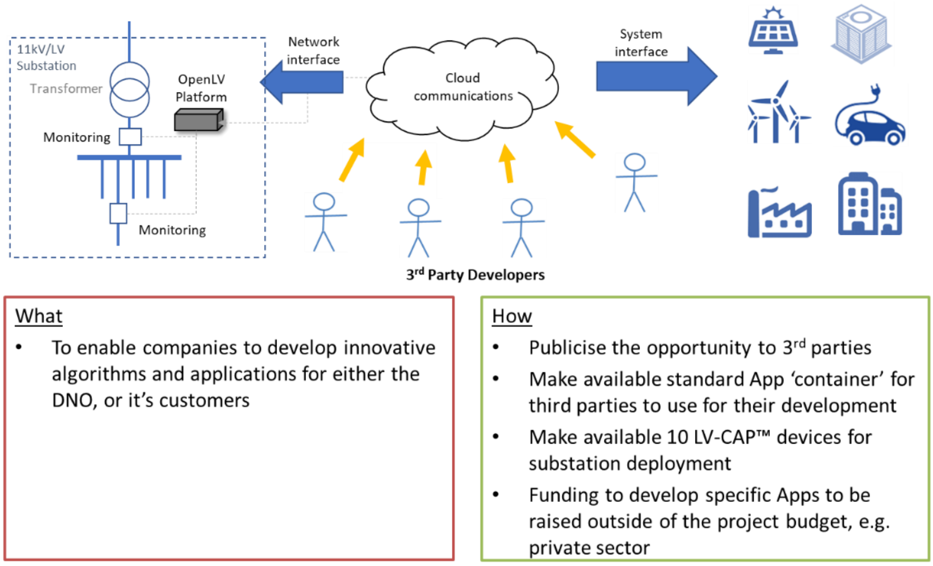


Figure 3: Method 3 – OpenLV Extensibility

1.2 Document Purpose

The OpenLV Project Successful Delivery Reward Criteria 4(SDRC) report 4 was structured to meet the evidence requirements outlined in the OpenLV Project Direction [2].

The primary SDRC 4 report was issued to Ofgem as a single document, detailing the evidence relating to Methods 1, 2 and 3 of the OpenLV project.

1. Sharing the level of capacity uplift achieved through Method 1
2. Sharing which LV networks can benefit from OpenLV and why
3. Establishing the level of capacity uplift that could be achieved in WPDs licence area
4. Sharing how DNOs can engage with communities who want to become part of a smarter grid to exploit the open and flexible nature of OpenLV
5. Sharing how community engagement supports the uptake of LCTs (Low Carbon Technologies)
6. Outlining the routes communities can take to raise funding
7. Sharing the network benefits provided by community engagement
8. Sharing how DNOs can engage with academics, companies (including non-energy companies) to exploit the open and flexible nature of OpenLV
9. Sharing the network benefits provided through Method 3
10. Sharing how the Method facilitates non-traditional business models

In this document we present the results and learning relating to Method 2, with matching documents available for Methods 1 and 3.

1.3 Report Structure

The structure of this report is as follows:

- **Section 2: Method 2: Community Engagement –** provides an overview of the community engagement that has been completed by the project and shares learning about the benefits to networks that could be realised by engaging with community groups
- **Section 3: Conclusions -** outlines how the project has met the Successful Delivery Reward Criteria as set out in Section 1.2

2 Method 2 – Community Engagement

As documented in previous reports, following a recruitment and interview process seven organisations were invited to participate in the OpenLV Project. Information about each of the organisations, their ethos, reasons for participating in the project and end use of the data that they received from the project is documented below.

The experiences of these participant organisations have been reviewed in order to inform the criterion below:

1. Sharing how DNOs can engage with communities that want to become part of a smarter grid to exploit the open and flexible nature of OpenLV
2. Sharing how community engagement supports the uptake of LCTs
3. Outlining the routes communities can take to raise funding
4. Sharing the network benefits provided by community engagement

SDRC 2.1 and 2.2 discussed the appetite amongst community groups and organisations to engage with smart grids via technology such as that being trialled by OpenLV. These reports also describe the process by which community organisations were recruited to become part of the OpenLV Project.

Further analysis of the Method 2 trial will be presented in SDRC 5, to be published in Spring 2020. This report will focus on the benefit of providing network data to communities allowing them a better share of their value to the energy chain.

2.1 Approach

The approach for the Method 2 trials was defined in the full bid submission and was documented in SDRC 2.2. The principle of the trial was to see whether there is a market for community or customer driven apps or interest in using data from low voltage substations. In order to facilitate this the project worked with two external partners. It:

- Appointed Centre for Sustainable Energy (CSE) to engage with communities to promote the availability of the substation intelligence platform and associated LV network data
- Appointed Regen to assess the longer-term potential / economic impact for the use of the OpenLV devices, and to develop enduring tools to assist communities in their engagement with the distribution network

CSE worked with communities initially:

- That want to be part of a smarter grid to identify how the LV network data could be utilised to benefit Community Engagement Schemes that cover aspects of collective action to reduce, purchase, manage and generate energy
- To understand whether innovative algorithms and/or applications could be developed and installed on the low-cost substation intelligence to benefit Community Engagement Schemes
- To identify potential funding streams for community groups to develop innovative algorithms and/or applications

The learning from this work is captured in this and previous SDRCs as well as the following project deliverables produced by CSE and Regen reproduced in the Annexes of this document:

1. Learning Gained Engaging with Community Groups – CSE (Annex 6)
2. Value and Benefit Analysis – Regen (Annex 7)
3. Mid-Trial Report 1 – Regen (Annex 8)
4. Mid-Trial Report 2 – Regen (Annex 9)
5. Mid-Trial Report 3 – Regen (Annex 10).

This SDRC report draws heavily on deliverables 1 and 2 authored by CSE and Regen respectively.

On behalf of the project, CSE recruited community organisations to participate in the trial. 10 LV-CAP™ devices were deployed at specific ground mounted LV substations to meet the recruited communities' needs.

2.1.1 How communities offer flexibility/why communities want data

Via the process outlined above it was confirmed that community organisations want to play an active role in our energy system as it becomes more decentralised. Data such as that provided by the OpenLV Project takes energy concepts that can be hard for someone outside the energy industry to grasp and puts them in a local context. With the data provided by platforms such as LV-CAP™, community energy organisations are ideally placed to engage wide audiences in their energy behaviour, with locally relevant messaging around how we can work alongside our neighbours as our energy system transitions. This engagement could then help communities to coordinate demand side response, promote LCTs and offer flexibility to help manage the network.

2.2 How was the trial implemented?

An initial piece of work carried out by CSE in 2017 established that there was sufficient interest in OpenLV data for the community 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. 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.

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 instigated during the initial application process, but there were some complications to overcome. There were some difficulties 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 were very helpful to the community organisations when selecting 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 were also 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).

Participating groups were also provided help by CSE to understand 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 limited project timeframes.

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)

Early on in the project a number of barriers preventing community access to substation data were identified, 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
- Insufficient time for successful fundraising for software development within the timeframes of the trials

A review of the project findings about fundraising potential for community organisations to undertake app development of this nature is provided below.

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 their 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 can access 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.

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) photovoltaic 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 for 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 were 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.

2.3 Fundraising potential for app development

Initially, when the OpenLV Project was conceived, it was decided at the outset of the OpenLV Project that community organisations participating in it would not be provided with funding directly from the project budget. Once the project was underway it became apparent that, for a range of different reasons, this was not practical. This section summarises the main considerations in relation to fundraising for community organisations who may wish to undertake app development or energy network data analysis work, and highlights the most obvious sources of funding based on survey responses from organisations who expressed an interest in taking part in the project prior to the selection of project participant organisation. It should be noted that this information was collated prior to the start of the OpenLV trial in August 2017.

