Local Energy Accelerating Net Zero

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Context

The UK Government has legislated to reduce its carbon emissions to net zero by 2050. Meeting this target will require significant decarbonisation and an increased demand upon the electricity network. Traditionally an increase in demand on the network would require network reinforcement. However, technology and the ability to balance demand on the system at different periods provides opportunities for new markets to be created and for new demand to be accommodated through a smarter, secure and more flexible network.

The future energy market offers the opportunity to create a decentralised energy system, supporting local renewable energy sources, and new markets that everyone can benefit from through providing flexibility services. To accommodate this change, Distribution Network Operators (DNOs) are changing to become Distribution System Operators (DSOs).

Project Local Energy Oxfordshire (LEO) is an important step in understanding how new markets can work and improving customer engagement. Project LEO is part funded via the Industrial Strategy Challenge Fund (ISCF) who set up a fund in 2018 of £102.5m for UK industry and research to develop systems that can support the global move to renewable energy called: Prospering From the Energy Revolution (PFER).

Project LEO is one of the most ambitious, wide-ranging, innovative and holistic smart grid trials ever conducted in the UK. LEO will improve our understanding of how opportunities can be maximised and unlocked from the transition to a smarter, flexible electricity system and how households, businesses and communities can realise the benefits. The increase in small-scale renewables and low-carbon technologies is creating opportunities for consumers to generate and sell electricity, store electricity using batteries and even for electric vehicles (EVs) to alleviate demand on the electricity system. To ensure the benefits of this are realised, Distribution Network Operators (DNO) like Scottish and Southern Electricity Networks (SSEN) are becoming Distribution System Operators (DSO).

Project LEO seeks to create the conditions that replicate the electricity system of the future to better understand these relationships and grow an evidence base that can inform how we manage the transition to a smarter electricity system. It will inform how DSOs function in the future, show how markets can be unlocked and supported, create new investment models for community engagement and support the development of a skilled community positioned to thrive and benefit from a smarter, responsive and flexible electricity network.

Project LEO brings together an exceptional group of stakeholders as Partners to deliver a common goal of creating a sustainable local energy system. This partnership represents the entire energy value chain in a compact and focused consortium and is further enhanced through global leading energy systems research brought by the University of Oxford and Oxford Brookes University consolidating multiple data sources and analysis tools to deliver a model for future local energy system mapping across all energy vectors.

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1 Introduction

In the original bid for Project Local Energy Oxfordshire (LEO),[1] the Low Carbon Hub committed to enabling communities and households to determine their energy future by taking part in 'hyperlocal' projects that could deliver flexibility services and also trade energy.

This companion piece provides more detailed cases studies of the six LEO Smart and Fair Neighbourhood (SFN) projects trials that did explore how Smart Community Energy Scheme (SCES)[2] business models can:

- sit at the heart of a smart, low carbon, locally balanced energy system; and
- create opportunities and benefits in an equitable and fair way for everyone.

A typology of SCES business models, with an escalating level of complexity and intensity, was developed together with a team that was at Origami Energy and is now at Baringa.[3] The Low Carbon Hub's aim was to make as much progress as we could in implementing Virtual Private Wire and Virtual MPAN business models, and then explore how these might then scale up into the Local Energy Services Company (LESCO) and Microgrid business models.[4]

Action at the grid edge is vital to achieving the UK's legally binding carbon targets and can deliver large amounts of local benefit at the same time. But how do we create new, repeatable and scalable ways of doing things, so that we can meet this urgent need for action and capture the benefits for our communities and our people? We are clear that place-based action on the energy transition needs to be carefully scaled, such that governance, planning and implementation happen at the appropriate geographic scale.

As part of LEO we worked with six communities to trial different flexibility services, right at the grid edge where the voltage steps down from primary to secondary substations and then down to the 240 volts that comes into each house and each business. Together with these local groups, we explored how smart technology and new commercial models can create opportunities in a local energy marketplace, including flexibility services. We also used the trials to help us understand how to do this in an equitable and fair way for everyone.[5]

Our aim in choosing a range of communities was so the trials would cover:

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[1] Note that all abbreviations are spelled out at the first mention in each section, then abbreviated. We also have included definitions of key concepts or terminology at the appropriate place. For key terms see also the online Project LEO glossary: https://project-leo.co.uk/glossary/.

[2] Low Carbon Hub defines this as: 'A collaborative scheme between energy system users who coordinate the way they consume, generate, and store electricity and manage their allocated capacity in the system to maximise the benefit to the community, other customers, the network and the system.'

[3] www.baringa.com/en/about/media-centre/baringa-bolsters-dso-consulting-arm/

[4] More details are in Section 2.1 of Project LEO report 'D3.10: Learning from the Smart and Fair Neighbourhood Trials', March 2023.

[5] See LEO report 'Developing an ethical framework for local energy approaches', November 2020. This video also gives a brief overview of all the SFNs, featuring participants: https://youtu.be/XwaEOyYs2Us.

- different socioeconomic contexts, for example: affluent or deprived areas; different type of predominant property tenure; existing and new developments; and urban versus rural areas
- various technological solutions, such as heat pumps, solar panels, batteries, electric vehicles and microgrids.[6]

As well as testing technical and commercial innovation, our SFN trials also aimed to help us better understand the social innovation that can lead to the development of a portfolio of successful energy service offerings. For example, we wanted to learn what sorts of benefits or returns, be they financial or otherwise, could motivate people to participate in the new energy system.

Our ultimate aim was to identify service offerings that are technically and commercially viable as well as socially desirable, as these will be crucial if grid-edge engagement is going to be unlocked successfully to enable the mass action that is needed in this low-voltage space for the transition to net zero. More about this aspect of the trials can be found in the second companion piece to D3.10, entitled 'Designing Smart and Fair Neighbourhood trials ethically', April 2023.

[6] A further project was added later to the five initial SFNs to fill a gap: Springfield Meadows, a new development of 25 'climate positive' households offering the possibility of developing at least a virtual MPAN and perhaps even a full microgrid.

2 Deddington and Duns Tew Heatsaver Smart and Fair Neighbourhood

Image 1: Members of Deddington Environment Network. Photo credit: Richard Cave.

2.1 About the area

- Deddington and Duns Tew are relatively affluent civil parishes in Oxfordshire with a combined population of circa 2,600. They are partially and completely off the gas grid, respectively. Many homes are heated by oil.
- Both have strong local sustainability groups grasping the challenge of what a zero-carbon future might look like for a rural community. They both joined Low Carbon Hub as community group members in recent years.
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2.2 What was trialled

The aim of this trial was to learn about the potential for flexible use of heat pumps to help enable a zero-carbon future for a rural, off-gas grid, community. We wanted to test whether the addition of flexibility services would be seen as beneficial by householders and communities, improving the uptake of this low carbon technology.

The key activity was to instal smart controls to new and existing heat pumps, to enable those pumps to take part in Project LEO flexibility trials. The key flexibility services to be delivered in this SFN were two Distribution Services Operator (DSO) ones, in this case Scottish and Southern Energy Networks (SSEN): Sustain – Peak Management and Sustain – Export Peak Management.[7]

2.3 Who was involved

Who	Steering group	Role(s)
Climate Action Deddington	Yes	Community lead – volunteer role
Sustainable Duns Tew	Yes	Community lead – volunteer role
Low Carbon Hub	Yes	Project management
PassivUK		Technology suppliers (smart controls for heat pumps)
Baringa		Energy and flexibility services consultants
Homeowners with (potentially) heat pumps		Participants in flexibility services trials

2.4 How the trial was developed and run

A key ethical principle was to support prospective participants to make choices appropriate to their homes and circumstances, in line with our 'Ethical Framework'.[8] So, we ran two webinars and attended outdoor only market events (due to Covid) to help potential participants understand if a heat pump is right for their home. The webinars and information for the events, namely one page explainer documents, where also sent out to other prospective participants who could not engage in these events.

Those who wanted to go further then received a free 'Whole House Plan' from Cosy Homes Oxfordshire[9] (usually priced at between £250–600) which details all the measures one could take to make the home as energy efficient as possible.

