Open LV

Using data from your local substation

A guidebook for community organisations

About the OpenLV project

The OpenLV project trialled an innovative new open access software platform (LV-CAP™) designed so that calculations and decisions can be made locally. This speeds up reaction times and reduces the amount of data that needs to be sent to central servers. As well as investigating the impact of the system for electricity network operators, the project made data from local Low Voltage (LV) substations available to community organisations, businesses and academia. This allowed them to assess how it could be of benefit to them. The project, which was managed by EA Technology, took place across Western Power Distribution's (WPD's) licence areas.

OpenLV installed software platforms in 80 LV substations across the Midlands, the South West and South Wales. Ten of these platforms were dedicated for the use of community organisations. Seven community organisations were recruited to participate in the project (some community organisations needed more than one platform so they could receive data from multiple substations). LV-CAP™ devices were installed in their local substations and the groups were given access to their substation data via a webapp. The participating groups took part in regular feedback sessions, allowing the project team to capture learning from their experiences.

The project partners would like to thank the Centre for Sustainable Energy (CSE) and Regen for their invaluable input into this project. Much of this Guidebook is taken from a project deliverable created by Regen – we would like to acknowledge their assistance.

We would also like to thank the community organisations who participated in the OpenLV project. Their enthusiasm is inspiring, and the feedback they provided has been crucial.

This Guidebook is based on the experiences of the seven community organisations that participated in OpenLV. They are all based in WPD's licence areas so many resources mentioned are those that WPD made available. Most Distribution Network Operators (DNOs) will have equivalent information available. We hope that this guide will be helpful to community organisations across Great Britain who are interested in participating in similar schemes.

www.openlv.net

A Changing Energy System

Our energy system is changing rapidly as we work towards a net zero carbon future. Electricity generation is increasingly renewable and has become more decentralised. Over the coming decade we expect to see more Low Carbon Technologies (LCTs), such as electric vehicles and heat pumps, that will place new demands on local low voltage (LV) networks. Network operators are already developing the tools to more actively and intelligently manage the network to maintain resilient supply and to minimise energy costs.

Energy data can support community engagement and actions to address issues from climate change to fuel poverty. Consumers and communities can help to manage their local network with behavioural changes around their energy use and by taking advantage of local energy generation. This is where substation information becomes especially useful. Equipped with this kind of information, community groups are ideally placed to engage with local audiences.