2.3.1 Defining proposed project outcomes

Groups would have a number of fundraising options: from their existing resources (e.g. income generated by their existing community renewable energy generation assets), from local sources (individuals, local companies, their council, parish council, or a local charitable trust, including the nearest community foundation), or from national sources (particularly large charitable trusts or lottery).

To access all types of charitable funding, groups would need to demonstrate the benefits of the project: rather than concentrating on the technical detail, they would need to determine and make some assessment of the change or difference they expect a project to make (its outcomes), and link this to broad funding themes such as social inequality, climate change or community resilience.

Different funders focus on a range of outcomes, and groups may need support to draft funding applications that reframe the project in different ways to appeal to a range of funders. For example, some projects could be framed in such a way that broad themes of social inequality are brought to the fore, in particular where a community can be shown to be disadvantaged in some way (low incomes, rurally isolated, off the gas network, to name a few). 42% of the survey respondents self-reported that they were based in a 'sparse hamlet or village'. Issues of rural isolation and lack of affordable energy services could prove a useful framing in these areas. There is a range of charitable trusts with a focus on rural issues, and many community foundations in rural areas have specific funding streams on access to services and utilities.

Similarly, a sizeable 67% of respondents were very interested in 'Community information alerts', which could be valuable for carers looking after vulnerable members of society. Alerts could be sent to members of a community or carers if supply is lost for a sustained period of time. In this instance the target funder outcomes would be very different, e.g. improving the health and wellbeing of vulnerable people, and would be better suited to funders with a focus on health or social isolation outcomes.

According to the survey, the two most popular uses for an app were to understand community electricity demand (92%) and connecting low carbon technologies to the LV grid (90%), which could enable community members to carry out carbon foot-printing or improve opportunities for community renewable generation. Potential outcomes could include reducing the UK's carbon dioxide emissions, promoting behaviour change to reduce energy consumption and building community resilience to climate change, all of which would appeal to funders operating in those themes.

Once the groups have been supported to define their outcomes (the change or the difference they want to make), they can be supported to apply to a range of funders who want to fund similar outcomes. Generally, if a group cannot raise funds from its regular supporters, from its own income, or its own members' contacts ('major donor fundraising'); they can be supported to apply to **local funding sources** and **major national funders**.

2.3.2 Legal structures

Before discussing these two options in detail, it is important to note that the legal structure of a group may have a bearing on whether they can apply for funding from some funders. For example, some charitable trusts may only support registered charities. Other funders will usually include support for other not for profit groups such as registered societies (co-operative societies, community benefit societies, and former industrial and provident societies).

Notably, of the 51 respondents to the survey, 12 were unincorporated. As a minimum, such groups will have to adopt a constitution and open a bank account in order to secure charitable funding (this is the lower bar set by some statutory funders such as Awards for All). However, some funders will require them to incorporate as a company, charity or registered society in order to receive funding, so the project team will need to understand and assess the risks to the delivery timetable associated with this, as such processes can take several months to complete.

2.3.3 Local funding sources

Local sources, such as a local charitable trust or Parish Council, might only support groups or projects based locally, so there will only ever be a limited number of competing causes for funding. As an example, one of the groups participating in the survey, Wolverton Community Energy, might be eligible for funding from The Ancell Trust, which specifically supports causes in Stony Stratford, a small-town neighbouring Wolverton, in Buckinghamshire. Groups should also consider any local authority grants (although these have diminished significantly in recent years), or if they are aiming to support the health and wellbeing of vulnerable people, the local health sector (the clinical commissioning group and public health) may help through programmes like the Better Care Fund.

Rural groups might consider applying to a LEADER programme which operates at local levels across England to support the rural economy as part of the Rural Development Programme for England (RDPE).

Local Community Foundations are also another popular source of local funding. There are 46 Community Foundations covering the whole of the United Kingdom, each working with individuals, families, companies and other organisations that want to support good causes in their local area. Community Foundations give out combined grants totalling over £65 million annually, almost exclusively small grants to local groups. The UK Community Foundation website has links to all 46 [3].

2.3.4 National funding sources

Major national funders have the advantage of significant resources. The most obvious funder is the National Lottery, which runs a programme specifically tailored to support small community groups, *Awards for All*, offering grants from £300 to £10,000. Groups must have a constitution and a bank account requiring two signatories. The project must meet at least one of three funding priorities:

- Bring people together and build strong relationships in and across communities
- Improve the places and spaces that matter to communities
- Enable more people to fulfil their potential by working to address issues at the earliest possible stage

These priorities demonstrate the importance of pre-planning to better understand the long-term change or difference groups want to make through the OpenLV Project.

In time, there may be other major grant programmes that emerge, who support community energy or technology for social good from government, lottery, energy companies or major charitable trusts (e.g. both Nominet Trust and Comic Relief have in the past supported technology that supports community benefits), but at the moment Awards for All would seem the best option from a national funder, not least because its decision-making timetables are relatively quick. Though there is a range of other funders with priorities around climate change and energy (for example, the Friends Provident Foundation), many national funders have fixed application dates, sometimes only twice a year, and do not run an open, rolling application system.

2.4 Trial participants

The map below shows the location community organisations participated in the OpenLV trial:

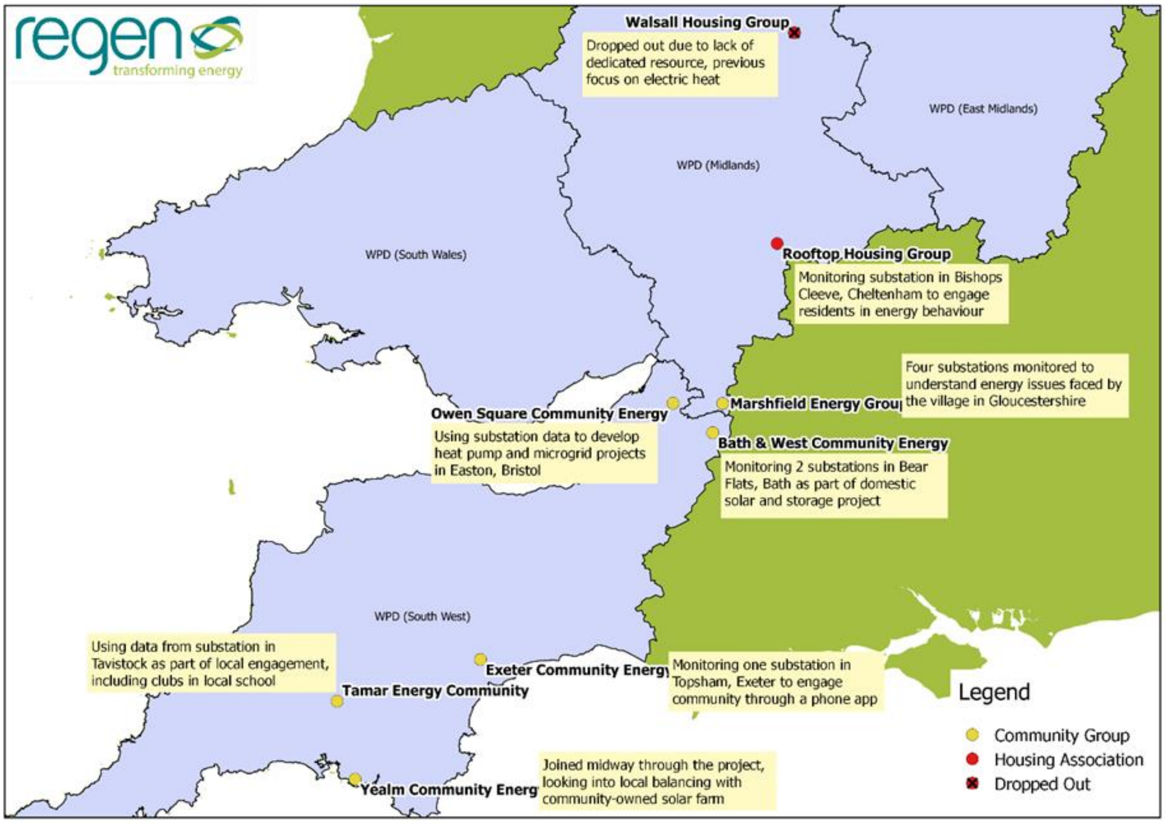


Figure 4: Geographical location of the community organisations participating in OpenLV