If the Cosy Homes assessment recommended an air source heat pump (ASHP) and the household decided to go ahead, they were offered additional support if they also signed up to take part in this SFN flexibility trial:

1. A £750 contribution to the Cosy Homes management fee was made to enable households to take part in the trial and install the heat pump.
2. The trial also paid for every participant to receive a PassivUK monitoring and control system which aims to operate an ASHP in an economical and comfortable way for the homeowner, who can also use the control system to unlock their ASHP's ability to deliver flexibility.
3. Once the control systems had been installed, Low Carbon Hub registered the ASHPs to be able to participate in delivery of services to SSEN via their DSO flexibility market, as part of

[7] For an explanation of the range of flexibility services, including Distribution Network Operator (DNO) ones – SSEN is a DNO – see https://project-leo.co.uk/the-context/flexibility-services/.
[8] LEO report 'Developing an ethical framework for local energy approaches', November 2020.
[9] https://cosyhomesoxfordshire.org/ – a partnership by Low Carbon Hub and Retrofit Works, aiming to make retrofit simple for the able-to-pay market in Oxfordshire.

Project LEO. A schedule was created for the ASHP and shared with the PassivUK system manually. PassivUK then controlled the heat pumps and provided Low Carbon Hub with the proof of delivery which was passed on to SSEN, with (a 20p-£1) payment was made for the delivery of the service as contracted.

Figure 1 shows a schematic of the flow of control from the heat pumps to delivering flexibility. In this scenario Low Carbon Hub is acting as a commercial aggregator, as it was in this SFN.

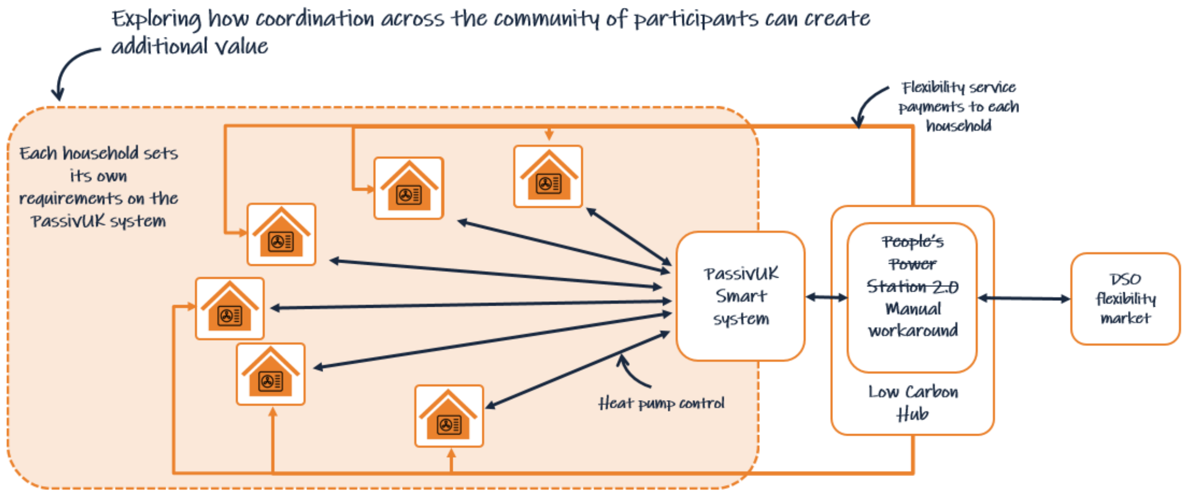

Figure 1: Deddington and Duns Tew Smart and Fair Neighbourhood, with Low Carbon Hub acting as a commercial aggregator of delivering flexibility

2.4.1 What worked well

- The communities were at the heart of how we designed and delivered the offer.
- The offer had mass appeal and lots of engagement: 88–90 people were engaged throughout the process from October 2020 to June 2022 and we did not lose community commitment despite issues with getting new ASHPs installed in the original target communities.
- The SFN achieved the technical objectives of the trial and delivered flexibility from heat pumps to the DSO and ESO, gathering useful data about value stacking and benefits to participants, though not necessarily through new instals in the original target off-gas communities.

2.4.2 What worked less well

- The high costs of retrofits that would have been needed to install heat pumps in the kind of properties in the two parishes, initially the focus of this SFN trial, proved to be a great barrier to uptake of the trial. On the flipside, this meant we acquired lots of learning through the adversities encountered.
- As few participants signed up in the Deddington and Duns Tew area, a wider geographic area, the whole of Oxfordshire, was targeted. At the same time, the SFN's scope was extended to homeowners with heat pumps already installed, to be able to deliver the technical aspects of the trial within the LEO timescales.
- PassivUK's control system only worked for heat pumps from two manufacturers, Grant and Samsung. This reduced the pool of already installed heat pumps the trial could utilise and

meant trial participants who were installing heat pumps were limited to only those specific manufacturers.

- Three contractors installed the control equipment. All had to do morethan initially expected, due to limited resource, expertise and perceived complexity of the control equipment.
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- Participant 2 had a small temperature window for comfort and so the heat pump had no flexible capacity for turn down, i.e. SPM (see Table 1).

2.5 Key results

- 88 people were engaged in the trial, responding to expressions of interest, surveys or accessing resources such as an air source heat pump FAQ (35 from the original Deddington and Duns Tew area, 53 from wider Oxfordshire)
- Cosy Homes Oxfordshire conducted 21 ‘Whole House Plans’, requiring £1,199,190 investment to implement fully, which would then result in 57.36 tonnes of CO_2 of identified potential carbon savings every year and £9,580 of potential savings on energy bills every year
- In total ten participants had eligible heat pumps across the whole trial: eight already installed and two being newly installed. Because of the LEO timeframes and challenges encountered in finding the resource and expertise needed to install the control system equipment, in the end three of these households received the smart controls.
- Three heat pumps successfully participated in two services from the newly created Distribution System Operator (DSO) flexibility market (see Table 1).

Outside Project LEO, but enabled by the smart technology installed as part of this SFN, one participant delivered around £28 of flexibility for the National Grid’s newly introduced Electricity System Operators Demand Flexibility Service between November and December 2023 whilst the temperature of the property stayed within their comfort range.

Participant	Date	DSO Service	Percentage delivered (%)	Flex amount (kW)	Price (£/kWh)	Revenue (£)
1	15-Nov	SPM	27	1	0.65	0.00
1	18-Nov	SPM	50	1	0.65	0.10
1	22-Nov	SEPM	169	1	0.85	0.85
2	15-Nov	SPM	2	1	0.65	0.00
2	18-Nov	SPM	4	1	0.65	0.00
2	22-Nov	SEPM	132	1	0.85	0.85
3	15-Nov	SPM	49	1	0.65	0.00
3	18-Nov	SPM	80	1	0.65	0.57
3	22-Nov	SEPM	330	1	0.85	0.85

Table 1: Heat pumps delivered Sustain – Peak Management (SPM) and Sustain – Export Peak Management (SEPM) flexibility services in LEO Transition trials

2.6 What we learned

1. Significant retrofit, such as improved insulation and new heaters, was required for off-gas properties that run on oil heating in Deddington and Duns Tew to switch to heat pumps. These additional costs proved to be a barrier to widespread adoption of heat pumps.
2. The 'Whole House Plan', to make the ASHP efficient recommended energy efficiency measures averaging £20k+ in costs. This prevented a significant number of participants from buying the ASHP and therefore enabling flexibility. By comparison, the upfront costs for an oil heating system are £2–3k.
3. To remove the number of barriers, and amount of work, involved in delivering flexibility from scratch, the value chain needs to be made more efficient. This might be achieved through the creation of a one-stop shop with efficient processes.
4. The PassivUK controlled ASHPs run at a constant low power (between 100–200W). This means that they are much better suited to turning up power (SEPM flexibility service) than turning down power, to deliver flexibility, as shown by the results of the trials.
5. Flexibility services can be delivered through ASHPs without impacting the quality of life of the residents, though it does depend on each individual's comfort zones when it comes to the temperature in their home.
6. Fulfilling the 'local convenor' role was resource-intensive: Low Carbon Hub had to correspond with prospective participants, Cosy Homes, ASHP installers, PassivUK system installers, all whilst communicating with participants to help them understand the trials and technology.

3 Osney Supercharge Smart and Fair Neighbourhood

3.1 About the area

- Community of c.300 densely developed Victorian terraces and modern flats; mainly affluent but with some social and private tenants.
- Some businesses are also sited on the island, with an Environment Agency site next door.
- The entire island is served by one secondary substation; there was already a community-owned hydro.
- The Victorian terraces are designated as a conservation area.

