Project LEO Final Report:
a digest of key learnings

Local Energy Oxfordshire

Project Partners

EDF
Helped identify local flexibility, provided expertise on DSR and supported the integration of the market platform.

equiwatt
Connected homes to their energy management platform via a consumer app to notify and run energy saving events at peak times of the day; managed consumer participation in demand flexibility trials; assessed household incentives turn down demand in exchange for incentives/rewards and investigated the effectiveness of local demand side management.

Low Carbon Hub
A leading social enterprise that used its renewable assets to participate in trials, and harnessed its community networks to deliver the SFN trials and raise significant investment for the project.

Nuvve
As the global leader in vehicle-to-grid (V2G) technology, Nuvve provided V2G and smart EV chargers.

Oxford Brookes University
Collected and analysed data to create a new model for mapping and planning the local energy system. Also purchased the installation of Vehicle2Grid chargers via Nuvve within their campus.

Oxford City Council
Supported stakeholder and community engagement, investigated enabling assets, and participated in trials using key infrastructure.

Oxfordshire County Council
Led the development of the Strategic Energy Mapping Platform to support energy planning and provided assets to participate in the TRANSITION trials.

Piclo
Developed Piclo Flex, an independent marketplace for trading energy flexibility services online.

Scottish and Southern Electricity Networks
The local electricity network operator, SSEN tested multiple aspects of the DSO model to balance local supply and demand, through the LEO-integrated TRANSITION Project.

University of Oxford
Collected and analysed data to create a new model for mapping and planning the local energy system.

Contents

Introduction to Project Local Energy Oxfordshire

Background

There is increasing value being placed on flexible resources, such as batteries and shiftable electricity demand, when they are connected to the electricity network. Small-scale electricity system users should be able to play a role in providing flexibility to the network, provided the right infrastructure, markets and regulation can be put in place.

Project Local Energy Oxfordshire (LEO) is one of three smart local energy system demonstrator projects in the UK and seeks to replicate the electricity system of the future in Oxfordshire, taking a 'whole systems' approach. Through collaborative, cross-sector working, LEO has demonstrated some of the ways we can meet challenges in the transition to Net Zero and bring about social, economic, and environmental benefits for all.

www.project-leo.co.uk


© SSEN

Benefits for the energy networks

- Keeping supply and demand within network parameters
- Supporting the transition from fossil fuels to renewables
- Increasing efficiency in the way we use the current system: easing congestion and constraints in the distribution network
- Freeing up space for more renewables and storage
- Supporting the electrification of heating and transport
- Reducing the need to invest in network and kit reinforcements and upgrades.


© Low Carbon Hub

Benefits for local energy generators

- Creating new revenue streams for existing community scale renewable generation projects (e.g. local hydro or solar)
- Creating opportunities for projects to expand, for example increasing their generation capacity or adding storage
- Improving the financial viability of new community scale renewable projects
- Enabling more renewable generation to connect to a local network (where before there might not have been 'room')
- Reducing the cost and how long it takes to get a new connection
- Sharing of network access rights through peer-to-peer capacity trading to optimise renewable generation.


© Richard Cave

Benefits for residents

- Reducing energy bills
- Increasing income
- Creating opportunities to decarbonise their heating and transport
- Supporting the upgrading of old heating systems
- Increasing usability and control
- Creating opportunities to take positive action on climate change.

© Richard Cave

Benefits for local communities

- Increasing access to participation, so more people can get involved and can benefit
- Making more space on the energy network to support the electrification of heat and transport and drive carbon reductions
- Widening the range of local energy strategies that communities and individuals can use to meet their needs, based on their local situation (e.g. to use in conjunction with peer-to-peer capacity trading and energy efficiency initiatives).
- Creating new business opportunities for community-run energy services that increase income and support carbon reduction.

Five key messages

Over the four years that Project LEO has run, it has generated evidence and key messages for policy makers to support the transition to Net Zero. Of the thirteen key messages detailed in the report, we have identified five as being the most important.

© Richard Cave


© Richard Cave

1

Local Area Energy Plans are vital to achieve Net Zero

Project LEO has shown how collaborative, Local Area Energy Planning (LAEPs) is necessary to get to Net Zero. LEO would recommend the development of a body that can enable the development of a flexible and scalable LAEP and associated toolkit in regional geographies where the local authority with democratic accountability, can properly interface with the energy system and network geographies. That body could enable delivery by providing advice, insight and supporting timely decision making to support LAEPs.

2

Aggregators in the broadest sense are key to enabling flexibility at the grid edge

There is a functional expertise gap to enable non-specialist flex providers to participate in flexibility markets, meaning that aggregators, in the widest sense, are essential for enabling Smart and Fair Neighbourhoods, flex at the grid edge and organising many Distributed Energy Resources.

3

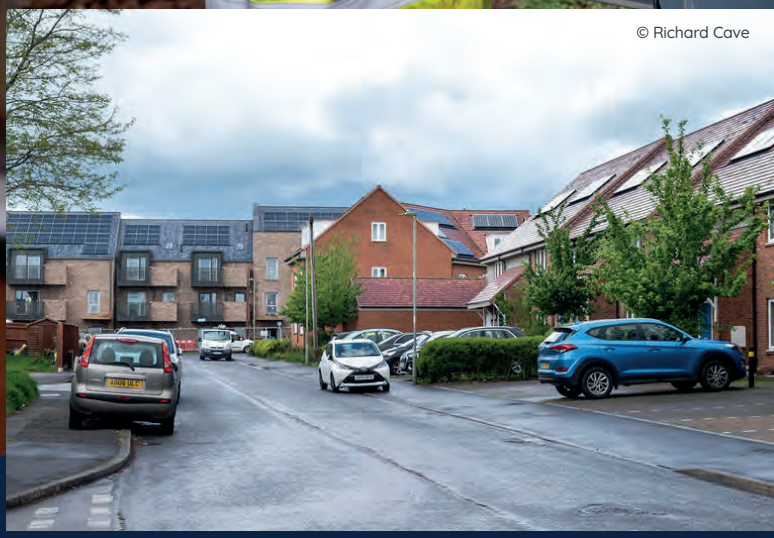
Optimisation behind the secondary substation brings a wide range of benefits

LEO has shown how optimisation can occur behind the secondary substation with the use of successful monitoring and optimised buildings that can take part in Smart Community Energy Schemes. As well as delivering efficient energy allocation and viable business models, such local optimisation has wider community benefits, for example creating Smart and Fair Neighbourhoods with engaged local participants.