Understanding the LV network

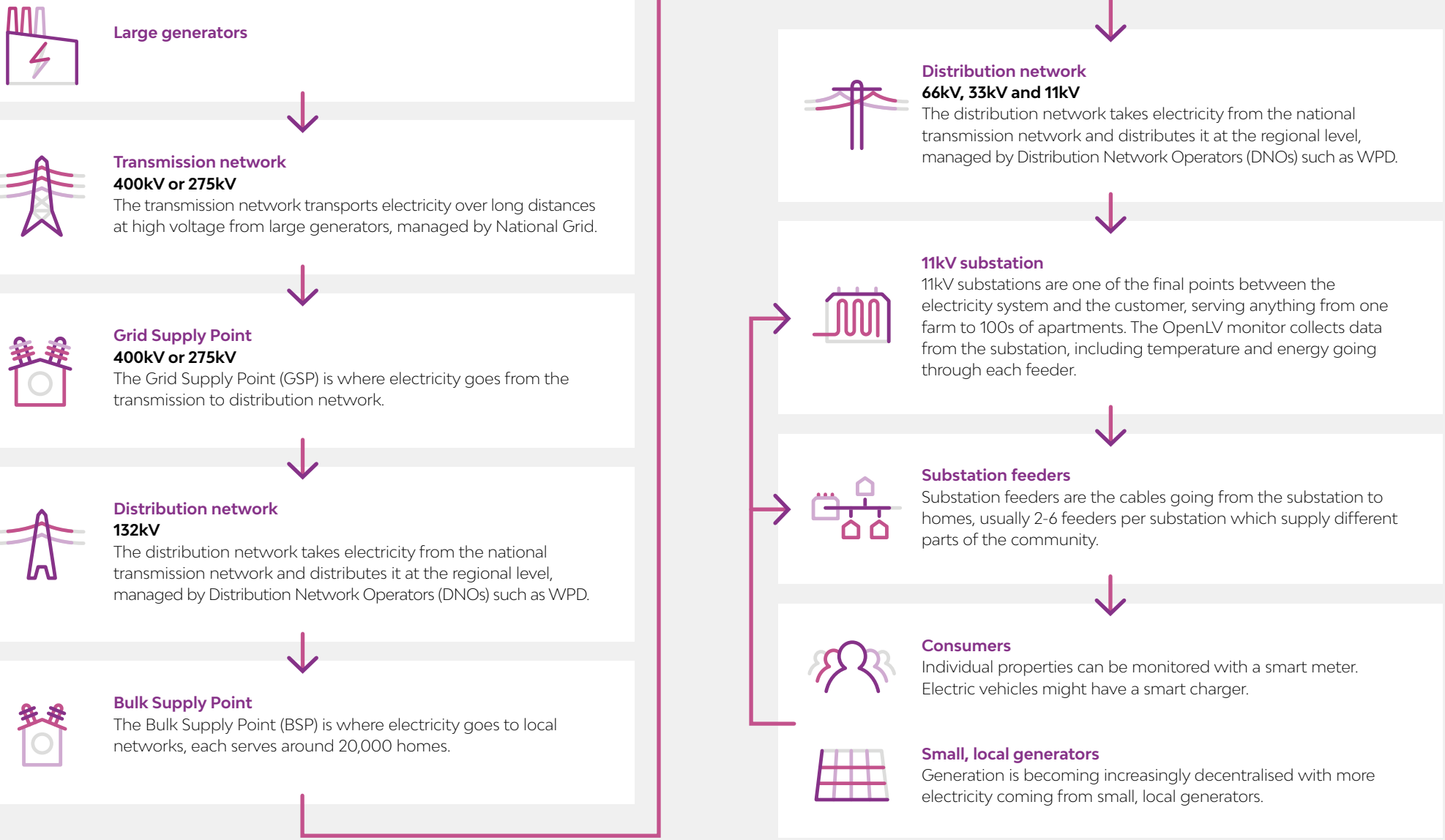
Low voltage electricity substations make up a key part of the local distribution network which delivers electricity from the grid into UK homes, public buildings and businesses.

LV substations typically serve tens to hundreds of consumer properties, although in rural areas especially, they may serve single farms or hamlets. Most substations also have several different 'feeders' coming from the substation which supply electricity to different sets of customers at a street level.

To understand the electricity flows at the local substation level, each substation selected for the trial was fitted with an OpenLV monitoring unit. Each OpenLV unit had hardware and sensors that monitored energy flows and other related activity, and brought this information together onto a software platform that analysed and displayed key data, such as electricity demand and transformer temperature (which is a measure of how hard the substation is working).

A website application, developed by the Centre for Sustainable Energy (CSE), processed and displayed the substation data in combination with other information such as data on the carbon intensity of electricity.

Figure 1 Illustration of the electricity supply network and substation monitoring



Using the substation data to tell a story

Most of the community organisations in the trials reported that substation data was useful in helping to engage people in energy issues. The data and information showed how homes were connected on the network as part of an energy community, and how people share use of the local electricity network assets. This shared use case was the most common and immediate way community energy organisations used substation data.

Community groups reported that much of the existing information about energy and carbon emissions was using national trends, or information limited to individual households. Therefore using local network data could provide village or street level information to start conversations with people who are interested in their local community, but not specifically interested in energy.

In some communities, conversations centred on local profiles of usage (when peak demand might typically occur) and interesting facts about the community (who is connected to which substation and how this might reflect the historic building pattern of the neighbourhood).

