

Network Innovation Allowance Annual Summary

Progress and results from regulatory year 2023/24

July 2024



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Foreword



The UK's electricity system is moving at an unprecedented pace, with low carbon technologies (LCTs) continuing to increase in volume and customers' expectations rising. It is UK Power Networks' vision to be an enabler of the transition to net zero and to be sustainably cost-efficient. Innovation has a critical role to play in supporting this vision.

Our 2023/24 Network Innovation Allowance (NIA) annual summary showcases some of our industry-leading innovation projects. As a leader in innovation, we are committed to delivering value to our customers and stakeholders, while facilitating the transition to a net zero energy system and economy. As we enter a new regulatory price control period, RII0-ED2 from 2023-2028, we are placing a significant focus on business-funded innovation to drive improvement. Therefore, this report covers mostly NIA-funded projects, but also a few business-funded and Strategic Innovation Fund (SIF) funded projects, to reflect the breadth of topics addressed by our Innovation portfolio.

The challenges of achieving net zero are too great for any one organisation or even sector to achieve alone so we have an ongoing programme of engagement and research to enable us to build on existing insights and deepen our understanding of the changing needs of our customers and stakeholders. This report highlights some of our key learnings.

We have also adopted a clear and agile process to engage with our business and external stakeholders, to identify and prioritise innovation opportunities that meet the current and future needs of our customers and society. In this document, we highlight some of the key projects and achievements across our innovation themes, demonstrating how we are delivering benefits in terms of network performance, customer service, social impact, and cost savings.

We also share our learnings and challenges, and how we are addressing them through collaboration, fast-following, and continuous improvement. We are proud of our innovation portfolio and the outcomes we have achieved in the past year, and we look forward to continuing our journey of innovation excellence in the next year and beyond.

We are continually on the lookout for the best new ideas and innovators to collaborate with, whether you are an early-stage start-up or an established enterprise. If you have an idea or a new solution that could help us deliver a better service for our customers, then we want to hear from you. Get in touch at innovation@ukpowernetworks.co.uk

Matthew White

Head of Customer Services and Innovation

Our Innovation Strategy

This year was the first of a new regulatory period, and with it came a refresh of our industry Innovation Strategy. We have aligned our Innovation Themes with those of the industry as illustrated in Figure 1.

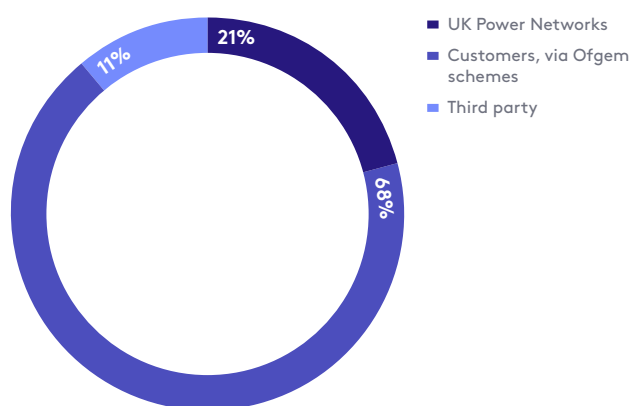
Our innovation portfolio now includes a significant focus on internally funded innovation, and covers a broader focus to assess benefits beyond the network which will positively impact society as a whole. Focusing on social return on investment, as well as providing additional support to vulnerable customers beyond our traditional role, has seen us expand the diversity of our innovation pipeline and the associated benefits we have forecast as a result.

During the 2023/34 regulatory year, 21% of our innovation project work was self-funded, as shown in Figure 2. 11% of the work was funded by partners we collaborated with, and 68% was funded by NIA, SIF and NIC.

Figure 1: Our RIIO-ED2 innovation themes.



Figure 2: Percentage of network company funding in innovation projects.



Our strategy also focuses on refining our processes to engage with our business during innovation ideation. This is both to ensure we are embarking on innovation that meets a business need, and that it is then adopted into our Business as Usual (BAU) practices efficiently, expediting the return on investment to our customers.

Figure 3: Our innovation strategy.



View our Innovation strategy [here](#).