© Richard Cave


© SSEN


© Low Carbon Hub


© Richard Cave

4

Investment in data and digital is key to enabling more efficient and smarter local area networks

Investment is needed in data and digital for networks, especially on the low voltage network at the grid edge, surfacing data that is visible and understandable to those interested in the local area, beyond the Distribution System Operation (DSO) environment. This would enable more efficient and smarter operation of the electricity network through flexible services.

All images © Richard Cave

5

Innovation funding is improving but must adapt to help deliver Net Zero

Combined innovation funding streams make project governance easier, allowing more time to be spent on innovation and encouraging collaboration between BEIS and Ofgem. Some of the rules on investment however, can hamper the ability to demonstrate domestic level participation in the energy transition. Future funding for major systems' change needs to allow and encourage, cross sectoral investment and also encourage the application of capital and revenue R&D investment to accelerate, at scale, real world innovation that delivers a benchmark for rapid change to deliver Net Zero ambitions.

Project LEO trials

In close collaboration with Project TRANSITION through development of a distribution network flexibility marketplace, Project LEO has delivered some of the most ambitious, wide ranging, innovative flexible electricity trials ever conducted in the UK.

The trials have enabled us to improve our understanding of how opportunities can be maximised and unlocked from the transition to a smarter, more flexible electricity system and how households, businesses, and communities can realise these benefits.

The trials have helped to develop an understanding of how new technologies and services, particularly at the 'grid edge' – closest to the point where people are using energy – can benefit local people, communities, and the energy system. The project has been:

- **Testing new market and flexibility models** – exploring new products and services that create commercial opportunities for everyone to benefit from the way we generate, store, and use energy in our homes, businesses, and communities.
- **Advancing the capabilities of networks to enable and manage smart, renewable, and storage technologies** – learning what needs to happen to our electricity networks to make them ready for the change to a smart local energy system.
- **Facilitating local participation in the energy system** – working with households, businesses and local institutions both individually and as part of Smart Community Energy Schemes at the low voltage level of the network.

The trials have helped us to understand the role flexible electricity use, storage and generation can play in optimising the use of existing network capacity as demand for energy increases, so traditional network investment (reinforcement) can be delayed, or even avoided.

In our trials, we have been testing:

- **Renewable energy generators** – such as river hydro and solar power
- **Storage batteries** – including batteries in electric vehicles (EVs), which as well as consuming energy can also return their stored energy to the network if it is needed to help to manage constraints.
- **Demand Side Response (DSR)** – individuals or businesses reducing or shifting their electricity usage when requested by a DNO. Our trials engaged with businesses with higher energy consumption, smaller businesses and domestic aggregated DSR.
- **Enablement of flexibility** – learning what systems and processes are required to enable flexibility, how much flexibility is available and how to participate in flexibility services.

Our trials can be split into two main categories.

Place based trials

© Richard Cave

Scope

Through our **Smart and Fair Neighbourhood (SFN)** trials, we worked with six local communities with distinct characteristics, considered how flexibility services can sit at the heart of a smarter, low carbon, locally balanced energy system, and how smart technology and new commercial models can create opportunities in a local energy marketplace and help us to understand how to do this in an equitable and fair way for everyone.

Trials

- **Eynsham Smart and Fair Futures SFN:** developing a 'Zero Carbon Energy Action Plan' for the Eynsham primary substation area.
- **Deddington and Duns Tew SFN:** decarbonising rural, off-gas communities through the exploration of installation of heat pumps, smart monitoring, deploying efficiency measures and creating flexibility from heating using thermal mass of houses. This has been extended to wider Oxfordshire in the Smart Flex Heat Pump Trial.
- **Osney Island SFN:** working with local residents to generate and store their own electricity and reduce demand on the electricity network, supporting the switch to EVs in a dense urban area.
- **Rose Hill SFN:** investigating how a community, including households who own few, if any low-carbon technologies, could contribute towards, and share the benefits from, the energy transition.
- **Springfield Meadows SFN:** aiming to optimise the use of large solar PV arrays on multiple domestic rooftops in order to maximise generation, deliver a net positive development and mitigate risks to the local network operations.
- **Westmill SFN:** looking at how with the existing solar and onshore wind farms, along with potential battery storage, the community could participate in local flexibility markets and use the existing network more efficiently.

© Richard Cave

Energy asset trials

Scope

Our energy asset trials explored the potential of various energy assets, such as a solar park or battery, to deliver flexible energy. We developed an iterative 'learn-by-doing' approach referred to as 'Minimum Viable System (MVS) trials', to enable short tests to be conducted to identify potential asset use cases, understand the required multiple system integrations and develop end-to-end procedures which could demonstrate operation of a local flexibility market.