As indicated on the map, during the course of the trial one community organisation (whg – a housing association in Walsall) withdrew from the project. Their place was re-allocated to Yealm Community Energy who already had links to the project via a business participating in Method 3 (therefore meaning that a LV-CAP™ was already installed in their village), thus maximising learning for the project.

An overview of each of the participating groups and their project aims is provided below.

2.4.1 Marshfield Energy Group, Marshfield Village, South Gloucestershire

Marshfield is a village of around 850 households in South Gloucestershire. Marshfield Energy Group is volunteer led, with support from the Community Land Trust. The OpenLV Project monitored all four substations in the village of Marshfield, providing a unique insight into a community's electricity demand patterns. Using OpenLV data allowed local people to see real-time energy demand in the village, alongside data about grid carbon intensity. Data was also used to provide an evidence base for a village-wide energy strategy.

2.4.2 Bath and West Community Energy (BWCE), Bear Flat, Bath

BWCE is an early pioneer of community-owned generation. The group is volunteer lead, with two paid staff members. It owns 18 sub-100kW solar-arrays (totalling 472kW), five ground-mounted solar arrays (totalling 11.84MW), and 13.5kW of hydro. BWCE wanted to use data from the OpenLV Project in conjunction with their involvement in Solar Streets project. As part of the Smart Streets project the community group installed domestic PV (Photo-Voltaic) and battery systems local resident’s homes. OpenLV data has been used to inform a series of demand reduction campaigns, facilitate local engagement and measure the impact of the new technology on local demand.

2.4.3 Rooftop Housing Group, Bishops Cleeve, Cheltenham

Rooftop Housing Association is a charitable housing association that provides affordable housing for all household types and needs. The trial took place on a social housing development in the Bishop’s Cleeve area of Cheltenham. The association wanted to use OpenLV data to start conversations with local residents about their energy use, forming the foundations of a larger extrapolated approach to tackle fuel poverty across all Rooftop communities.

2.4.4 whg Housing Association, Walsall, Birmingham

whg is a housing association in Walsall. The project monitored a substation that provided electricity for one of the tower blocks managed by the housing association. The trial coincided with the installation of a smart heating solution for the tower block. Data from the local substation would be used to monitor how the new heating solution was being used and open a conversation with residents aimed to help them use electricity economically. Unfortunately, due to events beyond the control of OpenLV, whg withdrew from the project.

2.4.5 Exeter Community Energy Ltd, Topsham, near Exeter

Exeter Community Energy is an established community energy group serving the Exeter area. It is volunteer lead, with many local professionals giving their time. The group has been instrumental in the provision of 209kW of solar PV on the roofs of Local Authority and local business properties and it is in the early stages of developing a hydro scheme in the city. Exeter Community Energy wanted to develop a prototype smart phone app to provide users in their local community with data about energy usage at their local substation and well as data on local generation and national carbon intensity.

2.4.6 Owen Square Community Energy, Easton, Bristol

Owen Square Community Initiative is a member-based local energy company. The Owen Square Community Energy initiative is tackling the challenge of how to develop a replicable business case for intensive low carbon retrofits of homes. OpenLV substation data provided an evidence base for funding applications for domestic low carbon retrofit schemes and to raise awareness of energy use in the community promoting take up of low carbon technologies by local households.

2.4.7 Tamar Energy Community, Tavistock, Devon

Tamar Energy Community (TEC) is a Devon-based community energy group with 327kW of solar PV on schools, businesses and the local swimming pool. The group is volunteer led. It runs fuel poverty and domestic energy advice services. The TEC OpenLV Project centred around raising awareness, changing energy use behaviour, and the development of local tariff models. Local energy use data gave a visual representation of demand at the substation, which could be combined with data on local generation from assets owned by the group, as well as national grid carbon intensity.

2.4.8 Yealm Community Energy, Yealm,

Yealm Community Energy joined the project at a late stage to fill the space vacated by whg. They are a well-established member owned community group serving the Yealm area. The aim of the group is to bring renewable energy installations such as solar farms into local community ownership, then use the profits to fund local environmental project. The groups own an existing solar farm at Newton Downs close to Yealm. The group wanted to combine data from their solar farm with local substation data to engage the community in issues such as local energy consumption, local generation and carbon intensity. The group also aimed to help people understand the link between domestic energy consumption, substation activity and local renewable generation.

2.4.9 Data Access

The three main ways through which substation data was made available to the community trial participants were:

1. Through a web app, which provides functionality for substation data, data from external sources (e.g. local generation data), and aggregated data (e.g. tariff modelling) to be visualised for time periods specified by the user
2. Through access to ‘raw’ data for data manipulation, modelling and planning. Access was provided remotely, via an API (Application Programming Interface), to datasets from the m2 collation app (i.e. the half hourly collated data) as .csv files
3. Community organisations were also able to access the full granular data from the LV-CAP unit (i.e. minute by minute data from all LV-CAP measurement points), via EA Technology

2.4.10 Data Use

All of the participating organisations wanted to use the data to achieve key project outcomes, most of which can be grouped into three broad categories:

- Behaviour change
- Installation of renewables
- Exploring potential for future low carbon developments at community scale

Behaviour change

OpenLV provided a means of both measuring and visualising electricity data, which in turn offered a unique opportunity to engage individuals in a community with a concept that tends to be quite intangible. This helps to achieve outcomes linked to increasing understanding of energy, and affecting behaviour change around energy use by individuals. Most of the trial participant groups had a strong element of community engagement in their planned activities and planned to create visualisations of the OpenLV data (e.g. graphs and smileys) and share information based on the data in different ways. These included:

1. Printing **posters** for display in local centres (e.g. the shop, pub, or common areas in housing blocks) to show total energy use on different feeders within a community
2. Running **events** where graphs of substation electricity use over time could be viewed and discussed
    - Embedding substation electricity **visualisations in community websites**, with explanations of what was being shown and explanations of what it means – for example, looking at the cost of electricity at substation level
3. Sharing information via **social media** – for example, carbon intensity of electricity use at different times of day
4. Sending out **alerts** (i.e. text messages or emails) to tell community members about peaks in demand, cheaper times of day for using electricity, and carbon intensity for a given moment in time, with a message letting the recipient know that it is (or isn't) a good time to switch an electrical appliance on
5. Using **competitions and games** showing current electricity data to gamify behaviour change initiatives

Uniquely, the OpenLV Project allowed people to consider their energy use *as a community*, rather than *as an individual*. One of the outcomes to be evaluated is therefore whether people feel more inclined to act because they feel they are part of a group effort, as opposed to acting in isolation. A common reason given for the failure of individuals to act on climate change is that individuals can feel that their small contribution is so small as to be worthless when faced with such a large problem.