3.2 What was trialled

Overall, the aim was to see if the headroom on the grid behind a single secondary substation might be increased by a community of distributed energy resources (DERs, e.g. hydro, solar PV, battery storage) working together.

That involved testing whether domestic and community-scale batteries can deliver a network management service, as well as coordinated monitoring and visualisation of data from multiple smart meters and DERs (see Figure 2).

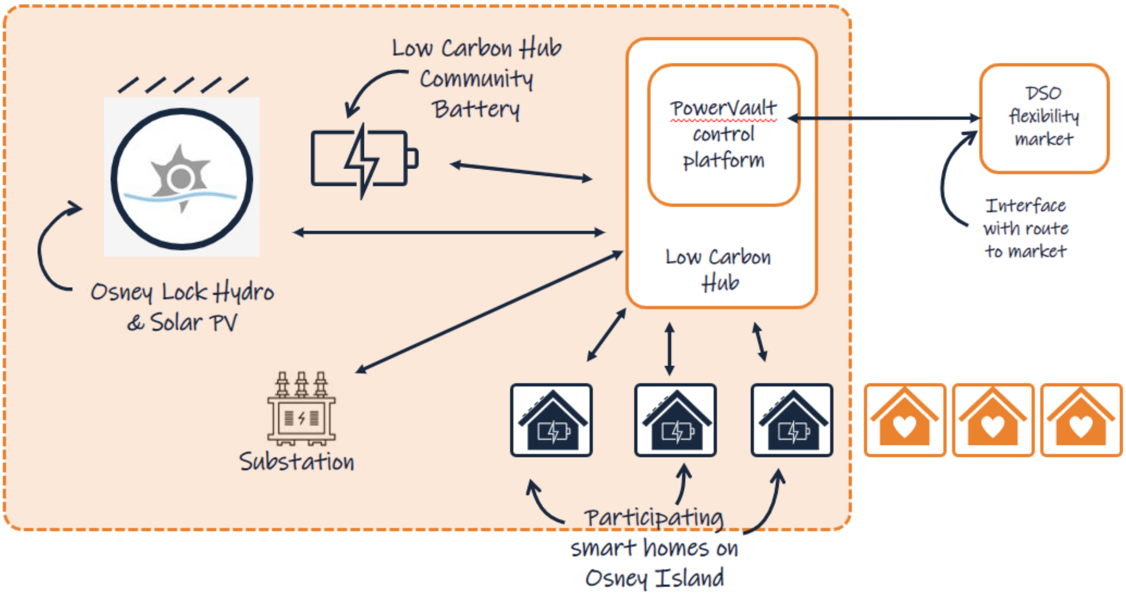


Figure 2: Osney Supercharge – overview of energy system behind a single secondary substation, linking into flexibility markets

The aim was to explore how to share energy and flexibility for the benefit of all on the island and the island community, helping everyone to take part in the transition to e-mobility.

3.3 Who was involved

Who	Steering group	Role(s)
Osney Community Energy	Yes	Community lead – volunteer role
Osney Lock Hydro (OLH, part of WOCORE)	Yes	Community lead – volunteer role
Low Carbon Hub	Yes	Project Management
Baringa		Battery and PV modelling
PowerVault		Battery supplier
Fractal Networks		Software development
Hildebrand		CAD devices
Oxford City Council		Planning advice
Scottish and Southern Electricity Networks (SSEN)		Local energy system advice, inc. monitoring and mapping
Oxfordshire County Council		Liaison about EV charging and parking infrastructure
Local homeowners and businesses with (potentially) distributed energy resources		Participants in local energy system balancing trials

Image 2: Osney Supercharge Smart Community Energy System elements. Photo credits: Low Carbon Hub.

3.4 How the trial was developed and run

Getting the energy assets in place which involved:

1. recruiting households and businesses that either already had solar PV panels and batteries or that would consider installing them, either paying themselves or taking up the Low Carbon Hub offer set out next
2. offering a license agreement with Low Carbon Hub to pay for the solar panels and battery over 20 years, with the homeowner charged for any of the electricity generated and/or

stored that they use, at a discount of 10% based on what they would pay on their other, regular tariff from their energy supplier (after 20 years the panels and battery will belong to the homeowner)

3. offering a Cosy Homes Oxfordshire 'Whole House Plan'[10] (usually priced at between £250–600) which details all the measures one could take to make the home as energy efficient as possible
4. installing the new solar and/or batteries to domestic and business properties.

Creating a personal and community energy dashboard for this secondary substation area (see Figure 3) which involved:

5. connecting the solar panels, batteries and electricity meters to the People's Power Station 2.0[11] in order to read their data (these energy assets were controlled by using the platform of the battery manufacturer, PowerVault, not this dashboard)
6. developing a dashboard on the People's Power Station 2.0 to display all energy data in one place for each participating household, and to provide information about their collective energy use and that of the community hydro and battery (see Figure 4)
7. asking participants to evaluate the dashboard.

Peak OLH generation was stored in the commercial batteries when grid carbon intensity was low and discharged at times of high grid intensity.

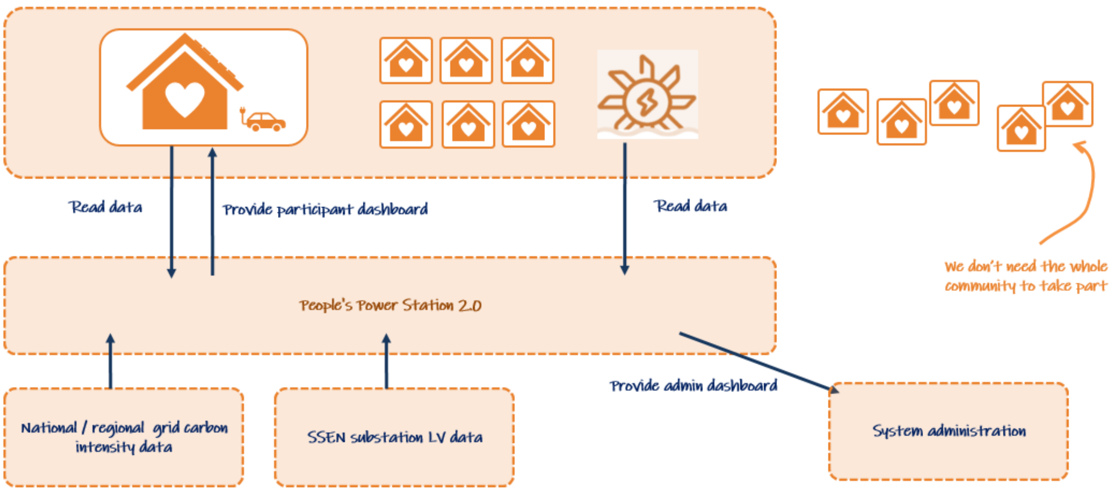
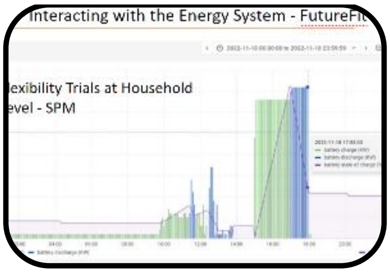


Figure 3: Data feeding into the Smart Community Energy System dashboard in Osney Supercharge

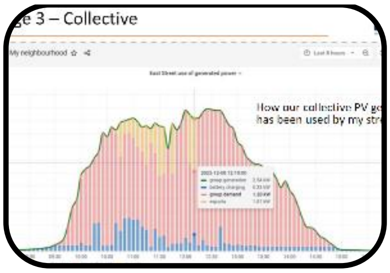
[10] https://cosyhomesoxfordshire.org/ – a partnership by Low Carbon Hub and Retrofit Works, aiming to make retrofit simple for the able-to-pay market in Oxfordshire.

[11] A new cloud-based platform that was developed in collaboration with Fractal Networks; see https://project-leo.co.uk/blog/explaining-the-peoples-power-station-2-0/

Layer 1 -- self consumption of energy generated



Layer 2 -- interacting with the energy system



Layer 3 -- optimising community net-consumption

Figure 4: The three layers of the Smart Community Energy System platform and images of the dashboard used in Osney Supercharge

3.4.1 What worked well

The uptake of low carbon technologies was quick in this SFN, due to excellent community engagement:

- four batteries (4kWh–8kWh) in residents' homes
- two batteries (24kWh each) at Osney Lock Hydro
- nine buildings had solar panels installed
- eleven Consumer Access Devices (CAD) devices installed for obtaining data.