Trials

- **Rose Hill Primary School PV and co-located battery:** aimed to understand how a small battery and rooftop PV could provide flexibility to the DNO.
- **Sandford Hydro:** upgrading the hydro control system to simplify delivery of flexibility services; testing the hydro to use the river as energy storage and provide flexibility to the energy network.
- **Sackler Library:** Oxford Behind the Meter (OBM) is a LEO plug-in project investigating the opportunity of DSR within Oxford city in the provision of both flexibility services and additional benefits made possible through virtual private wires applied across city-based organisations. The Sackler Library, part of the Bodleian Libraries, was chosen for the first trials.
- **Oxfordshire County Council Library:** This trial aimed to learn whether it is possible to use buildings as batteries to provide flexibility to the electricity network.
- **equiwatt aggregated involvement:** Equiwatt is a leading residential demand flexibility provider. The Equiwatt app enables households in Oxfordshire to participate collectively in flexibility services and be rewarded for helping balance demand and supply on the electricity network.
- **Ev.energy:** ev.energy participated in LEO's innovative trials and in response to a signal from the new trading platform, successfully bid for and provided a flexibility service to help balance the network by increasing demand and absorbing excess energy.
- **Ray Valley Solar:** Low Carbon Hub purchased the rights to a 19MW ground mounted solar park. To finance the project, Low Carbon Hub re-opened its Community Energy Fund. Uniquely, the solar park was designed to have the ability to control the export limitation for participation in capacity trading services.
- **Oxford Brookes University V2G chargers:** V2G chargers installed within the Oxford Brookes University campus managed by Nuvve's vehicle-to-grid (V2G) platform, called GIVe™ (Grid Integrated Vehicles), offers reliable, powerful charging for electric vehicles (EVs) that enables two-way energy flows between an EV battery and the electric grid.
- **Osney Lock Hydro:** LEO looked into ways to improve local renewable generation at OLH and the potential opportunities a local hydro scheme can have in providing flexibility services to the network and delivering benefits to the local community through Smart Local Community Energy scheme.

Findings and key messages

This report is intended to discuss the findings and key messages from the LEO Project, with a focus on providing insights that may be of use to regulators and policymakers. Further detail about any of the trials undertaken as part of the project can be found on the Project LEO website.[3] The findings from this project have been categorised into five pillars.

Project LEO pillars

DSO market development

It is expected that local flexibility will need to be facilitated by DSO actions, which will identify network needs and procure services from customer assets to manage network capacity constraints. The development of DSO capabilities is enabling both large and small assets to participate in flexibility markets, bringing benefits to customers, the network and wider society.

© Richard Cave

Benefits of DSO flexibility markets

Customers

- Enables connections by **'freeing up space'** on the network
- Provides a more affordable energy system through **flexibility**
- Secures a **route to markets** for larger customers

Network

- Allows effective prioritisation of network **reinforcement**
- Improves operational **monitoring** and forcasting capability
- Demonstrates ability to operate **markets**

Society

- Promotes **collaborative** working across sectors for Net Zero
- Enables a **societal shift** for travel, heat and interaction with the network
- Provides a **greener** energy system

Project LEO tested a range of DSO functions on a local scale, examining the technical and commercial elements required to enable local flexibility, and attempting to understand and adapt to the needs of individuals and communities.

The electrification of heating and transport systems is expected to drive up the consumption of electricity by households. To mitigate the costs associated with this transition, and in particular to manage the peak loads that drive network reinforcement, a combination of efficiency and flexibility will be required.

Flexibility services are a necessary part of such a transition because they allow customers to contribute to a system where network capacity is optimised. Without it, peak electricity demand is likely to be higher than it needs to be, and the subsequent network upgrades – as well as being costly – may not be deliverable in the required timescales. Furthermore, peer-to-peer services can enable the sharing of capacity to allow the growth of renewables without the need for significant infrastructure expenditure.

If individuals and local communities are to become active participants in the electricity system, appropriate flexibility markets need to be developed. There is significant flexibility potential at the local scale. V2G technology, for example, was trialled during this project, and was shown to have significant potential.

V2G must be encouraged

Key Message	Evidence	Policy Impacted
The Government's Smart charging action plan and Decarbonising Transport report must have continuous support and longevity to encourage broader V2G compatibility from manufacturers and inclusion of Vehicle-to-Anything (V2X)-ready chargers in planning guidance for new developments and building standards, to utilise the energy storage potential of growing fleet of EVs effectively.	The V2G trials demonstrated that energy can be discharged back into the network at the appropriate times successfully and has the potential to be used to support vulnerable customers, and during power outages, but predominately with constraint management.	• Electric Vehicle Smart Charging Action Plan[4] • Decarbonising Transport Plan[5] • Statutory Guidance on Infrastructure for charging electric vehicles: Approved Document S[6]

Domestic properties – in particular new builds – represent the potential for behind-the-meter optimisation of demand with small-scale generation and storage. However, in addition to regulatory reform, a new set of flexibility products and services are needed that reveal the value to those developing, owning and occupying these properties.

Holistic behind the meter approach is needed

Key Message	Evidence	Policy Impacted
We need very quick scaling of hyper-local products that are attractive to householders, social landlords, private landlords and SMEs. These products need to move beyond 'retrofit' to become 'futurefit' where fabric measures are part of a whole house/business behind the meter optimisation offer, considering long-term benefits over immediate costs.	Householders in SFNs, through work led by Low Carbon Hub are able to optimise their behind-the-meter energy use in a holistic manner including building retrofit and opportunities for supporting network operation.	• Delivering a smart and secure electricity system[7] • British energy security strategy[8] • Statutory Guidance on Conservation of fuel and power: Approved Document L[9].

Although there is significant flexibility potential at the local scale, there is also the risk that the transaction costs outweigh the benefits. Flexibility procurement, therefore, needs to be made as streamlined and automated as possible for all participants – both buyers and sellers. One key to achieving this is the standardisation of flexibility markets, services, products, contracts and interfaces.

This should both make participation simpler for flexibility providers across the country and ensure that the available flexibility procured by the DNOs, the ESO and other network actors is used without conflict and for the optimal Whole System benefit. In turn, flexibility providers then need to be rewarded in a way that reflects the value of those Whole System benefits.