Installation of renewable energy assets

Groups aimed to use the data made available through the trials to facilitate the installation of more low carbon technologies (both at domestic and community scale), in particular renewable energy technology. For example:

- **Analysing substation data** in order to determine whether there was greater capacity on the substation than previously thought (for connecting new technology)
- **Modelling different scenarios** to see if there was potential for managing existing technology more efficiently
- Using data to support **business cases** for proposed developments
- Using data to **compare local electricity use with renewable energy generation** over a given period of time to encourage energy 'sustainability' of a specific area, and generate support for future renewable energy installations

Decarbonisation plans

Several participating groups planned to use the data to explore the potential for future developments to help to accelerate the pace of decarbonisation. These included:

- modelling possible **time of use tariffs** which could be explored in future;
- using data in **energy mapping** for a neighbourhood, to use as the basis for planning future energy strategies;
- using data to assess impact of **electric vehicle rollout;**
- using voltage and temperature measurements to **assess substation 'health'** and potential community scale actions to reduce network reinforcement costs;
- modelling data to explore the **microgrid model**; and
- exploring potential for **flexibility services** based on assets owned within a community.

2.5 Trial assessment Methodology

Both CSE and Regen gathered learning from the groups, sharing information gathered with each other. The evaluation process is outlined in the table below.

Table 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 a 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

The projects delivered a number of learnings about how communities might utilise the data provided. This learning has been developed into three community 'use cases' which are explored in more detail in this report. These use cases are:

1. **Transparency value** – Communities having access to OpenLV data means they can identify opportunities, assess and evaluate plans for distribution connected projects and investments.
   The trials found that sophisticated community groups, such as Owen Square, and commercial organisations, such as developers and housing associations, benefitted from having greater transparency of substation data which they used to help plan new developments or local projects. To support this value case the OpenLV data needs to be supplemented with more information which can be provided by DNOs, such as data about network constraints and capacity in local areas.
2. **Engagement value** – OpenLV data helps build community knowledge on energy use and energy infrastructure.
   OpenLV was used in a number of the trials to support local engagement by providing important context and community level information on energy. Trial communities Tamar Energy Community, Yealm Community Energy and Rooftop Housing Group used the data to engage local communities in various ways. In the final interviews it was noted that communities would value an evolution of the existing App into an engaging smart phone application. They might also value a communications toolkit to enhance what community groups are able to achieve with limited resources.
3. **Flexibility value** – OpenLV data and functionality supports community level aggregation and coordination of community level demand-side response.
   Community groups were keen to develop these opportunities and recognised the potential for OpenLV to facilitate community level aggregated services. Further trials would need to be done to fully understand the potential of the technology in this area to support local flexibility. Both Bath and West Community Energy (BWCE) and whg had hoped their projects would work to change local usage that would be measurable by the OpenLV unit at the substation. However due to delays and restructures, these projects were not able to test their impacts nor the potential for OpenLV to send alerts to communities to shift usage.

2.6 Project achievements description– per group

The project aims and achievements of each community organisation are outlined below:

2.6.1 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 Technologies (LCT's) 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.

2.6.2 Exeter Community Energy Ltd

Exeter Community Energy (ECOE) aimed to engage with the OpenLV Project by developing a smart phone app for their local community using the OpenLV 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 assumed that by enabling people to see when local renewable energy is being generated they would choose 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 OpenLV 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).

2.6.3 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 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.

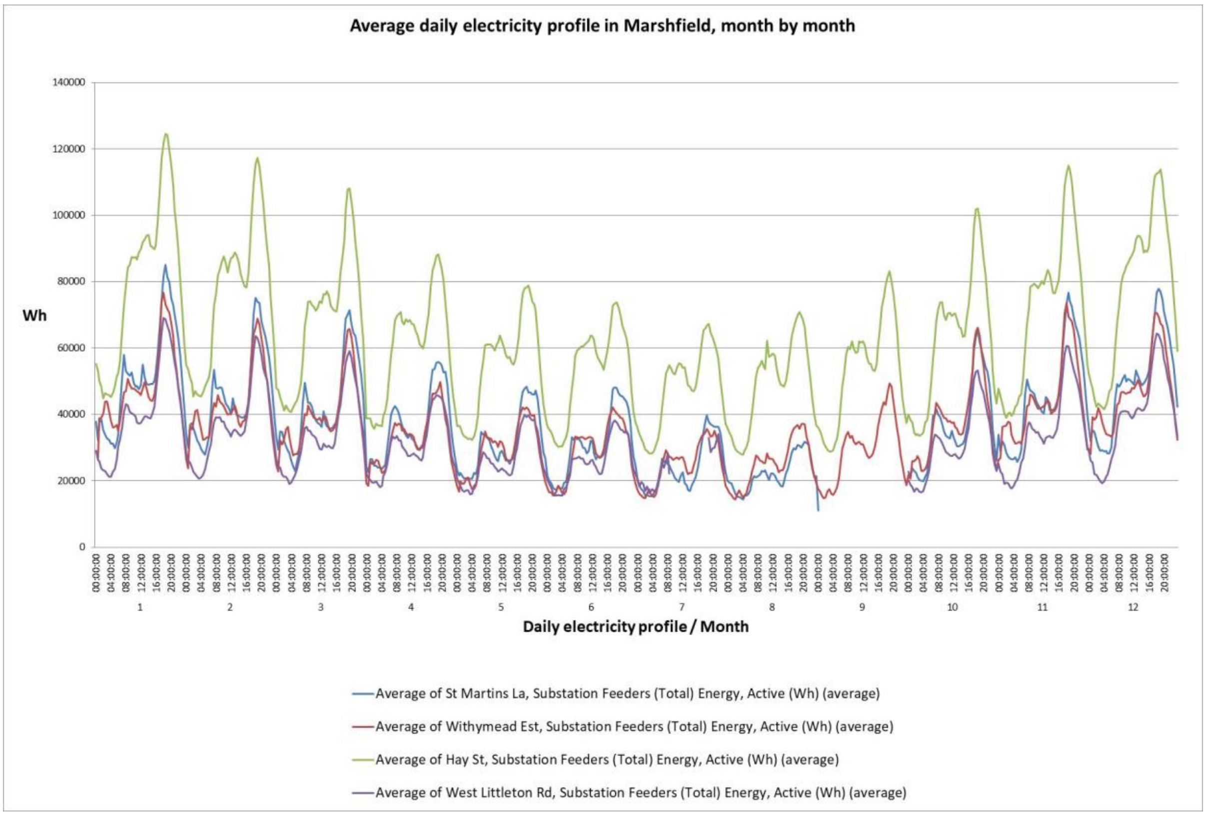


Figure 5: Daily electricity profile (month by month) for Marshfield village

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).

2.6.4 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 API to download and work with JSON files, and have found the data useful in supporting their funding applications (some of which are still pending). They 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.

2.6.5 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.

2.6.6 Tamar Energy Community

Tamar Energy Community (TEC) have been using OpenLV 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 OpenLV 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.

2.6.7 whg

whg housing association was selected to participate in the trials to use the OpenLV data for two main purposes. Firstly, to support behaviour 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.

2.6.8 Yealm Community Energy, Yealm, South Devon

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.

2.6.9 How community groups used data

The table below summarises the way that community organisations participating in the project used OpenLV data.