For example, being able to illustrate local peaks in electricity usage helped people understand the advantage of time of use tariffs, and therefore the need for smarter or off-peak charging for electric vehicles.

Figure 2 on the following pages shows the steps to develop a model around this engagement, once a community group has access to substation data and knows which parts of the community the data is coming from.

How the webapp supports this shared use case

The webapp collects and processes several useful bits of information for local communities; this data supports community engagement, including:

Data Collected	Webapp usage
Active energy	Active energy (Wh) shows the net amount of electricity being used (demand minus generation), one of the most useful substation measurements used by trial participants.
Active power	Active power (W) is the power being used, or the rate of energy transfer at a moment in time (Voltage x Current). The webapp can display average power and the maximum power in a half hour period.
Electricity cost	The webapp multiplies active energy by a unit rate for electricity set by the user to show electricity cost (£). This estimates spending on electricity at substation or feeder level, which can then be turned into an average household spend for a community.

Presenting the information

Examples of how communities used substation data for local engagement included:

- **Tamar Energy Community** (TEC) presented OpenLV data in Eco Clubs at the local school to teach schoolchildren about energy and the link between the electricity they use at home and climate change. TEC also used substation data when door-knocking in the community to start conversations around local generation, energy bills and decarbonisation.
- **Rooftop Housing Group** spoke to housing association residents about energy use, lowering their energy bills and encouraged energy efficiency. They held a community event early in the project to raise awareness of local energy issues.
- **Exeter Community Energy** (ECOE) received in-kind funding to develop a smart phone app for residents to measure their individual electricity use relative to others in the local community. Users could then enter a competition to score points for energy saving.

There are many ways to present information in the webapp. For example, **Figure 3** shows energy use each day added together for the four different feeders at one substation in Bristol during 2019. This effectively shows the difference between summer and winter electricity usage. The lowest usage was during July and August and the highest usage in winter reached around 40% above the summer.

Figure 2 Steps to successfully engaging the community and telling a story around electricity using local substation data

Using substation data to tell a story about electricity

1 Community energy organisation accesses substation data

Work out which local substations you want to monitor	Apply by getting in touch with your DNO or visiting the **CSE website**[1]	When your application is successful, go to the webapp to set up graphs for your community

2 Understand the existing knowledge and engagement with energy in the community

Find out which homes are connected to substations being monitored	Send out a householders' survey about energy to the local community	Hold an engagement event to tell people about your project and answer questions

3 Develop engagement objective – e.g. number of people using an app, households shifting energy use

Review current engagement in energy issues in the community	Decide the story you want to tell about electricity to get people interested	Decide how many people you want to engage and how you'll measure it

4 Develop an engagement strategy, including messaging to be used and how to spread the word

Look at best practice for talking to people about energy, including OpenLV case studies	Use a range of engagement techniques – online, by post and face-to-face events	Reach as many people in the community as you can

5 Measure and evaluate to understand the impact of engagement – e.g. event feedback, app statistics

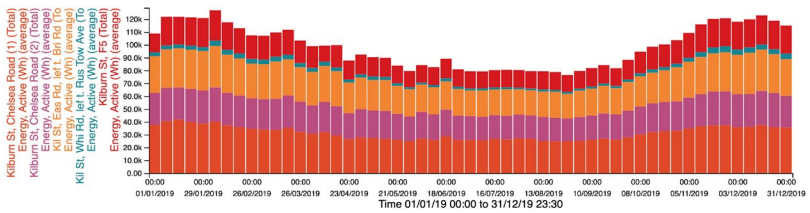
Review webapp statistics to see how many people are looking at the data or setting up alerts	Gather feedback on your engagement at events and with online surveys

6 Review your engagement and potentially extend objectives

Assess how many people engaged with the project and how successfully you told a story about electricity	Decide on next steps – to advance with your community engagement or tell a different story around local energy