Standardise flexibility markets

Key Message	Evidence	Policy Impacted
Flexibility markets require the development of standardised contracts between all participants with the potential of a new code of distribution services that defines the operation of flexibility on the distribution network with DSO, ESO and participants including supremacy rules.	There has been difficulty in recruiting participants to the project due to the complexity of the schedules, and the different requirements of individual actors. This has led to different contracts across DNOs, which adds to the complexity and makes the markets less attractive.	• Energy industry codes and agreements (e.g. DCUSA, BSC)[10] • Review of electricity market arrangements (REMA)[11] • ENA Open Networks Programme[11].

Even with standard procurement principles in place, it is unrealistic to expect local actors – with a range of interests and areas of expertise, not specialising in flexibility services – to engage effectively in the more complex nuances of energy markets. Suppliers and aggregators (technical and commercial) are therefore a key element, translating system and network flexibility needs into simple and credible customer propositions.

This includes facilitating access to a wider range of markets and services, ensuring that flexibility from a diverse range of small providers can be translated into a predictable and reliable source of flexibility upon which the network and system operators can rely to make planning and operational decisions.

Aggregators in the broadest sense are key to enabling flexibility at the grid edge

Key Message	Evidence	Policy Impacted
There is a functional expertise gap to enable non-specialist flex providers to participate in flexibility markets, meaning that aggregators, in the widest sense, are essential for enabling Smart and Fair Neighbourhoods, flex at the grid edge and organising many DERs.	Project LEO has demonstrated that flex market platforms and DSO-procured services can work and can help balance the network. But getting assets 'Flex Ready' can be specialist and resource intensive, for example adjustments to Building Management Systems. That support must be provided to ensure flex markets fulfil their potential.	• Review of electricity market arrangements (REMA)[13]

Flexibility markets are an important element of encouraging the development and provision of flexibility at the local level. In designing flexibility markets, though, there needs to be recognition that there are a number of technical, commercial, social, policy and regulatory challenges that need to be overcome.

Designing flexibility markets to overcome potential challenges

Challenge	Finding
Technical	• Every building, organisation or technology has different flexibility potential, presents its own challenges and is suited to providing a different combination of flexibility sources • Retrofitting buildings for flexibility is challenging, so where possible new builds and new installations should be future proofed • We need a simple, trusted and universal approach to accessing smart meter data that balances data transparency and individual agency • Stand-alone flexibility is only useful if it is coordinated, which may require integration with a market platform • DSO investment is required for a smart network and transparent market
Commercial	• Liquidity is one of the biggest challenges for local flexibility, particularly in the early stages of market development • It is particularly difficult for non-energy actors – such as leisure businesses – to assess the commercial potential of their sites ahead of time • There is a risk of tension between the short-term procurement favoured by DSOs and the need for forward visibility by flexibility providers
Social	• Recruitment of participants can be challenging, with a key barrier being the complexity of concepts and ideas around the need for flexibility and the benefits that it can bring • Recognising community and wider social benefits in a value proposition is greatly facilitated if customers have some knowledge of the problems that flex technologies can help to resolve • It is important to incorporate benefits for local communities into the value proposition, recognising that the benefits of flexibility will vary dramatically by audience and by technology
Policy & Regulatory	• Procurement process and contractual terms risk being too onerous for small flexibility providers • Local energy systems need the support of national level policy, regulation and planning

Investable business models

If local flexibility is to grow and endure, the regulatory and commercial environment must enable sustainable business models to develop. Without innovation funding, current business models in this area may not be sustainable. However, if the transactional costs around recruiting, integrating and dispatching flexibility are addressed, Project LEO provides evidence that these business models can become sustainable in the future.

Project LEO showed that there is significant potential associated with optimising energy systems at the local level, rather than relying primarily on the Transmission network to import and export power.

Optimisation behind the secondary substation brings a wide range of benefits

Key Message	Evidence	Policy Impacted
LEO has shown how optimisation can occur behind the secondary substation with the use of successful monitoring and optimised buildings that can take part in Smart Community Energy Schemes. As well as delivering efficient energy allocation and viable business models, such local optimisation has wider community benefits, creating Smart and Fair Neighbourhoods with engaged local participants.	Osney SFN includes embedded hydro generation and active participants with considerable numbers of DER. The project benefits from extensive low voltage network knowledge through connectivity and monitoring by the DNO.	• Review of electricity market arrangements (REMA)[14] • Elexon BSC P441 'Creation of Complex Sites' proposal[15]

It is, however, challenging to understand the volume and location of flexibility at the local level, as well as the value that it can bring to the local distribution network, without making flexibility visible through systems integration. Investment is therefore needed in data and digital capabilities to reveal the value of flexibility to the networks and to potential investors.

Investment in data and digital is key to enabling more efficient and smarter local area networks

Key Message	Evidence	Policy Impacted
Investment is needed in data and digital for networks, especially at the grid edge, surfacing data that is visible and understandable to those interested in the local area, outside of the DSO environment. This would enable more efficient and smarter operation of the electricity network through flexible services.	Innovation has allowed the development of proof-of-concept IT systems[16] to enable flexibility markets and develop further academic research projects. Osney Supercharge SFN is evidence of the power of modelling the low voltage network to allow the update of further low carbon technologies.	• Future regulatory price control (RIIO) determinations[17] • BEIS Low voltage network capacity study[18]

In recent years, there has been a reluctance to allow network companies to invest 'ahead of need'. However, Project LEO has shown that strategic investment in the network can deliver significant benefits for the network and local communities and is essential to meet Net Zero timelines. This investment needs to be justified on the basis of robust data, mapping and planning processes such as LAEPs.