Table 2: Summary of Method 2 uses of LV network data

Community benefit	Examples of intended outcomes	How OpenLV data was used to facilitate local projects
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

Community benefit	Examples of intended outcomes	How OpenLV data was used to facilitate local projects
		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.
Transparency helps local 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 for energy or developments.	• Taking more control / starting up new community schemes (e.g. exploring Time of Use Tariffs 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 (& indirectly reduces 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

Community benefit	Examples of intended outcomes	How OpenLV data was used to facilitate local projects
		move to more electrification of heat • BWCE would like to use the PV estimation tool to see where EV charging points could be installed
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.

2.7 Benefits to DNO's of engaging with community organisations

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.

2.7.1 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.

2.7.2 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

2.7.3 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.

2.7.4 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.

2.7.5 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.

2.7.6 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

2.7.7 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.

2.7.8 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.

Owen Square used OpenLV data to formulate bids for funding of their energy co-operative.

2.8 Key findings – Community engagement

Recruitment and engagement of community organisation:

- There was a high level of interest from communities in using electricity data in local projects
- The technical nature of the project and the lack of funding to participate were seen as barriers to housing associations and parish councils. This was circumvented to an extent by provision of a community energy app by the OpenLV Project that was then shared with communities. It was also noted that communities were rarely able to contextualise the network capacity information. One respondent explained that what they really needed was “something with the complexity of an emoji” to indicate when the network was full up
- 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 applying to the trials

- Memorandum of Understandings and named person as the 'point of contact' at CSE worked well
- Selection of substations for communities was more complicated than originally anticipated. This was partly because neighbourhood boundaries do not generally match areas served by individual substations
- Feeder maps were identified as a useful resource for community energy groups
- Use of lengthy data sharing agreements was perceived as a deterrent

Project Delivery:

- Community development work takes time which needs to be factored into projects appropriately
- Logic models were a useful project management tool to help clarify ideas and track progress
- Identified project support needs changed during the project

Using LV data

- 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", rather a conversation opener or enabler
- Relatable narratives can help to explain the data and use it to maximise local impact

Delivery and use of community web app

- A more limited set of data points would have been sufficient to meet 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 overestimated in the application phase of the project
- Additional training and networking opportunities would have been useful to trial participants

Recommendations for future 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 (for example avoid the summer vacation period or Christmas when volunteers are likely to be preoccupied), 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 sharing agreement
- Ensure a memorandum of understanding 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
- Neighbourhoods do not generally correlate with substation maps, because of this, 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

2.9 Value and benefits assessment

Using the findings described above, and the outlined Methodology in Section 2.5 above an initial overview of the quantitative value that access to the OpenLV data provided is below. This will be expanded in SDRC 5 where the results of a cost benefit analysis undertaken of this Method will be reviewed.

2.9.1 Transparency value

Communities having access to OpenLV data means they can identify opportunities, assess and evaluate plans for distribution connected projects and investments.

Description of value

Two communities (Owen Square and Marshfield) had anticipated using the data as a planning tool for new demand or generation in their communities. Both organisations have on-going work plans that extend beyond the trial period. However, they have both made progress through the trial and have used the data to inform future plans.

The trials have therefore successfully demonstrated that, for the more sophisticated community or commercial organisations**, the OpenLV data provided an important insight into the functioning of the local electricity network**. They reported that an appreciation of the data meant they were better able to understand the local network and where there might be potential to invest, for example in new homes, EV chargers or renewable energy.

Owen Square felt that by **making this information transparent** for their substation (and others) it would help them identifying where network capacity might support their plans to increase electrification of heat more easily, reducing planning time. This value case implies a cost saving for both community energy organisations (who would avoid work in areas that were not suitable), and for WPD who would avoid having to responding to requests about unsuitable areas.

Although primarily interested in engaging their residents, housing association Rooftop, felt that **the information from substations would be increasingly useful to make decisions about where to put new homes and which technologies they would install in new housing developments**. Rooftop is, where possible, looking to electrify heat in new homes and include EV charging points. They noted they would also welcome a tool to help them identify where there was more substation capacity available to build additional housing on their existing estates or to build higher density housing[1].

BWCE community energy also felt the information from OpenLV provided some value for where they might be able to locate new generation assets but cautioned that there also needed to be more detailed contextual information available about constraints, substation capacity and network availability at the lower voltage levels. They noted that the WPD website currently had this information but only at 33kV voltage level and not the substation level explored in the OpenLV trial

[1] NB: This tool is currently available for primary substations but not secondary substations.

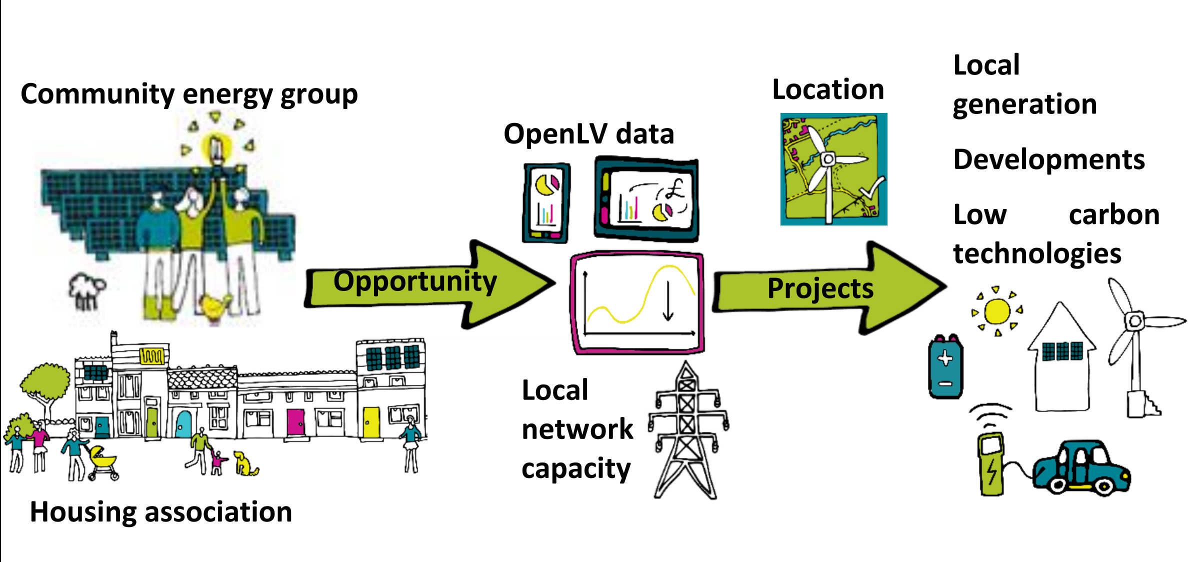


Figure 7: Transparency value from substation data

Summary of final interviews

The seven trial participants were asked to rate a series of statements between 1 (strongly disagree) and 5 (completely agree) and give reasons for their responses. The results to the questions about the transparency value case are shown in the Table 3.

Table 3: Average scores on transparency value

Transparency value case	Average score (1-5)
Using the data from the OpenLV unit (accessed via the OpenLV app) makes it easier to understand how the local electricity infrastructure is set up and how much electricity is used.	4.3
The data (from one or more substations) can help communities plan where to locate future demand or generation	2.9
Community energy organisations will require support from DNOs to fully understand what the OpenLV data is revealing	3.4

The interviews showed that most communities agreed that OpenLV provided important background information about local electricity networks. However, the responses were more split when asked specifically about how OpenLV could help them plan future for demand or generation.

In their responses this score reflected that the OpenLV data was only one, albeit important, element of the information they needed to make a siting or technology investment decision.