3.4.2 What worked less well

In some cases, at Osney, there was not sufficient space for the current type of PowerVault batteries; this reduced the number of installations. The 8kWh batteries measure 127cmx100cmx25cm and weigh 180kg.

It is complicated for individuals to obtain access to their own energy data due to the number of ways and steps involved. Should you decide to get your energy data from your supplier, you often need to find the right department, make a request, wait for a month or two, then submit your ID and later receive energy data. It can also be expensive because of the charges imposed by the gatekeepers, such as manufacturers of the equipment, to the raw data.

SSEN's connections team raised concerns that there might be voltage rise issues that would prevent them allowing so many householders to connect their solar panel systems to the grid.

3.5 Key results

- This project installed six batteries and nine sets of solar PV behind the secondary substation at Osney.

- Using three of the domestic batteries and two of the commercial batteries to deliver DSO flexibility such as SPM and SEPM services, using the People's Power Station 2.0 platform, with results from the domestic battery trials shown in Table 2.[12]
- SSEN have developed a more detailed energy system model than is available anywhere else in their network, based on additional network monitoring and modelling at the low-voltage level for Osney island. They are now applying the learnings to the rest of the business.

Participant	Date	Service	Percentage delivered (%)	Flex offered (kWh)	Revenue (£)
a	15-Nov	SPM	226	3	1.95
a	18-Nov	SPM	224	3	1.95
a	22-Nov	SEPM	98	3	2.55
b	15-Nov	SPM	215	3	1.95
b	18-Nov	SPM	210	3	1.95
b	22-Nov	SEPM	80	3	1.75
c	15-Nov	SPM	169	3	1.95
c	18-Nov	SPM	168	3	1.95
c	22-Nov	SEPM	78	3	1.75

Table 2: Osney domestic battery participation in DSO flexibility markets

- Moreover, SSEN's detailed modelling will allow us to work back from net zero scenarios for the island so we can establish the network infrastructure required for net zero. This could enable Osney island to be the first secondary substation area in the UK to have a network upgrade plan that works back from a Local Area Energy Plan (LAEP), rather than working forward in incremental steps to avoid acute network constraints.

3.6 What we learned

- The report by SSEN titled 'Local Energy System Modelling: Local Energy System Modelling: Osney Island Smart and Fair Neighbourhood Case Study' confirmed that the level of solar panel and battery installations planned for this SFN could go ahead without causing the voltage issues that SSEN initially feared and in fact it proved to help balance that part of the grid. Now that the LV monitoring is in place it will allow SSEN to assess what level of low carbon technology adoption can be managed within the existing network infrastructure through strategic location and dynamic control.
- Fractal Networks are writing up learnings in a report 'People's Power Station: Development of a digital environment for value creation in Smart Local Energy Systems', April 2023.Third parties face high costs in gaining access to half-hourly data from smart meters, which is barrier to small-scale innovation.

[12] Table 1 shows that the batteries overdelivered (green) when discharging onto the grid. This is due to the preconditioning of the battery prior to the delivery window and the impact it has on the baseline. The baseline is what the battery would be doing on an average day at that time. The batteries underdelivered (red) for SEPM, which is when they charge.

4 Rose Hill Smart and Fair Neighbourhood, including Solar Saver trial

4.1 About the area

Mainly residential community, with a rich mix of housing tenures (homeowners, council tenants, private renters and housing association tenants, both flats and houses (rented and shared ownership) – parts of the estate are in the most 20% deprived nationally, and in the worst 10% for child poverty and poverty amongst older people.

- A number of community (local authority-owned) buildings with solar PV; school hosting a Low Carbon Hub solar array and one larger battery (Project Local Energy Oxfordshire, LEO-funded); 70+ existing solar PV on both privately and socially owned houses (inc. some funded by a previous project in the area).
- Two new social housing developments of flats (one local authority-owned, the other shared ownership) with communal solar PV (part LEO-funded).

4.2 What was trialled

The Solar Saver trial sought to find out whether it is possible:

- for tenants in blocks of flats with shared solar PV in a dense urban area of multiple deprivation to benefit from flexibility services, by shifting their energy demand to increase during peak solar hours
- to enable and incentivise them to do so through a tailor-made Time of Use Tariff
- for many small amounts of flexibility and energy generation to make an impact, if optimised and managed collectively.

Also trialled was using the online Local Area Energy Mapping tool (LEMAP) tool being developed by Oxford Brookes University through EnergyRev for developing a roadmap towards becoming a zero carbon community, including those with least flexibility potential. The detailed report and results of the LEMAP work are published in the Project Local Energy Oxfordshire (LEO) report 'Net Zero Rose Hill – Local Roadmap', February 2023.

Using the larger LEO-funded battery for flexibility trials was another aim, which is not covered here but in the LEO report 'Low Carbon Hub Portfolio and Routes to Market', February 2022 (Appendix A2).

4.3 Who was involved

Who	**Steering group**	**Role(s)**
Rose Hill and Iffley Low Carbon (RHILC) members and nominees	Yes	Community lead – volunteer role
	Yes	
Oxford City Council	Attended some meetings	Project assistance / local energy asset owner (housing, solar panels)

Low Carbon Hub	Yes	Project Management / local energy asset owner (solar panels, battery)
Oxford Brookes University	Attended some meetings	LEMAP participatory mapping tool
Younity and Co-operative Energy		SolarSaver Tariff providers
Baringa		Energy and flexibility services consultancy
Residents of new flats (social housing / shared ownership)		Participants in SolarSaver Time-of-Use tariff trial

Image 3: Rose Hill SFN Local Steering Group members with Low Carbon Hub solar PV installation

4.4 How the trial was developed and run

SolarSaver:
Activities included:

- a recruitment drive which included stalls outside the new homes, door-knocking, letters, information packs and online welcome events
- trial design covering development of incentives, agreement of method and trial dates and a comparative analysis of meter and solar panel generation data
- thirteen separate trial SolarSaver dates during August and September 2022 for participants, including them keeping 'diaries' of energy use
- analysis of all SolarSaver trial data by Baringa, with an exploration of what these findings might mean at scale
- follow-up event to present findings from SolarSaver trial to participants and the community, with further presentations to Oxford City Council
- engaging with social housing tenants to grow understanding around lack of participation in trial, in contrast to shared ownership ones.

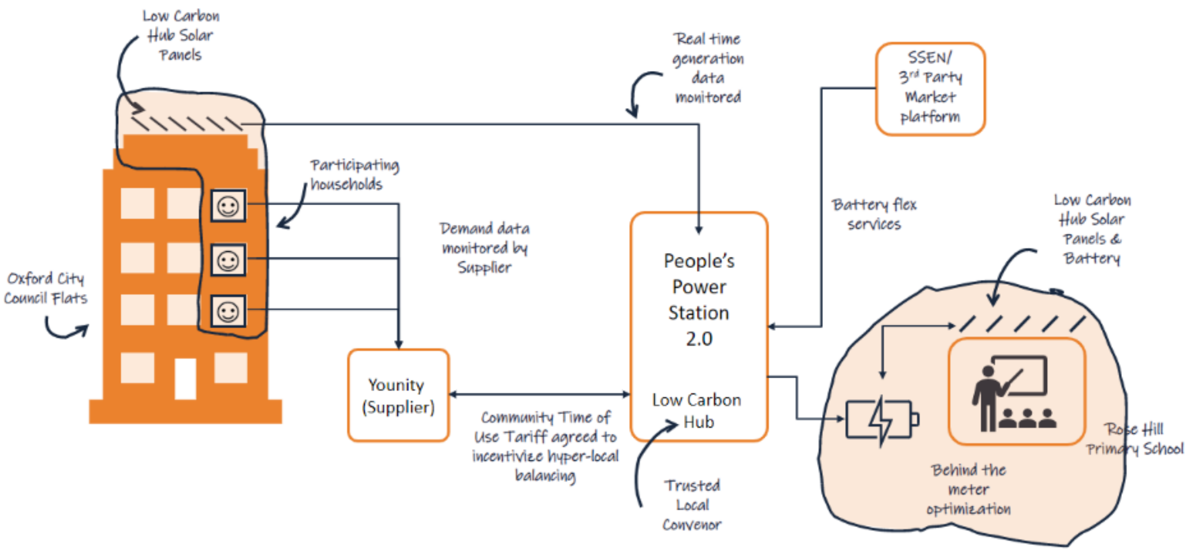


Figure 5: Components of the Rose Hill Smart and Fair Neighbourhood

Zero-carbon roadmap:

- The Rose Hill SFN Local Steering Group conducted community testing of LEMAP and got feedback, leading to tweaks to the survey and LEMAP tool.
- The SFN also designed publicity and incentives for the survey; participants were offered a £10 Co-op voucher or a £10 donation to Rose Hill Youth Group.
- The results from the survey, launched in early 2022, were added to LEMAP by Oxford Brookes University.
- Baringa, the Low Carbon Hub and Oxford City Council analysed survey data looking into the useability of LEMAP, from a community group user viewpoint, for creating a baseline and targeting information for a local roadmap or similar. The results are in the LEO report 'Net Zero Rose Hill Local Roadmap Report', February 2023.