Strategic investment is required

Key Message	Evidence	Policy Impacted
In order to deliver the additional capacity required for the energy transition there is the requirement for investment ahead of connection request in the network (strategic investment) complemented by flexibility services.	Councils' and local energy businesses' plans for the energy transition are not to be limited by current network capacity but use the LAEPs to justify strategic investment at all voltage levels on the electricity network out to 2040. Current generation projects planned by Low Carbon Hub have been delayed due to connections queues and lack of capacity, and this experience is slowing down the energy transition.	• Future regulatory price control (RIIO) determinations[19]

Flexibility is purchased by the ESO or DNO (or an aggregator acting as an intermediary) to support national needs on an ongoing basis or for local needs at specific times. Services are mainly purchased through auctions and the price may be capped or fixed. However, Project LEO has shown that the cost of making an asset flex-ready is high, the value of flexibility paid is generally low and the value does not recognise the benefits the delivery of flexibility provides to others at no cost. Given the aggregate level of flexibility expected to be available at the grid edge, the price may be insufficient to encourage smaller assets, e.g. EVs or heat pumps (even with automation and economies of scale).

The value of flexibility is currently undervalued, particularly locally

Key Message	Evidence	Policy Impacted
In order to encourage new flexibility to be made available, particularly at the grid edge, there is a need to reduce the flex-ready cost for providers (metering and verification) and for flexibility to be fairly rewarded for the benefits it delivers to others.	Project LEO identified high costs to make an existing asset flex-ready and reducing the metering and verification burden would help. The flexibility price paid represents the value to the buyer of the service. This ignores the benefits to the supplier (reduced energy costs), the distribution and transmission operation (reduced O&M costs), reduced carbon emissions, improved local air quality and delivery of Net Zero at lower cost if used to avoid investment in new capacity whilst enabling new renewables.	• Review of electricity market arrangements (REMA)[20] • ENA Open Networks, e.g. Common Evaluation Methodology[21] and Whole System CBA[22]

Skilled community of people

In order to create and sustain a local energy system, a range of new skills, roles, and knowledge-sharing capabilities are essential. This 'knowledge ecosystem' needs to encompass technical, commercial, social and organisational capabilities. At present, these capabilities do not exist to the extent necessary, but Project LEO has identified where the gaps are and the conditions necessary to foster the required local expertise.

Local collaboration

Key Message	Evidence	Policy Impacted
Project LEO has shown that SSEN, local stakeholders and local communities are up for the challenge of making the transition to Net Zero happen at the grid edge; they need support with policy changes at the national level if UK plc is to take advantage of this growing partnership approach.	The plain English approach to explaining the distribution network and flex services – and the positive response from householders, communities and local authority members resulted in a pipeline of people engaging with SFNs. The local authorities in LEO and Low Carbon Hub have made great efforts to understand their estate and enable it to deliver flex services.	• National Energy Category Strategy for Local Government[23] • Ofgem Call for Input: Future of local energy institutions and governance[24]

The range of priority skills identified as part of the project includes:

- **Technical skills:** Significant new technical expertise is required, including installers of low carbon technologies and people capable of operating these technologies. Skills gaps also exist in electrical engineering and power flow analysis.
- **Modelling skills:** This includes the modelling of flexibility assets such as buildings, but also local and network planning modelling to provide robust information and analysis to decision-makers.
- **Project Management skills:** To handle the complexity of interactions when building and operating a local flexibility market, Project Management and "technical convener" skills are required to coordinate relevant actors.
- **Marketing, communications, community development skills:** Local authorities have had cuts in funding for community engagement, youth work, community work and, as a result, lost skilled staff to other sectors . There also appears to be a skills gap around B2C marketing.
- **Commercial skills:** This includes the ability of potential flexibility providers to understand the risks and opportunities that flexibility markets create. It also extends to the DNOs who are having to improve their commercial capabilities as they take on more DSO functions.[25]
- **Legal skills:** Legal issues present a significant hurdle for participants in flexibility markets (for example, significant resource from the university went on legal review of the FSA (Flexibility Services Agreement) so there is a need for good legal skills both to draft and approve contractual agreements and to understand the legal risks.

© Low Carbon Hub

The Strategic Innovation Fund (SIF) is an innovation funding mechanism that is part of the regulatory price controls for electricity networks (RIIO-ED2). It has the potential to accelerate the knowledge and skills of network operators and local actors but some of the rules – particularly around the way in which investment can be deployed – risk limiting the scheme's potential.

Innovation funding is improving but must adapt to help deliver on Net Zero

Key Message	Evidence	Policy Impacted
Combined innovation funding streams make project governance easier, allowing more time to be spent on innovation and encouraging collaboration between BEIS and Ofgem. Some of the rules on investment, however, risk hampering our ability to demonstrate domestic level participation in the energy transition. Future funding for major systems change must allow for, and encourage, cross sectoral investment and the application of capital and revenue R&D investment to accelerate, at scale, real world innovation that delivers a benchmark for rapid change to deliver Net Zero ambitions.	The SIF funding stream has been developed to enable BEIS and Ofgem to innovate together and provides the opportunity to develop LEO and other projects further. Low Carbon Hub has been prevented from fully developing its technical aggregation tool (PPS 2.0) in Project LEO because of the iUK funding rules that prevented us from offering grant funding directly to households. The combination of funding streams and the investment in capital and revenue assets has allowed LEO to provide the pathway for future energy systems. Traditionally under typical innovation funding rules this could have taken many more years and funding rounds.	• RIIO innovation funding process and governance, including SIF and Network Innovation Allowance

Trialling Flexibility

Project LEO has been successful in motivating individuals and organisations to participate in Minimum Viable System (MVS) and Project TRANSITION's flexibility market trials. The agile approach of MVS trials allowed a dynamic 'learn by doing' approach: local energy asset owners could understand the requirements and processes to enable and use flexibility, adapting the processes with trial learning, introducing automation of processes, and informing the end-to-end procedures of the flexibility service delivery in the flexibility marketplace developed by Project TRANSITION.

Applying the learning and experience from MVS trials, Project LEO partners and external participants were able to take part in flexibility market trials involving DSO-procured and DSO-enabled peer-to-peer flexibility services, gradually increasing the size, complexity and liquidity of the market.