The results also showed that communities felt they needed a level of support from DNOs or project partners to understand what the data was telling them. It was noted that in many communities the level of support needed will vary depending on the skills and experience of the volunteers. The participants agreed that most communities would require basic support to understand the information they were being given and how to process it.

2.9.2 Engagement value

OpenLV data helps build community knowledge on energy use and energy infrastructure.

Description of value

The trials successfully demonstrated the potential for substation data to provide locally relevant and engaging information for communities on electricity use and the network. The data was found to be particularly valuable to community energy groups, because it shows people how they are connected as a community and how people share the local electricity network assets. Marshfield noted that what attracted most interest from its community was the substation feeder map, as people were naturally interested in where they fitted into the network [4].

The data provided by the OpenLV Project differs from most of the other available data about electricity and energy use which provides information about either national trends or individual households. **This community level information therefore has significant potential to be used to interest and engage people who are naturally interested in their local community, but not specifically interested in energy**.

For community energy organisations, using this information as part of their engagement toolkits provided them with a source of valuable information including local profiles of usage (when a peak might occur) and facts about the community (who is connected to which substation) that they felt made conversations with households easier, more productive and potentially less time consuming.

Tamar Energy Community (TEC) noted in their final interview that the information was **a useful conversation starter** for households (though further conversations could still be difficult) but that being able to show local peaks helped people understand the idea of time-of-use-tariff and, by implication, the need for smart charging or other appliances.

An unexpected benefit to TEC was the project and data also helped build a more sophisticated understanding of local electricity networks within the community organisation itself. It has been consistently proven that having a community group as a messenger of information gets a significantly higher response. It is therefore inherently valuable for these community energy organisations to have a more detailed knowledge of the challenges of the energy transition and implications for local infrastructure.

Furthermore, the idea that people can take energy actions in order to help their local community has been found to be more effective in encouraging people to change behaviour than other motivators. For example, the Scottish and Southern Electricity Network's (SSEN) Solent Achieving Value from Energy Efficiency (SAVE) project tested energy efficiency, demand reduction and shifting with Time-of-use-tariffs to defer network upgrades. They found that community engagement with the message of being part of a caring, connected community, rather than saving money or the planet, led to a reduction in peak demand on the local substation [5].

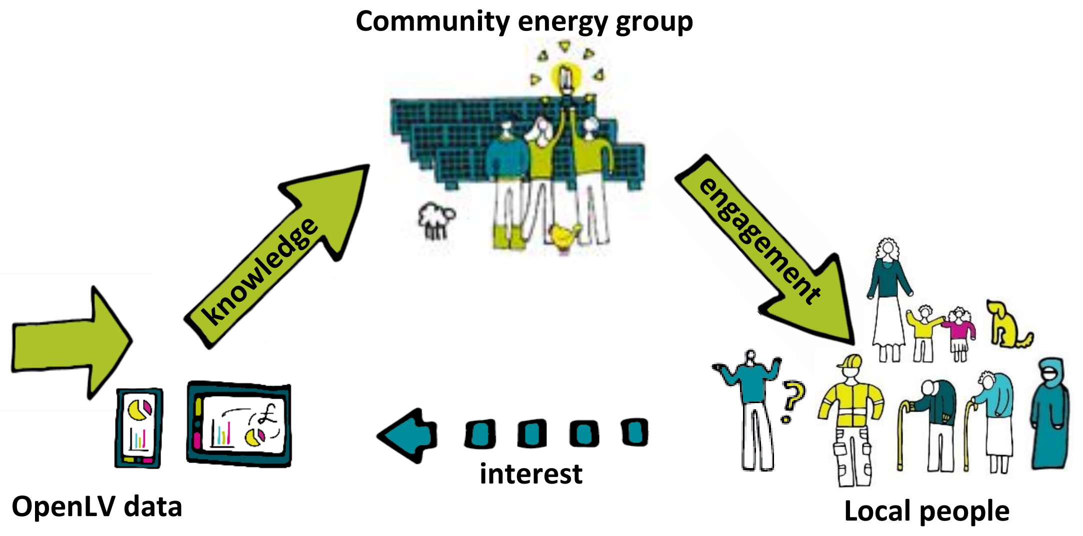


Figure 8: Community energy organisations using OpenLV as an engagement tool

Summary of final interviews

In the final interview, the seven trial projects were asked to rate a series of statements between 1 (strongly disagree) and 5 (completely agree) and give reasons for their responses. These results to the questions about the engagement value case are shown in Table 4.

Table 4 Average scores engagement value

Engagement value case	Average score (1-5)
Local substation data is an important source of information for community energy organisations	4.1
Local substation data helps people understand broader climate and energy issues – low carbon transitions	3.8
Local substation data helps people understand the needs of the local electricity infrastructure and network	4.1
Local substation data helps people accept the need for smart appliances (including smart meters and smart EV charging)	3.1
Encourages people to switch to the time-of-use tariff	3.9

The responses showed that communities all agreed that the OpenLV information was valuable for them and noted that it was particularly useful for engagement because the information was locally relevant and tangible.

They felt that this helped people understand the needs of the local network and in some instances, helped conversations about responding to climate change.

Rooftop noted that the data itself doesn't communicate directly and so any OpenLV data for residents or communities will need to be supplemented with a robust engagement strategy as it was the use and context of the data in messaging, meetings or house calls – that changed understanding or encouraged actions such as switching or changing use profiles.

2.9.3 Flexibility value

OpenLV data and functionality supports community level aggregation and coordination of community level demand-side response.

Description of value

OpenLV could enable communities to realise value (e.g. payments from DNO) from taking collective community level action to changing the profile of electricity usage at a substation or a combination of substations. This third value case for communities is an area which remains, at present, in nascent form of commercially viable.

The OpenLV information and functionality opens up significant potential for the substation to act as a community aggregator and to remotely prompt actions by users under a particular substation. This would be with the objective to change or manipulate their aggregated usage in response to local network conditions. Bath and West Community Energy used OpenLV data as part of their Solar Streets project and aimed to measure the impact of domestic PV and battery installations on the local substation. They also wanted to use it to build a business case for further installations and understand what flexibility services the community might be able to provide.

As part of their trial they hoped to run two demand reduction and shifting campaign months. Unfortunately, due to delays installing the PV and battery technology these campaigns were not run before the end of the official OpenLV trial period in October 2019.

The whg trial (which was discontinued due to staff changes) was also expected to show a community impact on the substation. All housing association residents were connected to electric storage heaters in one tower block. The OpenLV monitoring data showed a very significant 2am usage peak in the winter due to storage heaters turning on to benefit from the economy 7 tariff. Figure 9 shows a peak electrical load on this substation which is around four times higher than typical non-heating day. As a result, it is clear that the profile of electrical heat will have a clear and recognisable impact on a local substation.