Our Innovation Strategy

Continued

What our stakeholders are telling us

We carry out a broad and inclusive programme of ongoing engagement and research to deepen our understanding of the evolving needs of our stakeholders and customers. Our innovation programme is shaped in response to both ongoing and emerging issues in the external environment, our business priorities and objectives, and learnings from engagement and research activities. This helps us tackle the complex challenges of both the industry and our stakeholders.

The table below highlights how our engagement activities have helped us understand what is important to our stakeholders and customers, in relation to our innovation themes.

	Challenge/Key question	What we learned	What we did
Consumer vulnerability	How can we better support Priority Services Register customers in high-impact events?	From engagement and research, we know customers who are medically dependent on electricity can suffer considerably from a power cut and the thought of an unexpected power cut can be the source of high anxiety and stress.	Through our Power Protect project, we are increasing the support available to customers who are medically dependent on electricity. We are the first distribution network operator (DNO) to create a dedicated support service using portable batteries for customers reliant on vital medical equipment during any power outage over four hours long.
Net Zero and the Energy System Transition	How can we support communities to transition to LCTs as quickly and easily as possible?	Local authorities face challenges in developing Local Area Energy Plans (LAEPs). The LAEP process is both complex and unfamiliar with many local authorities lacking the resources and expertise to develop these plans.	We made it easier for local authorities to get started by developing a free online energy planning tool, Your Local Net Zero Hub via project CLEO. The tool was co-designed with local authorities, LAEP practitioners and community energy groups, providing information, data visualisation and optioneering tools, with live chat support, as well as ongoing training.
Proactive Optimised Assets and Practices	How can we enhance our support during power cuts and major events?	We understand that more of our customers work from home than they did pre-pandemic and require both a continuous power supply and a steady internet connection. Whereas previously customers would be in the office for the majority of planned outages, we now have a significant customer base who may be affected by our daytime maintenance activities.	Planned supply interruptions are necessary in normal operation of the network. However, given the increased dependency on electricity of our customers, we are continuing to meet their needs by trialling a new portable device through our project Reskuba. This device can provide temporary power and internet to homes, enabling customers to continue to work from home throughout any planned work we need to carry out to maintain the network.

Our Innovation Strategy

Continued

	Challenge/Key question	What we learned	What we did
Flexibility and Commercial Evolution	What actions should we take to develop the flexibility market and enable broader participation?	With more and more customers transitioning to LCTs, flexibility will play a key role in the day-to-day management of the network. Through smart charging, customers can shift their consumptions to times when the tariff is lower, which align with when demand on the network is traditionally lower. Through engagement with flexibility providers, we have learnt that in future they will encourage more and more smart charging from their customers to maximise renewable energy generation. This could occur during periods where the network is constrained and create secondary peaks. Additionally, flexibility providers have told us they want to explore dynamic network pricing by location to demonstrate this will lead to an overall lower cost and enable more LCTs to connect.	We are trialling locational day-ahead price signals which could complement the flexibility services we contract. Through our Shift 2.0 project with Octopus Energy and ev.energy, we are testing commercial arrangements and mechanisms to manage the growth of secondary peaks, understanding the diversity of response between different market participants and exploring the potential to unlock greater participation in flexibility.
Data and Digitalisation	How can we make our services easier and more convenient for customers to interact with?	Our customers told us it was taking too long to get a formal connection offer for new high voltage (HV) connections. Customers were also often dissatisfied with the process as there was a lack of visibility of both the network constraints and how the costs are calculated.	We are developing an online self-serve tool, HV Autoquote, for formal connection offers and budget estimates, reducing the time to quote from weeks to minutes. Speeding up the process for customers and providing greater visibility of how costs are calculated, ultimately enabling us to deliver work quicker for our customers.
Whole Energy System	How can we enable those ready to connect to do so faster?	Increasing levels of renewable generation are connecting to the network, but transmission-level constraints are resulting in connection lead times in the 2040s in some areas. Since the South East of England is seeing impacts on connection lead times earlier and more severely than other parts of the country, we need to tackle this challenge to ensure we are not a blocker to the transition and that capacity on the network is used in a fair way that meets growing demand for electricity.	Our Trading Connections project builds on our engagement with the ENA last year to optimise and manage the queue of connecting customers. Through the project, we are looking to provide customers visibility of UK Power Networks' connections queue and enable customers to trade queue positions where appropriate, enabling those who are ready, to connect sooner.