LEO and TRANSITION flexibility trials in numbers

	Trial period		
	Nov 21 - Feb 22	May 22 – Sep 22	Nov 22 - Feb 23[11]
Number of BSP substations participating	3	6	6
Number of participating DER types	Battery, Hydro, V2G, Solar PV	Battery, Hydro, EV, V2G, Solar PV, DSR domestic and commercial	Battery, Hydro, EV, V2G, Solar PV, DSR domestic and commercial
Number of DSO-procured services	1	4	4 + 2 stacked
Number of DSO-enabled services	2	2	2
Service horizons	Week ahead	Season, week and day ahead	Season, week and day ahead
Capacity procured	611	2925	784
kWh delivered	560	1118	3078
Price range for DSO-procured services (£/MWh)	300 - 500	600 - 1,200	600 - 1,200
Total auctions	48	124	194
Total service delivery events	73	95	103

The majority of these trials made use of a local market in one form or another. In that sense, Project LEO suggests local markets are an important motivating factor when recruiting participants into local energy systems. However, the trials have also shown that the reasons people give for participation are complex and not necessarily financially motivated. They also show that the value that can be derived from a local market in isolation is unlikely to be sufficient to motivate participation.

Hurdles to participation which have been identified by engaging with potential participants primarily relate to the complexity of the trials, the level of financial reward, the challenges surrounding internal engagement and governance within an organisation, the technical capability of an organisation's assets to provide flexibility, and finally whether organisations have the resource and skills to participate.

Project LEO partners have benefitted from interacting with, using, and informing new tools and systems developed by Project TRANSITION to streamline and simplify the end-to-end process for participation in the flexibility marketplace for all participants. These have included:

- **Market platform (known as the Neutral Market Facilitator (NMF))** which advertises auctions through a user interface and enables participation in auctions for DNO and peer-to-peer services. A satellite platform (operated by Piclo) provides visibility of auctions on the NMF and relays offers to the NMF. The NMF makes all decisions on contract award and delivery instructions (in conjunction with the Power System Analysis tool).
- **Power System Analysis (PSA)** tool enables near real-time decisions to be made on electricity flows on the network and supports NMF decisions on contract award and delivery
- **Baselining tool** uses historic metering data and delivery data and provides a transparent mechanism to support the validation of service delivery.

Lessons that have emerged from the trial relate to the need for robust and ongoing stakeholder engagement and the need to tie customer value to an articulation of the social good that they are providing. Furthermore, the limited value of any single market requires flexibility services to be designed in such a way that is not onerous or risky for participants, ideally with common standards to enable economies of scale through the use of automation and commercial aggregators.

Further community trials are required

Key Message	Evidence	Policy Impacted
Additional trials are required to further develop the Smart and Fair Neighbourhood Projects at a larger scale before integrating them into Business as Usual (BaU) processes.	We have most, if not all of, the above in trial in LEO through the SFN projects. This will allow us to move on swiftly to develop and trial these models in large-scale test areas, where DNO BaU and innovation teams are enabled to work together to support the development of the new products.	SIF and other funding sources aimed at local and community schemes, such as those identified by Community Energy England.[26]

Mapping for Local Area Energy Plans

LAEP development has the potential to provide the structural framework around which markets can be created, new roles can be defined, skills can be enhanced through training and recruitment, and ultimately sustainable business models can emerge. Whilst LAEPs are not a panacea, if viewed as a process rather than a product they can provide the basis for information sharing, coordinated planning, and a common path forward around which the necessary local ecosystem can form.

Importance of LAEPs Local Area Energy Plans (LAEPs) are vital to achieve Net Zero

Key Message	Evidence	Policy Impacted
Project LEO has shown how collaborative, Local Area Energy Planning is necessary to get to Net Zero. LEO would recommend the development of a body that can enable the development of a flexible and scalable LAEP and associated toolkit in regional geographies where the local authority with democratic accountability, can properly interface with the energy system and network geographies. That body could enable delivery by providing advice, insight and supporting timely decision making to support LAEPs.	Beyond innovation projects, councils struggle to find the resource and capabilities to develop plans with the level of engagement required, that can feasibly be delivered. The LEO Project was supported by the Low Carbon Hub which helped make the project a success. As part of the Eynsham SFN, Low Carbon Hub developed a trial of energy planning at the Primary Substation Area: using the energy mapping Toolkit supported by ESC (Energy Systems Catapult). The Rose Hill area has used the LEMAP tool in local area energy planning, and has included spatial mapping and analysis of technical, economic and social aspects of developing the plans.	Ofgem Call for Input: Future of local energy institutions and governance[27] National Planning Policy Framework.[28]

One of the primary purposes of an LAEP is to facilitate broad engagement from the local community, planners and governmental organisations, networks (gas, water and electricity) and energy market experts. In order to achieve this coordinated approach, entities need to be well represented in the consortium developing the LAEP.

However, there is also a need for a single entity to take ultimate responsibility for creating and maintaining the LAEP. In response to Ofgem's Call for Input of local energy institutions and governance, Project LEO recognised the importance of the local authority in providing a strategic view but that there was a resourcing and skills gap. We recommended that there be an additional actor to coordinate and enforce the long-term plans of all energy vectors including the energy, gas and heat networks.

This could be a regional system planner (not operator) who has the capacity to integrate deep technical knowledge of grid operation both now and in the future with understanding of the social, economic and technical capability of a neighbourhood to progress down a Net Zero path. However, we would note that this is no small undertaking, and to carry it out requires appropriate resourcing. It is our belief that LAEPs should be made a statutory requirement, but this requires a clear mandate at the national level, supported by an appropriate level of funding.