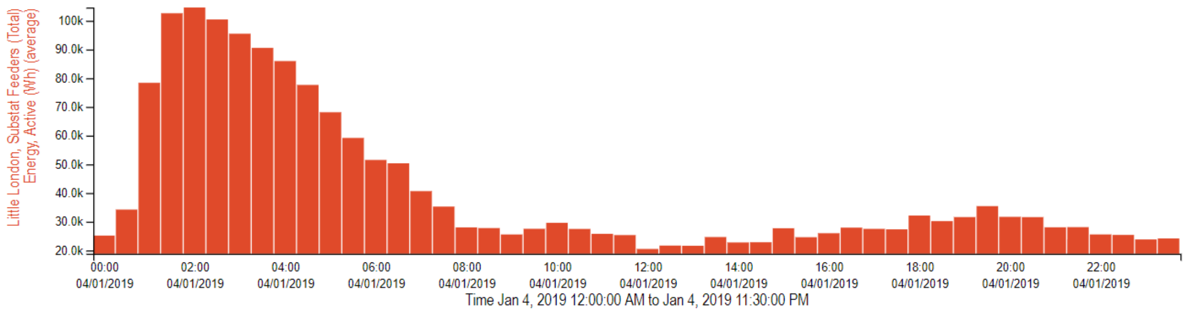


Figure 9: Energy use displayed on CSE App, whg Little London House - 4 January 2019

Substation level flexibility value to networks

Some communities connected to a substation, particularly those with larger flexible loads such as EVs, batteries or electric heating will be able to change their substation profile to a greater or lesser extent either through coordinated household action or automated smart technologies. This could open several potential sources of value for communities where investment may be avoided or delayed in a local substation or network for which the DSO may be willing (in the future) to make a payment. It needs to be noted however that this value is not necessarily new value but would instead be redistribution to communities of existing value created by savings assumed through contracting flexibility instead of more costly network investment.

The balancing of generation and supply at a local level has the potential to reduce pressure further up the network by increasing or reducing demand at times when the network is under stress. This will become more important as the levels of disruptive demand from heating and transport increase along with further growth in distribution renewable generation as the UK transitions towards net-zero. Two flexibility payment examples are explored in Figure 10.

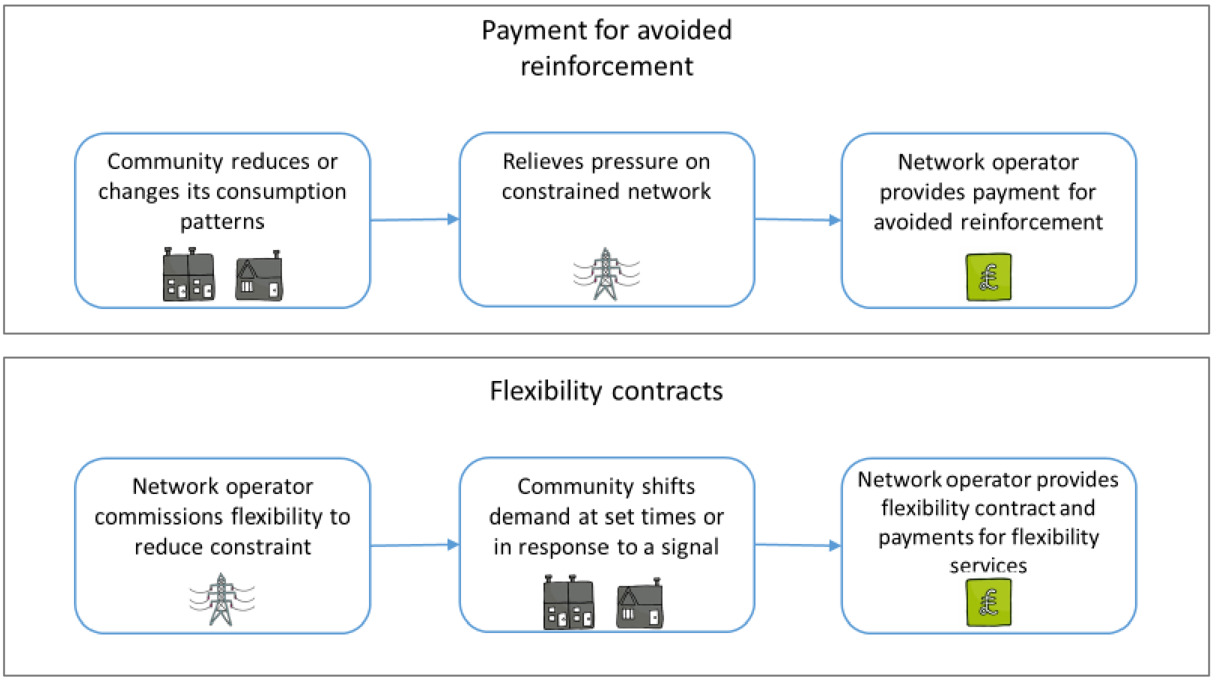


Figure 10. DNO payment potential for community flexibility

Cost saving aggregation model

A further benefit of community aggregation would be cost saving against typical aggregation models. Aggregators are already exploring the potential for domestic demand response which involves each household having an individual contract and smart monitoring. However, monitoring substations instead of individual households could involve significantly less administration costs and lower barriers to participation. Those households wanting to participate on a basic level could just shift in response to signals, they would not need to switch suppliers, share data or require any administrative effort or investment.

This community DSR model would instead require both contracts and payments to be made at a community or substation level. By implication, this means payments would in part or in whole benefit a community fund or community organisation rather than the participating households.

The SAVE project suggests that this community element could in some cases provide a much higher motivation for households than individual payments. Where individual household payments may be relatively small, collectively across a substation they could provide a useful source of additional of revenue for community organisations, schools etc.

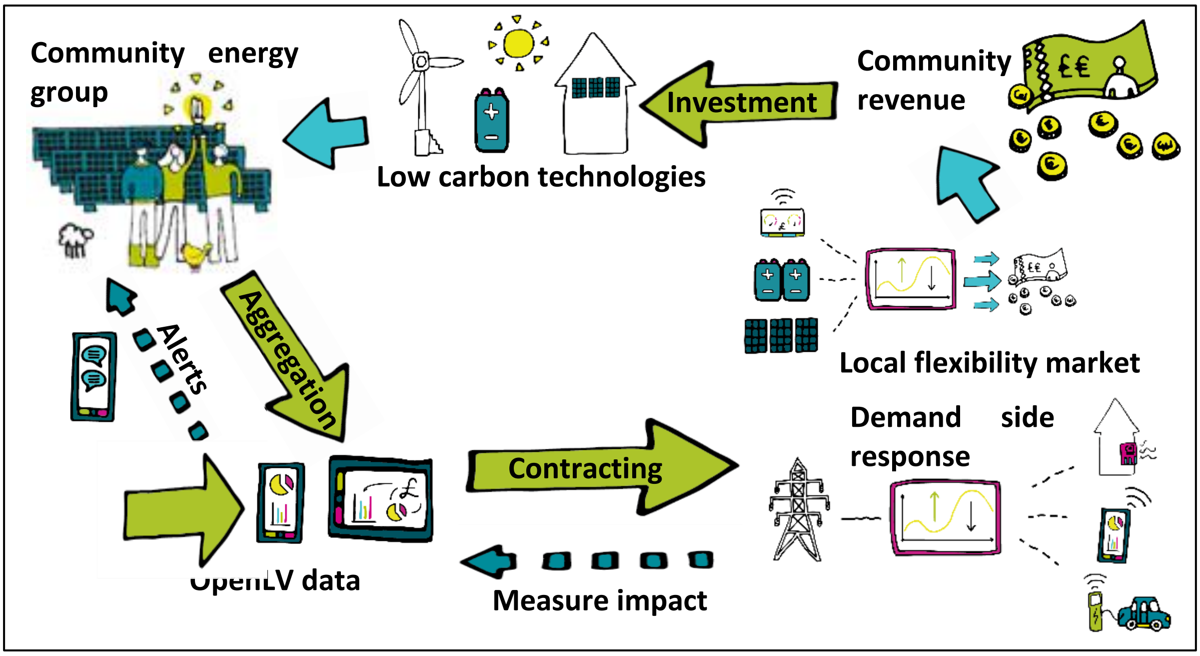


Figure 11: Flexibility value for local communities

Summary of final interviews

In the final interview the seven trial projects were asked to rate a series of statements between 1 (strongly disagree) and 5 (completely agree) and give reasons for their responses. These scores relating to the transparency value case are shown in Table 5.