4.4.1 What worked well

SolarSaver:

Some participants were successful in increasing their demand during peak PV generation, and some demonstrated a clear shift from energy usually used during peak demand in the evening. The total financial reward for taking part was £81, i.e. an average payment of £5.06 per participating household, with a maximum achieved total payment of £15 and minimum of £1.

Zero-carbon roadmap:

The LEMAP survey was useful to generate general community engagement about energy systems issues such as retrofit, energy efficiency and flexibility.

4.4.2 What worked less well

SolarSaver:

Many of the installed smart meters did not work at the outset of the project and these were newly built block of flats. Unfortunately, it reduced the number of residents that could take part.

An important reason given for not taking part was about the time and effort the trial was anticipated to take, which could perhaps have been mitigated by even greater engagement and explanation at an even earlier stage.

4.5 Key results

SolarSaver:

- Sixteen flats out of [TBC] participated in the SolarSaver trial.The trial showed that people with little by way of energy assets other than domestic appliances are able to increase demand to make use of local generation when requested.

Zero-carbon roadmap:

There was a strong response to the call for local residents to participate in the LEMAP survey with 108 responses collected in under two months, and much potential to collect further results given more time.

Unfortunately, the use of LEMAP tool did not enable the community production of a roadmap of what is required at the Rose Hill area to achieve net zero. Nonetheless there have been some benefits in terms of forecasting technical ability for domestic properties for EVs, solar panel and heat pumps and the data gathered from local residents have potential to inform a future engagement activities.

4.6 What we learned

- The SolarSaver trial shows that people with few energy assets and no automated controls are able to increase demand to make use of local generation when requested.
- Whilst the small sample size means the data cannot be extrapolated, it showed it is possible for residents of flats to demonstrate shift and flexibility. This would lead to greater system and financial benefits if larger numbers did the same over a longer period (as now also shown by the response to the Demand Flexibility Service launched by National Grid in the winter of 2022/23).
- The greatest shift of activities was through using the dishwasher, the washing machine and electric hobs during the peak solar period. Working patterns impacted the success of trial days – if people were working from home and did not have back-to-back afternoon meetings it was possible to shift. However, if residents were out on trial days that meant they could not do much, in the absence of smart appliances or similar technology. In other cases, diaries suggest that sometimes participants did not realise what was a trial day. A thorough review of media, messaging, and communication styles and what worked and did not should

be conducted.

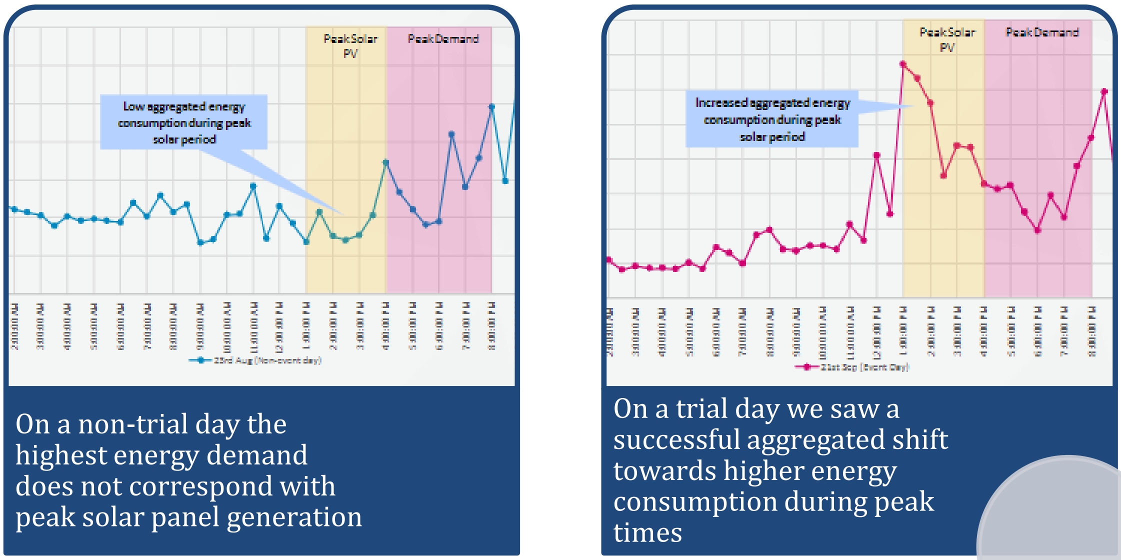


Figure 6: Graphs showing the shift in time of use by participants in Rose Hill SolarSaver trial

Zero-carbon road mapping:

- The project had two months available for the LEMAP survey, 108 households responded, so 5% of the housing stock.
- Benefits of running the LEMAP survey include:
    - increased engagement and connection with the wider community
    - learning how to reach a wide cross section of residents (including stalls at food banks)
    - useful insights for RHILC regarding community interest in time of use tariffs and gaps in knowledge on insulation
    - an opportunity to explore the strengths and weaknesses of different available mapping tools
- It is challenging working with a range of different residents with different languages, needs and capacity for interest in active participation.

5 Westmill Smart and Fair Neighbourhood

5.1 About the area

- Two community energy co-operatives owning separate generation assets on the same site: the Westmill Wind and Solar Co-operatives have operated a 6.5MW wind farm and 5MW solar farm, respectively, for around 10 years.
- The cooperatives are looking to identify new business models going forward. In doing this they want to consider how flexibility services might play a role in future operating models and/or investment cases that would deliver on the co-operatives' long-term vision for their site and mission.
- Together, they have over 3,000 co-operative members who can't yet share the benefits of trading directly. Moreover, there are three surrounding villages for future consideration as a potential Smart Community Energy Scheme (SCES) – Longcot, Shrivenham and Watchfield.

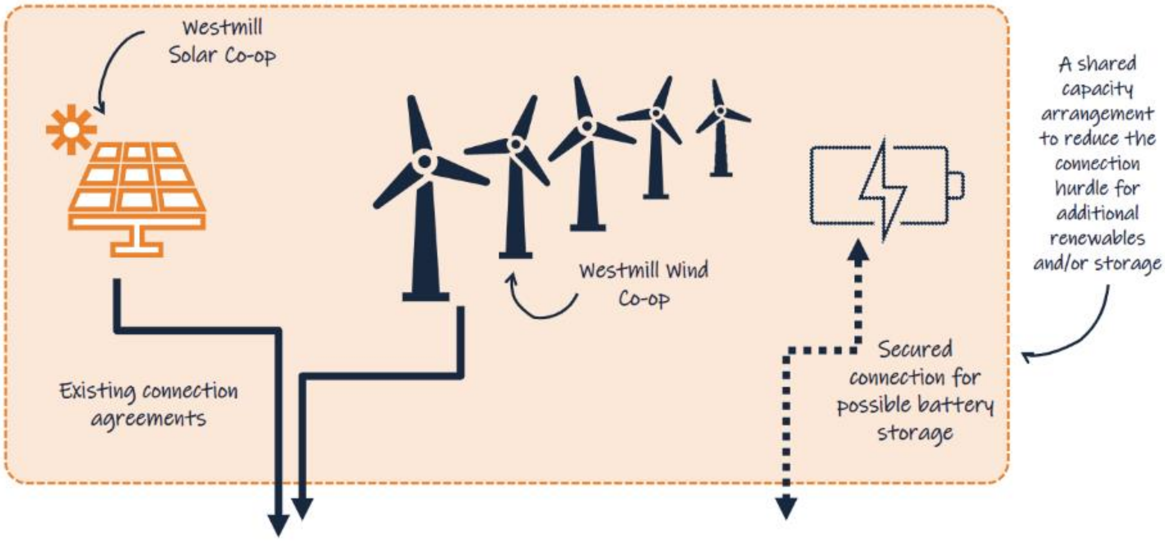


Figure 7: Potential Shared Capacity Agreement for Westmill organisations

5.2 What was trialled

To explore how existing grid-scale wind and solar generators on a shared site can move beyond 'just' generating.