[1] *https://www.cse.org.uk*

Figure 3 Energy use over a year in Bristol



Learning from trial communities

The community projects used a variety of engagement techniques to reach as many people as possible in their community, including websites, newsletters, emails, door-knocking and events. They reported the following learning points:

- It is useful to have or create a recognisable brand or presence in the community. This was reported by groups who identified their familiarity in the community as benefiting their engagement.
- The passion of early adopters and energy enthusiasts helps to engage others – utilise this as early as possible as it is challenging to maintain momentum using project leaders alone.
- Conduct a variety of events and activities to capture a larger audience, build interest and maintain momentum. For example, groups have organised:
  - Door-knocking of local households by knowledgeable volunteers to raise awareness and help people understand the data's relevance to them
  - Engaging through existing clubs or organisations (e.g. schools)
  - Providing information flyers for households
  - Having a presence or stand at local community events
  - Conducting surveys to gather information on energy understanding and use.
- Maintaining momentum is important. One group was impacted by delays outside their control and experienced reduced motivation within the community as a result.

- A school provides a useful point for engagement. A group used their school's Eco Clubs to introduce children to energy concepts, such as the link between the electricity you use in your house and climate change, and the purpose of solar panels on the school roof. They encouraged schoolchildren to go home and have conversations with their family about energy use, which built the trust and familiarity of the group in the local community.
- Locally relevant information in the webapp makes energy more interesting to people and facilitates new conversations. After presenting graphs at the local show, one group reported that several people were interested in the potential for developing domestic demand-side response platforms in the future, particularly with EVs.

Case Study 1: Tamar Energy Community

Tamar Energy Community (TEC) used OpenLV data as part of their 'The Power in Your Hands' project to engage their community in energy issues and influence their energy behaviour. To do this, TEC ran educational after-school 'Eco Clubs' in the local junior school to teach children about concepts such as carbon emissions, climate change and the importance of how we use energy. In their weekly Eco Clubs, TEC showed graphs and smiley faces of energy data to introduce schoolchildren to their projects, so they could go home and talk to their family about it.

TEC set up a dedicated workstream with its own branding, *'The Power in Your Hands'*, to promote the OpenLV project locally. The messaging used in TEC's project focused on understanding how the electricity system is changing and what this means for consumers: *"The Power in Your Hands is a ground-breaking project looking at how energy networks could be managed better in the future... We all have the opportunity to make a difference to our energy network... you could help shape it for the future."*

TEC engaged the wider community, by going out door-knocking, sending out an online householders survey on energy use, embedding OpenLV graphs in their website and hosting drop-in sessions to introduce people to the project and answer any questions about local energy. TEC also worked towards developing their own app with the help of a software engineer in their community.

The OpenLV app helped the community to better understand local energy challenges and concepts such as local flexibility, as well as being used by residents and schoolchildren to start conversations about energy issues. With this deeper understanding of their local electricity network, TEC were able to build a closer relationship with their DNO and develop new project ideas.

Figure 4 Tamar Energy Community promoting 'The Power in Your Hands' project at the local school

View more case studies: *https://openlv.net/case-studies*

Using the data to plan for more Low Carbon Technology (LCT)

LV substation data gives communities an insight into the functioning and performance of the local electricity network. This could help organisations that are planning to develop new LCT projects to see if there might be network issues – such as a lack of local network capacity – in their area.

While some network operators already provide an overview 'heat map' of local network constraints, such as WPD's Network Capacity Map: *https://www.westernpower.co.uk/our-network/network-capacity-map-application*, using OpenLV trial data allowed organisations to better appreciate what sort of additional low carbon technologies could be connected to the local network and where there might be potential to site them, for example, electric vehicle chargers or additional solar PV.

The webapp was also able to provide additional information on local renewable generation and graphically show how local demand could be matched with community-owned or local renewable generation, which could assist with the development of local energy supply models.

Figure 5 shows the process of using local substation data to try and overcome these barriers.