Planning legislation reform is required

Key Message	Evidence	Policy Impacted
There needs to be planning legislation changes to enable greater uptake of solar installations and Net Zero building policy.	LAEPs need to be supported by local policy, policies need to be updated, and the time it takes to apply them needs to be reduced. The development planning process is not fit for purpose to enable Net Zero to be delivered to required timescales, as evidenced by the Salt Cross Area Action Plan inspection, West Eynsham's lack of a Strategic Development Plan, and the Osney issues over rooftop solar.	Ofgem Call for Input: Future of local energy institutions and governance[26] National Planning Policy Framework[30] Planning (Listed Buildings and Conservation Areas) Act 1990.[31]

The development of accurate datasets and clear mapping tools has proven to be essential for sharing knowledge and facilitating engagement with the diverse range of stakeholders needed to create and operate a local flexibility market. In particular, mapping is an essential prerequisite for the development of an LAEP.

LAEPs should be made a statutory requirement and should be administered by Local Authorities. However, there should be a broad consortium of stakeholders involved in their ongoing development to ensure that they are reflective of both the capabilities and needs of local communities.

© Richard Cave

Conclusions

Project LEO focused on understanding how flexibility at the 'grid edge' – where energy is put to use – can help us reach our Net Zero ambitions, as well as bringing value to people, communities, and the energy system. With the right infrastructure, markets and regulation, small-scale electricity system users should be able to provide the flexibility to the electricity network.

Local flexibility has the potential to be a key part of a future low carbon electricity system. However, implementing flexibility at this level brings with it a range of technical, commercial, social and regulatory challenges. Some of these are likely to resolve themselves as these markets develop, scale up and become mature. However, it will be essential to reduce the transaction costs associated with securing flexibility from large numbers of small flexibility providers.

Flexibility markets have the potential to motivate potential flexibility providers to participate. However, it is not enough simply to create the markets and define the services. Most flexibility providers – particularly at this scale – are not energy market experts and have 'day jobs' to focus on. There is a significant role for aggregators and other third parties to facilitate the involvement of these actors in flexibility markets. We also expect that automation is going to be essential both to facilitate participation in what can be complex and dynamic markets, as well as reducing the transaction costs associated with buying and selling flexibility.

Local flexibility will only be deliverable at scale with the development and recruitment of new skills. These skills need to be channelled into well-defined roles. This needs to be placed within a well-functioning knowledge 'ecosystem' where actors can share information and knowledge, and understand each other's roles and responsibilities.

Whilst there are various non-monetary benefits associated with providing flexibility at the local level, it will be important to ensure that the individuals and organisations providing flexibility are well-incentivised. It is also important to recognise the complex value chain associated with delivering flexibility, including aggregators, platform developers and governmental organisations such as local authorities. Each of these needs to be able to fund its operations – and in the case of private organisations to do so profitably. There is some latitude for innovation-based investment in the short term, but for local flexibility to become a significant part of the overall flexibility landscape these business models need to be self-sustaining.

Provided they are underpinned by good data and mapping, LAEPs are a valuable means of creating consensus and providing a common vision for a local area. Whilst a broad consortium of stakeholders is needed, local authorities are likely to be central to the ongoing maintenance of LAEPs. To enable this, there is a need for a supportive planning framework and strong policy context to resource and allow them to develop strong local plans and policy for smart local energy systems.

A supportive policy and regulatory context is critical to creating the sense that investment in smart technologies is future-proofing a home, business or organisation. The adoption of Net Zero at a national and local level has been strongly influential in guiding local authority decision-making in respect of flexibility and smart energy initiatives. Governmental support for Net Zero gives people and organisations confidence that the coming reforms require widespread participation, that there are real benefits to be had from taking part, and that being a 'first mover' is the only way to Net Zero in the time available.

© Richard Cave

Glossary of key terms

Aggregation
The bringing together of multiple energy assets (wind, solar, batteries etc) often owned by more than one person, into one combined portfolio to provide a flexibility service.

Aggregator
A company or other body that brings multiple energy assets (e.g. wind, solar, batteries) together and acts as an intermediary between the asset owners and the flexibility market, acting on the owners' behalf.

Baseline
What a meter reading would have been if the flexibility service were not being delivered, i.e. the usual generation or consumption of the Distributed Energy Resource (DER) at a specific time.

Behind the meter
Usage, generation or storage of electricity inside a property or site, on the energy user's side of the electricity meter that connects the property or site to the grid. Conversely, anything that happens on the distribution network side of the meter is deemed to be 'in front of the meter'.

Constraint
A situation where an imbalance in electricity supply or demand means the network is unable to transport sufficient electricity to meet the electricity demand at a given time and place or that is being produced by a generator.

Distributed Energy Resource (DER)
Anything that generates electricity (like a wind turbine) or stores electricity (like a battery) and sends it to the local DNO can be called an energy resource. If that energy resource can temporarily change the amount of electricity it sends to the local network and can do this on request, it is called a Distributed Energy Resource (DER).

Distributed generation
In the past, large scale energy generators like power stations were often located a long way from where the electricity was being used. Now with a growing number of smaller scale and more environmentally friendly ways of generating electricity, such as solar panels and wind turbines, energy can be generated near to where it is being used: this is called distributed generation.

Distribution network
This part of the electricity network reduces the higher voltage energy that is delivered to your area by the Transmission Network and uses power lines and other infrastructure to send it to homes and businesses where it is needed. The Distribution Network is also playing an increasingly important role in connecting local DERs to the network.

Distribution Network Operator (DNO)
The Distribution Network Operator, or DNO, is responsible for owning, operating, and maintaining the electrical network in a geographical licence area and delivering electricity to communities and customers throughout the licence area, including, homes, businesses, and industry. A DNO also maintains upkeep and investment in the electricity network to ensure it is functioning and capable of handling electricity demand.

Distribution Network Operation (DSO)
Distribution System Operation, or DSO, is a series of functions in coordinating and managing the operation of the distribution electricity system. These securely operate and develop an active distribution system comprising electricity networks, electricity demand and generation management, and other flexible distributed energy resources.