5.3 Who was involved

Who	Steering group:	Role(s)
Westmill Wind Farm Co-operative	Yes	Local community energy asset owner
Westmill Solar Co-operative	Yes	Local community energy asset owner
Westmill Battery CIC	Yes	Start-up exploring adding another energy asset to the site
Low Carbon Hub	Yes	Project management
Baringa		Energy and flexibility services consultants

5.4 How the trial was developed and run

1. The co-operatives, along with the Westmill Sustainable Energy Trust (WeSET) which is their charity partner organisation, held joint workshops together and with the co-operatives' members to explore their collective mission and vision and the high-level options for future operations and developments on the site.
2. A set of scenarios for potential future developments were created.
3. Baringa conducted a desktop review of the solar and wind farms and the terms of their connection to the local network to establish which flexibility services they could potentially deliver now, and which might be relevant if battery storage were developed on the site.
4. A capacity profiling study was completed for the wind and solar farms which analysed how much energy was being exported from the site in half-hourly periods and compared this to the amount that both sites have permission to export according to their connections terms.
5. As a result, a Shared Capacity Agreement was identified as the most relevant of the flexibility services considered in the desktop review. This is an arrangement, approved by the local network operator, in which the two organisations would effectively merge their connection terms into a single connection. Essentially that allows the two organisations to 'access' their combined free capacity, and is a flexibility service that is only just emerging. It was hoped that the co-operatives might be able to develop one, or at least the heads of terms, as part of Project LEO and that an organisation called the Energy Networks Association (ENA) might help with this work. Unfortunately, that ENA project was delayed and so this remains to be done.
6. The next step is to understand how such an agreement might contribute to the implementation or benefits of each of the future development scenarios.

5.4.1 What worked well

There was agreement about the vision in general, but this didn't help to distinguish what specific smart energy systems opportunities were a priority. A breakthrough came when the group decided to capture scenarios for the future development (or not) of the site (see Figure 8). This narrowed the scope of the 'vision' and the scenarios related to meaningful decisions that the co-operatives' boards may have to take decisions about.

1. Close of Play

Operate the wind and solar farm to the end of current planned life and decommission with no further operations

2. Keep Calm And Carry On Generating

Extend the lease for the existing wind and solar farms and operate them until it is no longer financially viable. No new generation added

3. Scale Up Solar

Expand the solar farm to use the 'free export capacity' with control system to make sure export doesn't exceed the Shared Capacity Agreement limit on windy days

4. Big Battery Benefits

Add battery storage to either 1 or 2, sized to maximise the benefits of the generation installed onsite. For example, to store solar generation that would otherwise be curtailed on a windier day.

Figure 8: Westmill site future scenarios

5.4.2 What worked less well

Flexibility services and markets are not easy to explain or understand, especially as they continue to evolve.

5.5 Key results

This was very complex ground even for a group of experienced community energy actors. It was a common challenge across the partners and activities of Project LEO and led to the creation of the 'Understanding Flexibility Services' page of the project website which explains the key services in simple terms.

For the Westmill co-operatives, this has proved a barrier worth overcoming as their renewable assets are older and they are looking for now business models and/or diversification. Having done that hard work, a real and valuable opportunity has been identified in the form of a Shared Capacity Agreement.

The capacity profiling analysis, in Figure 9, showed that for most of the time the wind and solar farms combined had at least 4MW of power capacity that they had permissions to be exporting to the local network, but which they weren't using. Permission to export energy to the local network is captured in a 'Connection Agreement' that is issued by the local network operator and comes with a 'connection charge'.

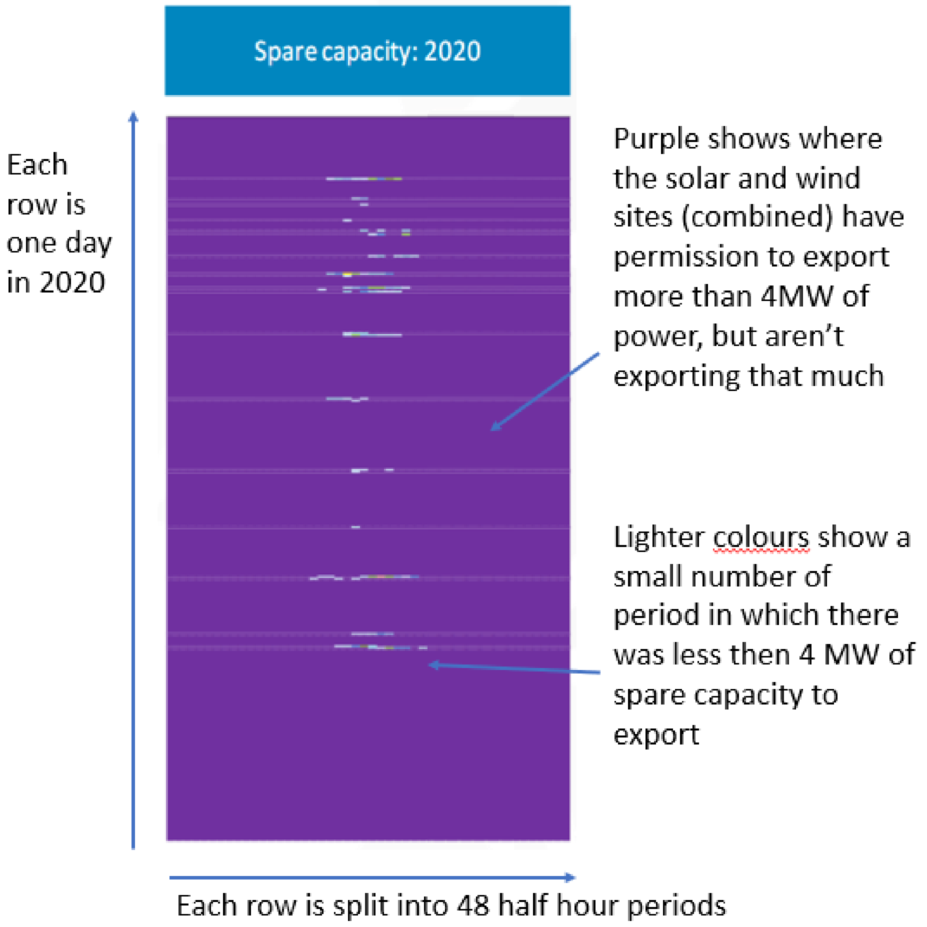


Figure 9: Capacity profile diagram for the solar and wind farms at Westmills

5.6 What we learned

The range and complexity of the different types of flexibility services, some more established, some emerging, make them tricky to understand, even for the Westmill organisations which are experienced community energy groups.

Project LEO's flexibility market trials have focused largely on those services that the local network operator can buy for the purpose of helping it manage the performance of the network. The purpose that the Westmill co-operatives have 'front of mind' at the moment is to maximise the renewable generation at their site: i.e. the 'mid-life crisis' of wind and solar farms for which the business model relies on subsidies that will not be available when it comes time to replace or upgrade the generators. So, it is not surprising that the most relevant service is one which is 'enabled' by the local network operator rather than 'procured' by it.

As experienced by this project, the topic of shared capacity agreements hasn't been a priority for the DNO, as it isn't formally included in SSEN's market trials and the ENA research was delayed. So, there is more work to be done to realise the benefits for existing renewable generation like the Westmill Co-operatives.

6 Eynsham Smart and Fair Futures

6.1 About the area

- A mixed area of six settlements (with different civic parish councils), where 3,200 new houses will double the size of the main settlement, Eynsham, to about 10,500 households.
- The low carbon group, Eynsham GreenTEA, wanted a way to help hold developers to account in delivering net zero carbon new housing and enable those in existing settlements to understand how to play their part in the transition.