Planning new low carbon technologies

Installing new low carbon technologies is a core goal of many community energy organisations. Some of the groups involved in the OpenLV trial used the data to plan and build a business case for new installations.

- **Owen Square Community Energy** included 'current' and 'active energy' data in funding applications for a low carbon heat project. The community group used the data to show that there was capacity on the local network to take on more demand from electric heat (heat pumps), allowing installation without incurring network reinforcement costs.
- **Yealm Community Energy** combined OpenLV data with data gathered from energy data loggers installed in member's homes. This enabled them to demonstrate the link between domestic energy usage, substation activity and electricity generation at a local solar farm (Newton Ferrers).
- **Marshfield Energy Group** received data from multiple substations that fed their village. With this data they were able to investigate the best places to locate new low carbon technology such as EV charge points.

Figure 5 Steps to using local substation data to plan new low carbon technology schemes

Using substation data to plan new low carbon technologies

1 Community energy organisation accesses substation data

Work out which local substations you want to monitor	Apply by getting in touch with your DNO or visiting the **CSE website**[1]	When your application is successful, go to the webapp to set up graphs for your community

2 Collate information on local renewable generation and low carbon technologies in the community

Set up an online survey for people to tell you what household LCTs they have	Get local generation data from your DNO and local council	Cross check this information using tools such as Google Maps to see rooftop solar

3 Add direct generation data feeds into the webapp

Contact generation owners and operators to access live and historic generation data	Feed the live data into the webapp through an Application Programming Interface (API)

4 Estimate solar rooftop capacity and set up webapp

Use the data to see what headroom there is at the substation	Use Google Maps, householder surveys and DNO capacity data such as **WPD's network capacity map**[2]

5 Compare community consumption and generation over time

Get live and historic consumption data from the webapp and home smart meters	Set up graphs in the webapp to directly compare local generation and consumption

6 Identify opportunities for more renewable generation based on local data

Compare data on generation and consumption together with local network capacity	Identify viable opportunities for new generation	Contact your DNO to develop a new project – read the Connecting Community Energy Guide

[1] *https://www.cse.org.uk*
[2] *https://www.westernpower.co.uk/our-network/network-capacity-map-application*

How the CSE webapp supports this shared use case

The webapp collects and processes a number of useful bits of information for local communities; this data supports planning for new low carbon technologies including:

Data Collected	Webapp usage
Carbon intensity	Using the active energy data point, the webapp measures the carbon intensity (gCO_2) of energy being used from the grid at a given time, and estimates the grammes of CO_2 created for every Watt used. This data uses WPD's regional and national averages.
Renewable energy generation	Displaying local renewable energy generation data in the webapp was developed for four of the trial projects. Marshfield viewed electricity generation from PV on a community building, a wind turbine at the school, and estimated domestic PV generation on roofs in the village. Bath & West Community Energy had data from solar PV and battery installations, while Yealm Community Energy and Tamar Energy Community viewed output from large solar arrays close to the substations being monitored.

Presenting the information

The webapp allowed communities to compare regional carbon intensity with national or regional data so they were able to identify whether their area had a higher or lower carbon impact. **Figure 6** shows this comparison for electricity use in Bath on 15 October 2019. This shows that local carbon intensity was lower and much more variable than regional levels, illustrating the amount of renewable generation on that part of the distribution network.

Case Study 2: Rooftop Housing Group

Rooftop Housing Group were an OpenLV trial participant and are a charitable housing association who provide affordable housing to all household types and needs.

As part of their work to regenerate an estate in Bishops Cleeve, they used local electricity data to start conversations around energy and help residents in fuel poverty. They held an open event at the start of the project where they explained to residents the OpenLV project and why they were participating in the trial.

Information and graphics from the app were displayed in the Rooftop office in Bishops Cleeve and shared with residents, who could drop in and talk about energy issues. Rooftop also produced materials to share with the local school, supported by CSE.