Our Innovation Performance

How we are innovating

Our culture of innovation

We are striving to maintain our position as an industry leader in innovation, and this means embedding our innovation culture beyond the team directly delivering projects. There has been significant investment into business funded innovation. This initiative sees our various business units delivering their own innovative projects with support from our innovation engineers. This approach has supported our wider innovation goals and has led to strong engagement with the various stakeholders across our portfolio.

We also readily engage to continuously improve the innovation approach across the wider industry. Led by UK Research and Innovation (UKRI), we helped co-author a comprehensive action plan to identify areas of further improvement of our culture of innovation for DNOs across the UK. Having surveyed the various DNOs across the country, the action plan found innovation teams could improve how they engage with their internal business units.

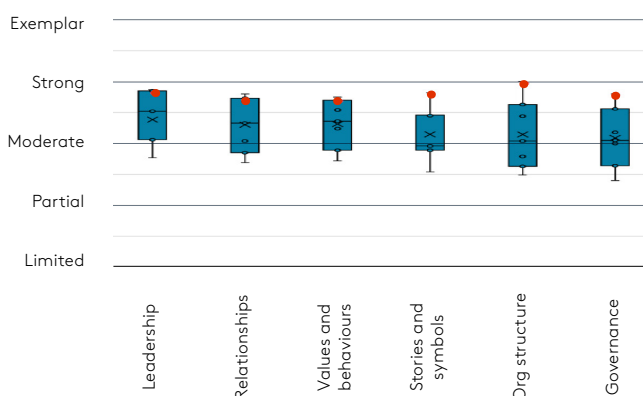
A key output of the industry project was an exemplar. This exemplar sets out the building blocks of the innovation culture needed to deliver net zero, and describes what great looks like for the soft and hard aspects of innovation culture within individual networks, and in the wider industry.

Figure 4 shows the survey results of all participating networks, against high-level components of the exemplar, with UK Power Networks' results shown as a red dot.

Building on insights from the survey, we investigated further which areas of our business are facing the biggest challenges and worked with these teams to facilitate in-depth workshops to develop innovation roadmaps for areas of interest. This initiative is part-owned by our various business units, which helps drive buy-in from key stakeholders.

Figure 4: Culture of innovation - how we compare to the exemplar and our peers.

● UK Power Networks



Collaborating with our partners and stakeholders

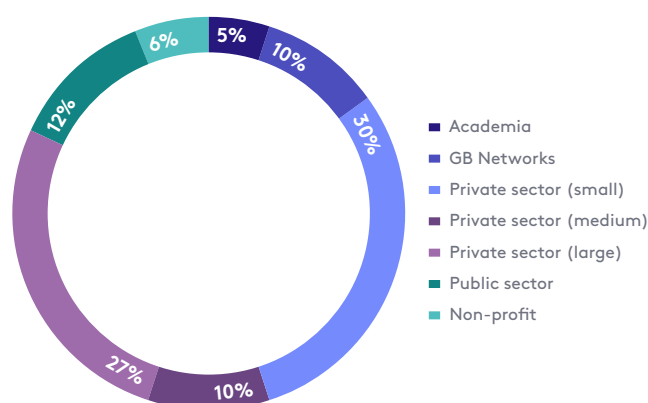
Collaboration remains one of the most important aspects of a healthy innovation portfolio and helps ensure our work is reflective of the diverse challenges our industry and customers are facing. We rely on collaboration with stakeholders and customers to identify new opportunities and maximise the impact of our service. To ensure this diversity of thought, we have worked with a range of partners including technology vendors, software start-ups, energy suppliers, vehicle and fleet operators, local public bodies, and government.

Improving the lines of communication between our teams and the wider industry means identifying and removing potential barriers to engagement. We are working to communicate our challenges to innovators in a straightforward way, while also increasing the frequency at which these calls to action go to market. We have also continued to leverage our strong relationship with the Energy Innovation Centre (EIC) to provide a collaborative space between innovators and the industry.

Figures 5 and 6 show the range of project partners and supporters we have been working with.