6.2 What was trialled

The aim was to develop a **C**ommunity **A**ction **P**lan for **Zero** Carbon Energy', abbreviated to 'Eynsham Area CAPZero', for a primary substation area to include new houses as well as the existing settlements, to identify scenarios how the whole area can transition to net zero by 2050 at the latest.[13]

The trial was also looking to explore business models for zero carbon new development that deal with the split incentive between developer wanting to minimise capital costs and occupier wanting to minimise operational costs. Key social drivers for the project were:

- acceptance of new development that doubles the size of Eynsham village
- long-term sustainable stewardship model to govern the CAPZero.

Image 4: Eynsham GreenTEA community group (energy subgroup). Photo credit: Low Carbon Hub.

[13] See the outline of Eynsham Smart & Fair Futures project on the GreenTEA webpage on energy: https://eynsham.org.uk/org.aspx?n=GreenTEA&id=992.

6.3 Who was involved

Who	Steering group	Role(s)
GreenTEA (Transition Eynsham Area)	Yes	Community lead – paid an honorarium for chairing the project
Representatives of local parish councils	Yes (at times)	Community lead
West Oxfordshire District Council (WODC)	Yes (officers)	Links to spatial planning and climate change work
Low Carbon Hub	Yes	Project management
Energy Systems Catapult	Attended some meetings	Energy modelling and planning consultants
Urbanomy	Attended some meetings	Energy modelling planning consultants (contract managed by Oxfordshire County Council, as part of Project LEO)
Oxfordshire County Council	Attended some meetings (officers)	Links to energy modelling and LEO mapping work
Scottish and Southern Electricity Networks (SSEN)		Providing local energy system data

6.4 How the trial was developed and run

The 'hyper-local' CAPZero is drawing upon the county-level 'Pathways to Zero Carbon Oxfordshire' LAEP, which in turn was informed by National Grid's national-level Future Energy Scenarios.[14] The CAPZERO mainly extrapolates net zero targets for 2030 and 2050 for the Eynsham primary substation area, based on proportions of population and land area. It has also benefited from other expert input:

- energy modelling of scenarios for new developments by Urbanomy (undertaken as part of Project LEO for Oxfordshire County Council)
- energy modelling of scenarios for the existing developments, and new ones (drawing on Urbanomy and WODC data) by the Energy Systems Catapult (ESC), commissioned as part of Project LEO for the EY SFN Local Steering Group (LSG)
- local knowledge of the community and area brought by the EY SFN LSG.

Engaging the community was integral to the aims of the CAPZero. The project did this by including updates in GreenTEA communications, an outdoor window display in November 2020 (when meetings were not possible).

When face-to-face engagement was possible, residents of Eynsham and other parishes served by the primary attended a range of events, competitions and games based around Great Big Green Week in September 2021 and September 2022. One of these was the Great Big Energy Saver event in 2022.[15]

[14] www.nationalgrideso.com/future-energy/future-energy-scenarios

[15] www.lowcarbonhub.org/p/great-big-energy-saver-eynsham-great-big-green-week-2022/; competitions and games involved local schools.

6.4.1 What worked well

The Smart and Fair Futures SFN did well in:

- the expertise and level of engagement by the representatives of the local steering group
- the level of community engagement, such as excellent public engagement in GBGW: this was made possible by the joint work and skills of GreenTEA members, including a link with the local schools trust, and Low Carbon Hub
- its work with the ESC to apply its energy modelling and scenario tools to a primary substation area to feed into the CAPZero, so at a much smaller, 'hyper-local' population level than its usual LAEP work to date
- positioning the CAPZero work within national and county future energy scenarios, and linking to other cutting-edge research, such as by that on reducing demand by CREDS[16]
- Low Carbon Hub feeding into the Ofgem consultation on the future of local energy institutions and governance,[17] including standards for mapping and data, then using CAPZero to follow through on these points.

6.4.2 What worked less well

- One of the priorities was to identify a long-term governance model that could steward implementation of the CAPZero plan through to 2050: funding for this has been assumed to be available from two solar groundmount projects which are still to be fully completed, leaving a gap.
- The details of the new developments have less clear than expected, due to the planning process not going as anticipated, with a protracted inspection of WODC's proposed Area Action Plan for Salt Cross Garden Village – also making liaison with all stakeholders more difficult and meaning the project had to change its approach on how to model these.
- None of the spatial boundaries map neatly on top of each other: the Eynsham primary substation area lies within the WODC administrative area, but includes parts of six different parishes and doesn't map either onto the postcode areas used for mapping energy use in households or businesses.
- It took time to obtain data from substations as SSEN had to install the monitoring equipment for Project LEO.
- The LSG looked into whether the Local Area Energy Mapping tool (LEMAP) tool being developed by Oxford Brookes University might be useful to this project, deciding it was not.
- Community engagement was more intermittent and not always as close with other parishes as it was with the largest settlement, Eynsham; this would have required additional resources.

6.5 Key results

The CAPZero for the Eynsham primary substation area identifies three priorities for action up to 2030, and new opportunities to be explored to help achieve them, concluding with a vision for 2050. It shows actions local councils, people and businesses can take now, based on known technologies

[16] https://low-energy.creds.ac.uk/the-report/
[17] www.ofgem.gov.uk/publications/consultation-future-local-energy-institutions-and-governance

and models. It looks at land use and outlines estimated costs and how the measures identified can potentially be delivered through a number of investible propositions. The addition of an assessment of suitable investment models to deliver identified decarbonisation projects is another innovation which has not previously been incorporated into local area energy planning.

So far Local Area Energy Plans (LAEP) are developed for entire conurbations or counties (around 300,000 residents), potentially districts. ESC were brought in to provide expert input to help develop the CAPZero. To do so, they adapted their method and scaled the modelling to a primary substation area in a first-of-its-kind approach.

Looking at the National Grid's Future Energy Scenarios, to make the successful transition to a zero carbon energy system we need, at least one includes a high level of societal change. The Smart and Fair Futures project assumes this is needed anyway, given that the most radical change to our energy system will be at the low voltage level, or the grid edge, where we all live and work. The primary substation level is a good match for that, but also bridges well between local communities in parishes and town council areas, and the local authority in district areas. That should make it possible to join together the electricity planning and local planning systems in a way that could really involve local citizens in taking actions to help the transition work smoothly.

The Eynsham Smart and Fair Futures project demonstrates the inherent need for such a 'local convenor' role[18] where local is defined by both admin boundaries and self-defined communities) to change by not only bringing the relevant parties together, accessing the diverse inputs needed from experts in spatial and energy planning; but also by:

- **Communicating energy and local planning to real people: a**ccessing local groups and institutions, such as parish councils, and doing the work to gain their buy-in and contribution towards a process to bring energy and spatial planning together; and, overcoming the language barrier of the energy sector and communicating complex concepts to the people that big decisions about energy and spatial planning will impact
- **Synthesising energy and spatial planning to 'make it real':** bringing energy sector expertise and specifically an understanding of what smart local energy systems are, then working out what such a system could offer a local area (existing and new build) on the ground – in collaboration with local and community representatives; and understanding energy system data, its limitations and how to interpret it in order to join up energy system planning processes with local spatial planning and consultation processes.

6.6 What we learned

1. Legitimacy is important, as is the 'local convenor' role: the Eynsham trial did follow a collaborative and inclusive approach, as outlined in the SFN Ethical Framework, led by GreenTea, generally with good success

[18] For more on this see LEO report D3.10 'Learning from the Smart and Fair Neighbourhood Trials' (March 2023), Key message 5: A 'Local Convenor' is needed to catalyse action and unlock the value at the grid edge.

2. Delays in projects expected to generate community benefit that would fund stewardship of the CAPZero means the. question who leads and stewards over the long term needs to be looked at again, and the resulting gap filled
3. We need a comprehensive national policy framework, joining up spatial and energy planning
    a. Placing the primary substation at the heart of the local area energy planning process to achieve a zero-carbon energy system is an important first trial to do so in a way which benefits and motivates current and future residents and organisations, and provides a template to inspire wider action
4. Data is infrastructure: data and information needs to be standardised, cleaned and (where necessary) translated so that it can become a resource, available to everyone who needs it equally, that can:
    a. be tailored and used flexibly to enable equitable outcomes
    b. and support the development of community-based business models for enabling and funding the transition
    c. and quick wins to address the energy crisis.[19]

[19] Note that when communities are presented with data the first response often is to point out what is wrong. How those presenting the data, and those fulfilling the role of 'local convenor', respond to this is crucial to building trust. It also underlines again the importance of 'Developing an ethical framework for local energy approaches', November 2020, and indeed using it.