In addition, Rooftop were interested in exploring whether there was potential to install solar rooftop generation to help generate electricity for their residents. They noted that the substation and local network information they received from the webapp would help them understand the potential to develop new homes in the area and what technologies they might be able to install in those homes, for example, solar PV, heat pumps or EV chargers.

Figure 6 Regional carbon intensity vs. national for Bath & West Community Energy

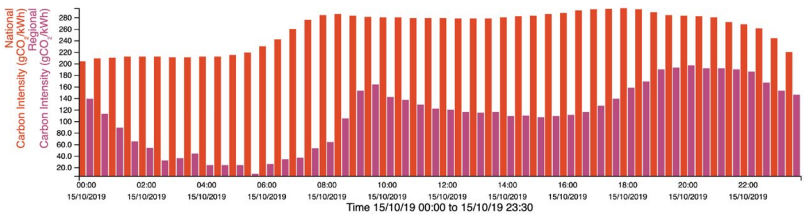
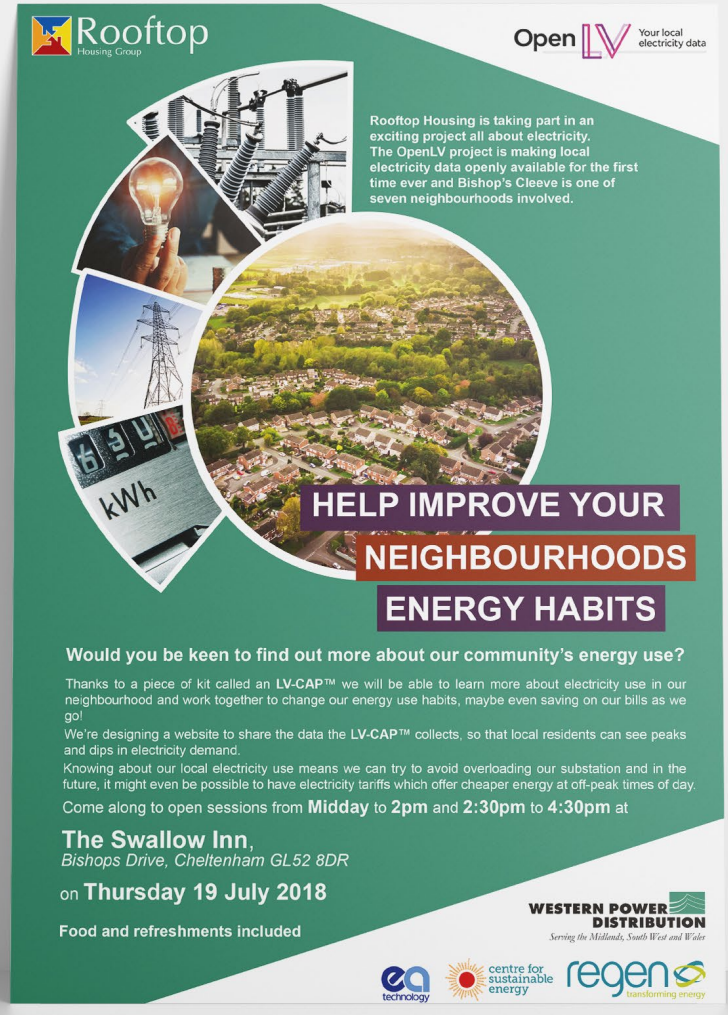


Figure 7 Rooftop's flyer to promote the project amongst residents



Exploring potential for revenue from network services

Some trial participants used the data to understand how they might be able to participate in providing flexibility services to the local network as an additional revenue stream.

As more heat and transport becomes electrictrified, householders and the community will be able to use flexible electricity demand to help manage the network and to potentially take advantage of lower cost electricity. In parts of the network which are experiencing constraints, such as those identified by network operators as part of their network planning, flexibility can be sold as a service – turning up or down electricity demand or generation – to help avoid or mitigate network issues.