Domestic Demand Side Management
The use of flexibility in household demand to reduce or shift consumption in a way that is beneficial to the network or system, for example by avoiding periods of peak demand where a network may be constrained.

Electricity supplier
A company that buys electricity from the network, and in turn sells it to domestic, commercial and industrial users. This is the company that customers receive their energy bills from.

Electricity System Operator (ESO)
Manages the electricity system and ensures supply meets the required demand. The ESO performs several important functions, including second-by-second balancing of electricity supply and demand, to developing markets and advising on network investments.

Flexibility
Making temporary changes in the way electricity is consumed, generated, or stored in response to a request, to support a more efficient use of the energy network.

Flexibility provider
A person or organisation who provides flexibility by making temporary changes to the way they consume, generate, or store electricity when requested.

Flexibility service
When flexibility is provided in response to a request, the person or organisation is providing a 'service.' Different sorts of services can respond to different network needs.

Generation
Any electricity that is produced. For example, electricity generated by energy assets such as wind, hydro or solar farm.

Grid edge
Where people make use of the low voltage power delivered by the DNO to homes, businesses and other organisations.

Grid edge technologies
The hardware, software and other innovations being developed for people to have a more active relationship with the electricity system, which can support the transition to a more decentralised and flexible energy system.

Minimum Viable System (MVS)
The minimum amount of people, technologies and processes needed to test whether an idea or process works as expected. In Project LEO, this enabled quick identification or confirmation of the value of what was being tested, before substantially more time, money and engagement was invested.

MPAN
An identification number for electricity meters. It can be used to identify the location of the electricity meter on the network and stands for "Meter Point Administration Number".

Smart grid
What makes an energy network into a 'smart grid' is the use of digital technologies that support a two-way flow of both electricity and information. This helps the network automatically detect and make decisions about what changes are needed to avoid network problems and for the network to 'fix itself' if issues occur. Smart grids can interact with people and resources both using and generating electricity to keep the network running smoothly and efficiently.

Smart Local Energy System (SLES)
A new concept which is where local and national energy infrastructure, people/communities, and technologies work together to make, move, store, sell, use and conserve energy locally. A successful SLES creates value for the community it serves and should respond to the community's objectives.

Time of Use (ToU) Tariff
An electricity tariff where the charge made for using electricity changes depending on the time of day. A "static" ToU Tariff has set times of day when charges differ, whereas a dynamic ToU Tariff varies its rates depending on how much it costs to generate electricity at any given point.

Transmission network
In England, this is commonly called "the National Grid". It is a high-voltage system designed to move electricity from large power stations around the country to where it is needed. It is made up of transmission lines, towers and substations.

Whole system
All aspects of the energy system including the electricity system of transmission and distribution networks, generation of electricity, storage, and how energy is used.

References

1. Funded by the UKRI Prospering from the Energy Revolution Programme
2. SSEN Transition (ssen-transition.com)
3. https://project-leo.co.uk/
4. Electric Vehicle Smart Charging Action Plan, BEIS, January 2023.
5. Decarbonising Transport: A Better, Greener Britain, Guidance by Department for Transport, July 2021
6. Infrastructure for charging electric vehicles: Approved Document S, Statutory guidance from the Department for Levelling Up, Housing and Communities, 2022
7. Delivering a smart and secure electricity system: the interoperability and cyber security of energy smart appliances and remote load control, BEIS, July 2022
8. British energy security strategy, Government policy paper, 2022
9. Conservation of fuel and power: Approved Document L, Statutory guidance from Department for Levelling Up, Housing and Communities and Ministry of Housing, Communities & Local Government, 2022
10. https://www.ofgem.gov.uk/energy-policy-and-regulation/industry-codes-and-standards
11. Review of electricity market arrangements, BEIS, 2022
12. https://www.energynetworks.org/creating-tomorrows-networks/open-networks/
13. Review of electricity market arrangements, BEIS, 2022
14. Review of electricity market arrangements, BEIS, 2022
15. https://www.elexon.co.uk/mod-proposal/p441/
16. Including the Neutral Market Facilitator, Select and Dispatch Tool, LV monitoring, Baselining, Forecasting Constraints, Power System Analysis.
17. https://www.ofgem.gov.uk/publications/riio-ed2-final-determinations
18. Low voltage network capacity study, BEIS, 2022
19. https://www.ofgem.gov.uk/publications/riio-ed2-final-determinations
20. Review of electricity market arrangements, BEIS, 2022
21. https://www.energynetworks.org/industry-hub/resource-library/on22-ws1a-p1-statement-for-common-evaluation-methodology-for-network-investment-decisions-(14-jan-2022).pdf
22. https://energynetworks.org/creating-tomorrows-networks/open-networks/whole-energy-systems
23. National Energy Category Strategy for Local Government, Local Government Association, 2022
24. https://www.ofgem.gov.uk/publications/call-input-future-local-energy-institutions-and-governance
25. https://www.energynetworks.org/industry-hub/resource-library/open-networks-2018-ws3-p2-dso-functional-requirements.pdf
26. https://communityenergyengland.org/pages/funding-opportunities-2
27. https://www.ofgem.gov.uk/publications/call-input-future-local-energy-institutions-and-governance
28. National Planning Policy Framework – GOV.UK (www.gov.uk)
29. Call for Input: Future of local energy institutions and governance | Ofgem
30. National Planning Policy Framework – GOV.UK (www.gov.uk)
31. Planning (Listed Buildings and Conservation Areas) Act 1990 (legislation.gov.uk)


© Richard Cave

DOI: https://doi.org/10.24384/wapg-qd24
ISBN: 9781739905873

Project LEO would like to thank

INDUSTRIAL STRATEGY

UK Research and Innovation

And all the communities, organisations and individuals, who also supported Project LEO

Scan to visit the Project LEO website

Scan to download the Project LEO Final Report

Scan to visit the TRANSITION website