7 Springfield Meadows Smart and Fair Neighbourhood

7.1 About the area

- Springfield Meadows is a recent multi-award winning, climate-positive development. The 25 houses are built to Passivhaus energy standards which include air source heat pumps, solar PV and some with EV chargers and household batteries.

7.2 What was trialled

Springfield Meadows was added towards the end of 2021 to fill a gap in the Smart and Fair Neighbourhood (SFN) trials. The new development of climate-positive homes offered the possibility of developing at least a virtual MPAN and perhaps even a full microgrid.

The local distribution network operator (DNO), Scottish and Southern Energy Networks (SEEN), temporarily restricted electricity exports from 11 properties so they are unable to export the excess electricity generated from their solar panels. The aim of this SFN was to enable all property owners in the estate to export generated electricity in a smart and fair way, without costly upgrades to the grid.

Image 5: Springfield Meadows Smart and Fair Neighbourhood

7.3 Who was involved

Who	Steering group	Role
Low Carbon Hub	Yes	Project management
Greencore Ltd	Yes	Developer of the estate and project sponsor
Baringa	Yes	Energy and flexibility services consultants
Scottish and Southern Electricity Networks (Innovation team)	Yes	Decision-makers on trial solution as local DNO
R-Eco		Solar panel consultants
Active Building Centre		Decarbonisation consultants
Power Transition		Microgrid specialists, working on feasibility studies
Springfield Meadow homeowners		Trial participants

7.4 How the trial was developed and run

To start with, a technical assessment of the challenge was conducted by Baringa, which included:

- specifying the solar generation that was being curtailed or which was desired to be installed
- the specification of the development's connection to the local network
- the specific network performance concern that the local network operator had, which was leading to the restrictions being put in place.

Solutions were brainstormd with the experts involved and captured in pro-forma summaries to allow them to be easily discussed, compared and contrasted by the project partners. However, it would be Greencore Ltd, as developers, to choose a solution that would work for them, though the DNO, SSEN, would also have to agree.

So, Greencore established criteria for assessing the potential solutions: time frame for implementation, cost, scalability of the solution to other housing developments, ease of delivery for Greencore and complexity. Ten solutions were assessed by the team, which was reduced to a shortlist of six solutions for SSEN to review (see

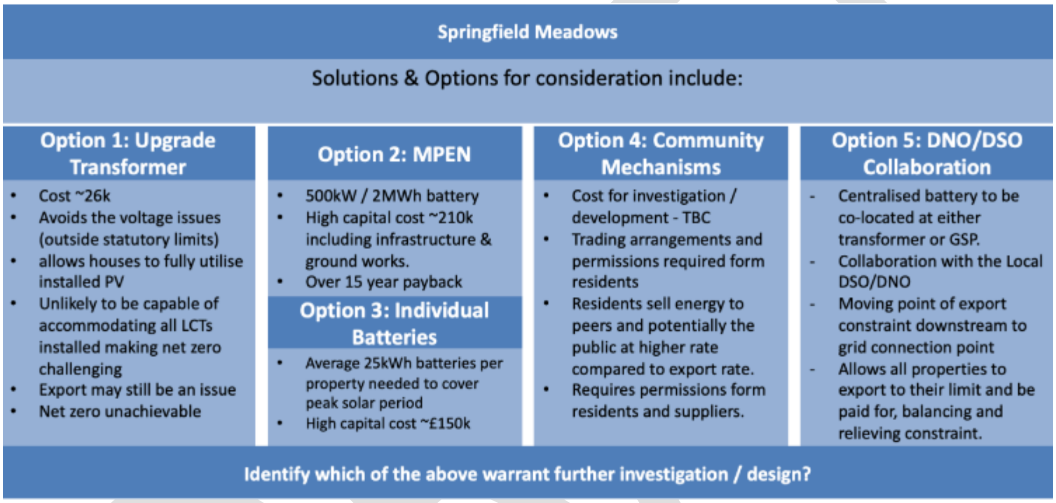


Table 3).

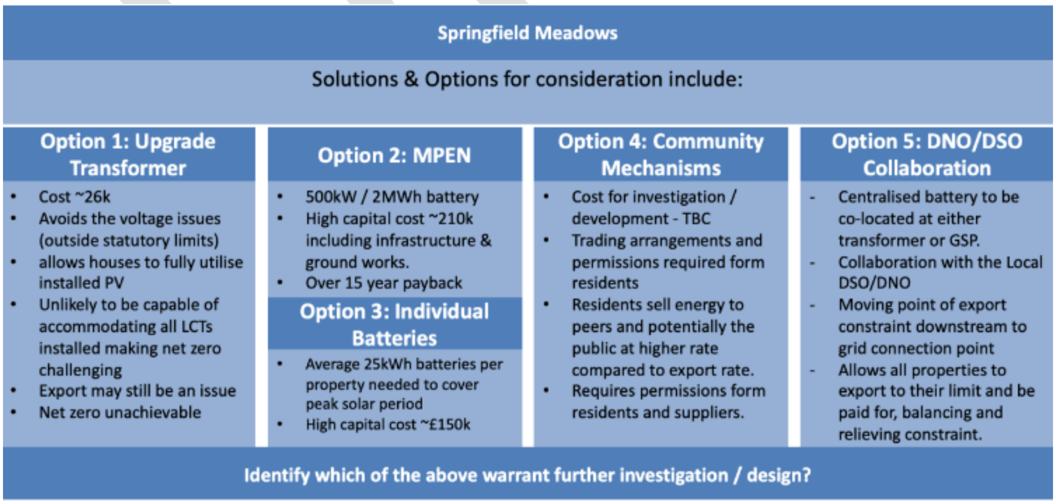


Table 3: Springfield Meadows load-sharing options analysis by Power Transition

SSEN were most interested in the solution 'Local Load Balancing' suggested by Power Transition. This involves using the energy assets at Springfield Meadows flexibly to ensure that the export thresholds of the substation are not exceeded. This solution would require an aggregator or flexibility provider to control assets at the development such as air source heat pumps, appliances, electric vehicle chargers and domestic batteries.

Power Transition did a desktop study on this option, i.e. whether it's possible for flexibility to mitigate the need for the incumbent solution which is to reinforce the infrastructure.

For this study, half-hourly household energy data going back one year was required. Thirteen Springfield Meadows homeowners have signed a consent form allowing Low Carbon Hub to get this data from their suppliers. Of these, nine have no export and three are able to export surplus electricity generated by the solar panels on their roofs.

7.4.1 What worked well

Having a steering group made up of representatives from seven partners meant that the project had great expert input and buy-in.

7.4.2 What worked less well

A steering group of representatives from seven partners meant it was difficult to understand who needed to make the decisions.

The use of energy jargon made it a challenge to establish a common language.

For the Power Transition study it was a challenge getting hold of local residents' historical energy data despite having permission. The energy suppliers have the information but in order to obtain it we had to have a signed letter, provide ID evidence and the timeframes were just over two months. In the end we asked the residents to download a special free app created by NHildebrand, called the Bright app. Only three residents downloaded the Bright app and accepted the additional SFN terms and conditions. This may be due to participant fatigue, after five interactions with the project team.

7.5 Key results

The report titled 'Local Load Balancing Pre-Feasibility' written by Power Transition has given us a clearer view of the precise issues with the Springfield Meadows development:

- the site exceeds its current 55kW export threshold set by SEEN by 757 times, hence a significant loss of site solar generation
- an aggregated 90–100kWp export threshold would be needed to allow the bulk of the surplus solar energy unused for domestic consumption and on-site battery charging to be exported
- overall, on the basis that in general consumption offers better value than export, and battery and EV adoption is likely to increase progressively, plus growth in demand for cooling/air conditioning, the problem of surplus energy production across Springfield Meadows is likely to diminish

- a review of alternative solutions is shown in Table 3, with a roadmap also supplied setting out the authors' recommended approach for follow-on work.

7.6 What we learned

Meeting the SFN's ultimate aim of enabling export of more solar energy generated on the Springfield Meadows development has proven to take more time, data gathering and expertise than expected.

The potential solutions developed as part of the work with a range of different partners covers a very wide range, from network upgrades to community mechanisms.