In the future, coordinating collective community impact at a substation might motivate organisations or communities to change how and when they use electricity in order to respond to network need – and potentially be paid to provide those services to the local network. Having easy access to local substation data which shows exact electricity use will help to facilitate this.

Figure 8 shows how this can be done by a community, after accessing local substation data then developing a relationship with their DNO.

Figure 8 Steps to using local substation data to explore network service provision

Using substation data to explore network services

1

Community energy organisation accesses substation data

Work out which local substations you want to monitor

Apply by getting in touch with your DNO or visiting the **CSE website**[1]

When your application is successful, go to the webapp to set up graphs for your community

2

Understand existing network conditions and local constraints by engaging with the DNO

Use data to assess local substation headroom

Examine generation and demand capacity in your local area, for example via **WPD's network capacity map**[2]

3

Set up a contact group and willing community participants to trial energy behaviour change

Tell people in the community about the project and the logic of energy behaviour change

Find volunteers willing to trial changing their energy habits, with the help of community champions

4

Model a time of use tariff or flexibility contract and send alerts to participants to encourage Demand Side Response (DSR)

Model time of use tariffs on the webapp to tell people shifting energy use how much they could save on energy bills

Set up alerts on the webapp to tell people when they should use more or less energy, simulating a DNO call and response flexibility contract

5

Monitor responses and impact on the local network

Assess the community response to DSR nudges – how much have people changed their energy behaviour?

Look at data to assess the impact community DSR has had on the local network

6

In the future: Engage with DSR aggregators or bid in to DNO flexibility tenders

Investigate what local flexibility opportunities exist such as WPD's flexible power scheme

If you're in a part of the network where flexibility is needed, partner with an aggregator or look at an **Energy Community Aggregator Service (ECAS)**[3]

[1] *https://www.cse.org.uk*
[2] *https://www.westernpower.co.uk/our-network/network-capacity-map-application*
[3] *https://www.regen.co.uk/publications/local-flexibility-markets-guide*

Communities providing network services

Electricity demand can vary significantly during the day and be subject to considerable peaks and troughs in demand, both of which can induce stresses on the electricity network. **Figure 9** shows energy use at the Meavy Way substation in Tavistock (monitored for the Tamar Energy Community group) on 13 November 2019.

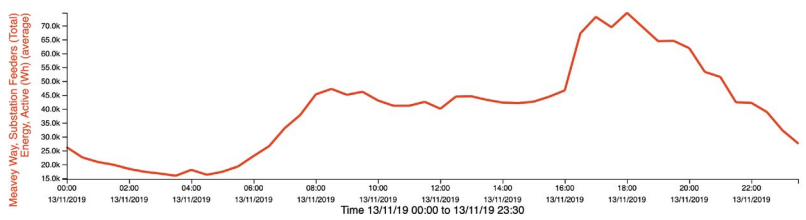
It illustrates a typical 24-hour profile including a significant evening peak. As more transport and heating becomes electrified, this evening peak is likely to rise. In some areas network operators may offer payments for consumers to be flexible in their energy use to offset this peak.

Bath & West Community Energy (BWCE) used data from their local substation to support a demand reduction campaign (months of June and October 2019) where they encouraged residents to be more energy efficient and 'turn down' their demand where possible, with the aim of measuring the impact on the substation. This campaign gave BWCE a clear indication of how much flexibility could be called upon in their community if they were to provide network services, bid into a DNO flexibility tender, or sign up with an aggregator.

How the CSE webapp supports this use case

The OpenV webapp can be used to set up alerts to be sent out to members of a community when certain conditions (related to the substation) are met

Figure 9 A typical winter day energy use at the Meavy Way substation in Tavistock



– simulating a call-and-response flexibility contract with a DNO, where the network operator would send out a call to the flexibility provider to modify their demand, generation or discharge for a financial reward.