Table 5: Average scores from flexibility value

Flexibility value case	Average score (1-5)
Accessing revenues by providing local network services to DNO	4.4
Switch timing of electricity demand to maximise use of local renewable generation (this would reduce carbon and/ or avoid curtailment)	4
Work with a new renewable generation project to share access to the network (creating cheaper connection charges)	3.8
Create a local electricity market contracts with local generation – local tariffs etc.	3.5

All the community energy organisations noted that they would be interested in developing demand side response or flexibility business models in the future.

Flexibility services provided to DNOs were the most popular and recognised as the closest to market.

Housing association Rooftop, however, felt that these business cases only related to more affluent areas with existing community energy organisations. However, they also noted that they were keen to sell their solar power to residents, but they understood the regulations did not allow this at present.

3 Conclusions

3.1 Method 2 – Community Engagement

3.1.1 Did OpenLV help engagement with communities?

OpenLV allowed DNO's to engage with communities via the following illustrative cases:

- Community groups have forged closer relationships with WPD via participation in the project. In particular, **Marshfield Energy Group** were able to communicate directly about outages that the village experienced (which were attributed to wildlife strikes on overhead lines) (see Section 2.6.3)
- Access to local data provided an excellent means to start conversations with residents about the energy system, the way that is evolving and saving energy (and money). **Tamar Energy Community** used the data in 'Eco Clubs' that it organised for to 10-year-old in its local junior school and **Rooftops Housing Association** used the data to start conversations about cost-efficient energy use (see Section 2.6.5 and 0)
- **Bath and West Community Energy**: 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 the future potential of selling aggregated flexibility services based on assets owned within a community

3.1.2 How did OpenLV community engagement support the uptake of LCT

Communities organisations participating in the OpenLV Project were principally able to support the uptake of LCTs in their project via the following means, described in Section 3.

- The data from OpenLV was used by community groups to start conversations with their communities about renewable energy sources. **Tamar Energy Community** were able to do this at their 'Eco Club' at the local junior school. **Yealm Community Energy** used the data to help promote their ownership of a local solar farm (see Section 2.6.8)
- **Marshfield Energy Group** developed a village-wide energy strategy based on analysis of OpenLV data that would allow them to pinpoint where in their village there is the potential to connect further renewable generation or EV chargers (see Section 2.6.3)
- **Rooftops Housing Association** suggested that having this type of data would help them identify where to site renewable schemes in the future (see Section2.6.5)

3.1.3 Outlining the routes communities can take to raise funding

Section 2.3 of this report provides an overview of potential funding routes available to community organisations:

- **Exeter Community Organisation**: Were able to secure in-kind funding worth £10,000 to fund the first stage of a smartphone app (see Section 2.6.2)

- **Owen Square Community Energy**: Used data provided via the project as an evidence base to support several funding applications (see Section 2.6.4)
- **Bath and West Community Energy**: Used their participation in the OpenLV Project to support their successful application for funding for the Solar Streets project (see Section 2.6.1)

3.1.4 What were the network benefits provided by community engagement?

Section 2.9 of this report provides an overview of network benefits that could be released by provided by DNO engagement with community organisations:

- **Bath and West Community Energy**: are monitoring integrated low carbon technologies installed by the group in their area, and combining it with substation data to determine substation impact, with a view to future selling aggregated flexibility services based on assets owned within a community
- **Tamar Energy Community** used the data in 'Eco Clubs' to educate the community on energy efficiency measures and **Rooftops Housing Association** used the data to drive cost-efficient energy use initiatives (see Section 2.6.5)
- **Marshfield Energy Group** developed a village-wide energy strategy based on analysis of OpenLV data that would allow them to pinpoint where, in their village, there is the potential to connect further renewable generation or EV chargers (see Section 2.6.3)
- **Rooftops Housing Association** suggested that having this type of data would help them identify where to site renewable schemes in the future (see Section2.4.3)

Making LV network data available to community groups has the potential to release network Flexibility value (see Section 2.9.3), Engagement value (see Section 2.9.2), and Transparency value (see Section 2.9.1), in the future.

3.2 Which LV networks can benefit from OpenLV and why?

The OpenLV network has shown distributed intelligence within 11kV/LV substations enables a diverse set of benefits cases. The specific benefits are dependent on either the structure of the network or alternatively the needs of customers connected to those networks.

Evidence from Method 2 shows that the ambitions of local communities can also inform of which networks would benefit from having an OpenLV platform, although it should be noted that these benefits extend from within the networks sector outwards across the energy sector. This means that any future cost-benefit analysis for the installation of any such units will need to have a perspective that is wider than cashflows within the electricity networks sector.

The next SDRC (SDRC 5) will investigate the costs and benefits of fitting OpenLV into substations onto the quantitative basis.

3.3 Next Steps

The next project deliverable will be SDRC 5 which considers the overall cost-benefit case of OpenLV and how it might be best employed to create industry value.

In addition to this next step, WPD has already announced that they are committed to maintaining the offer of community data by installing a number of EA Technology VisNet units that will be installed into substations.

3.4 Criterion Compliance

Table 6 provides a summary of the SDRC criterion that is expected for this milestone and where evidence is provided for its completion.

Table 6: SDRC Criterion & Evidence Compliance Matrix

Successful Delivery Reward Criterion	Section(s)
Sharing the level of capacity uplift achieved through Method 1	SDRC 4 – Method 1
Sharing which LV networks can benefit from OpenLV and why	SDRC 4 – Method 1
Establishing the level of capacity uplift that can be achieved in WPD's licence area and across GB	SDRC 4 – Method 1
Sharing how DNO's can engage with communities who want to become part of a smarter grid to exploit the open and flexible nature of OpenLV	Section 2
Sharing how community engagement supports the uptake of LCT	Section 2.7.3 Section 2.8
Outlining the routes communities can take to raise funding	Section 2.3
Sharing the network benefits provided by community engagement	Section 2.9
Sharing how DNOs can engage with companies (including non-energy companies) and academics to exploit the open and flexible nature of OpenLV	SDRC 4 – Method 3
Sharing how the Method facilitates non-traditional business models	SDRC 4 – Method 3

4 List of Annexes

1. Annex SDRC 4.A6: Learning Gained Engaging with Community Groups
   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.
2. Annex SDRC 4.A7: Value and Benefits Analysis
   This report analyses the benefits attributed to OpenLV as applicable to Community Group, compiled by Regen.
3. Annex SDRC 4.A8: Regen Mid-Trial Report 1
   This report focusses on initial project progress as well as community attributes and technology relevant to replication of trials with other communities.
4. Annex SDRC 4.A9: Regen Mid-Trial Report 2
   This report focusses on a mid-point evaluation of learning and project outputs.
5. Annex SDRC 4.A10: Regen Mid-Trial Report 3
   This report focuses on engagement in the communities and lessons from how best to communicate substation information

5 References

[1] “OpenLV Project Website,” [Online]. Available: https://openlv.net/.

[2] Ofgem, “OpenLV - WPD's Project Directory,” [Online]. Available: https://www.westernpower.co.uk/downloads/2311.

[3] “UK Community Funding,” [Online]. Available: http://www.ukcommunityfoundations.org/our-network.

[4] “Marshfield Villag Network Map,” [Online]. Available: http://marshfieldclt.org/wp-content/uploads/2019/03/Marshfield-Village-Substation-and-Feeder-Map.pdf. [Accessed 24 October 2019].

[5] “SAVE Project Website,” SSEN, [Online]. Available: https://save-project.co.uk/. [Accessed 14 October 2019].