Useful data streams for exploring flexibility and network services include:

Data Collected	Webapp usage
Current	The average current (A) value for a substation shows the transformer load. When combined with a temperature graph, this is a useful indicator of whether substations are experiencing stress – an important measure for some communities to determine whether the substation has capacity to take on extra load.
Substation temperature	Substation temperature (°C) measurements are recorded by the LV-CAP™ sensors and are a rough indicator of when the substation is under pressure. Several communities looked at the records for the ambient temperature, and that of the transformer oil, to determine if there were any periods when the substation seemed to be under particular stress.

Case Study 3: Bath & West Community Energy

Bath & West Community Energy (BWCE) used OpenLV data as part of their Solar Streets project. They wanted to measure the impact of domestic PV and battery systems they were installing in their community on the local substation and use the data to build a business case for further installations by understanding what services they could offer to the local network. BWCE also used the data to encourage behaviour change as part of two demand reduction and shifting campaign months during the project (June and October 2019), along with other campaign days, advertised in their newsletter.

As part of their community engagement, the substation data was used in conjunction with home energy monitors offered to residents, to see the impact of energy behaviour change on the local substation, in terms of cost and carbon savings.

BWCE ran drop-in sessions in the local pub, sent out newsletters and hosted community meetings as part of their project using substation data to engage local people in energy issues and help people better understand the energy system.

Figure 10 BWCE's newsletter to residents

Conclusions and next steps

The OpenLV project demonstrated some of the benefits for community energy organisations and housing associations from accessing local substation electricity data. Participating organisations found this data particularly useful for:

- Engaging community members and tenants in energy behaviour, getting people to think about their energy use and the role they have in the energy transition.
- Planning new projects involving low carbon technologies, and their impact on the local network.
- Exploring the potential to offer services to the network such as flexibility, and potential business models from this.
- Upskilling their own organisation by learning more about how their local electricity network operates.

There is now the opportunity for other organisations in WPD's licence areas, such as community energy groups, local authorities or housing associations, to access their own local electricity substation data. They should visit CSE's website for further information: *https://www.cse.org.uk/news/view/2421* Communities from outside WPD's licence areas should contact their own DNO for information on similar schemes.

Further reading and useful resources

Energy Networks Association (ENA) have created a useful guide with links to resources applicable across the UK. Connecting Community Energy – A Guide to getting a Network Connection: *https://www.energynetworks.org/assets/files/news/publications/1500108_ENA_WPD_guide_AW_110416.pdf*

The ENA website also provides connections to innovation and flexibility contacts at the UK DNOs: *https://www.energynetworks.org/electricity/futures/flexibility-in-great-britain.html*

CSE have also created a number of useful resources for community organisations including local councils, schools and community energy groups. These can be found at: *https://www.cse.org.uk/local-energy/resources*

Regen have created a number of publications that provide useful information for community organisations interested in energy issues. These can be found at: *https://www.regen.co.uk/publications*. Their national guides include:

- Rough Guide to Engaging Communities in Energy Network Innovation: *https://www.regen.co.uk/publications/rough-guide-to-engaging-communities-in-energy-network-innovation*
- Local Flexibility Markets Guide: *https://www.regen.co.uk/publications/local-flexibility-markets-guide*

UK Government statistical links can be found at: *https://www.gov.uk/environment/climate-change-energy*

WPD were the host DNO for the OpenLV project. Some resources that they have available are mentioned as examples throughout this Guide. They include:

- Network Capacity Map: *https://www.westernpower.co.uk/our-network/network-capacity-map*
- Network Flexibility Map: *https://www.westernpower.co.uk/network-flexibility-map*
- OpenLV project: *https://www.westernpower.co.uk/innovation*

Ofgem often have useful information on their website: *https://www.ofgem.gov.uk*

The OpenLV Team

EA Technology
www.eatechnology.com

Western Power Distribution
www.westernpower.co.uk

Project suppliers

Nortech
www.nortechonline.co.uk

CSE
www.cse.org.uk

Lucy Electric GridKey
www.lucyelectric.com

Regen
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