In the regulatory year 2023/24, we have worked with 86 partners to innovate, with large and small companies from the private sector representing the biggest shares.

Figure 5: Our project partners.



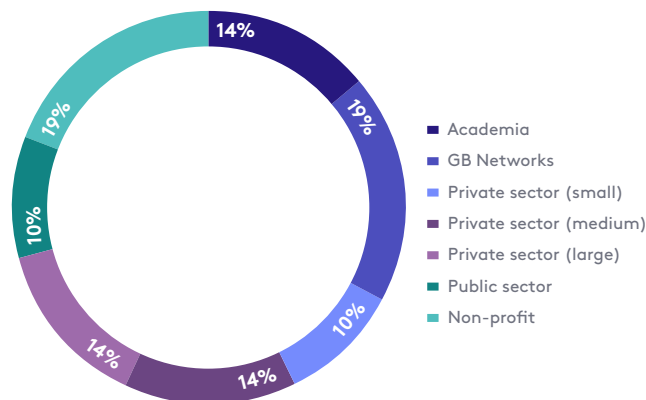
Beyond these partners, we had 30 project supporters, with the public sector and small private companies being the largest represented, closely followed by non-profit organisations and academia.

Our Innovation Performance

Continued

Collaborating with our partners and stakeholders (Continued)

Figure 6: Our project supporters.



Fast following others

Fast following forms an important part of the innovation ecosystem and ensures that benefits are disseminated to the industry and maximises customer benefits. We are continually collaborating with other DNOs and the EIC to identify successful projects that can be readily deployed into BAU. During 2023, we have been testing some solutions developed by other networks on our own network using our own business funds, rather than the NIA.

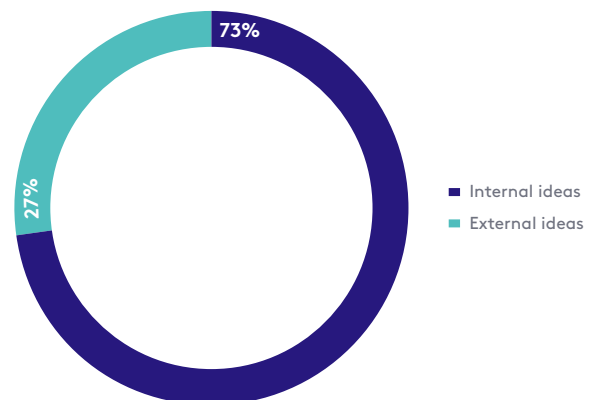
Ideas we are launching

Our innovation pipeline

We are constantly assessing the health of our innovation pipeline by considering, not only the value of the benefits to our consumers, but also the diversity of this portfolio, tracked against our innovation themes. In planning our innovation strategy for RIIO-ED2, we committed to ensuring that our innovation strategy is agile and allows us to pivot our priorities at a pace that matches any changes in the industry. A diverse portfolio allows us to do this.

In 2023/24, 73% of our ideas came from internal sources, as shown in Figure 7.

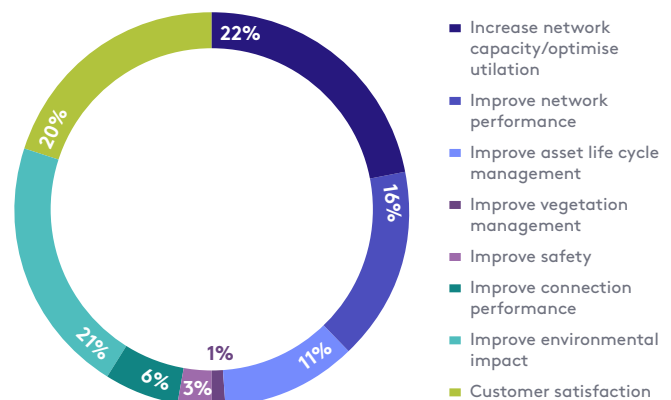
Figure 7: Percentage of internal and external ideas.



Figures 8 and 9 show the distribution of our innovation delivery portfolio across areas of value and innovation themes.

The three value areas in which we had most projects were Optimising network utilisation (22%), Improving environmental impact (21%) and Improving customer satisfaction (20%).

Figure 8: Distribution of our projects across areas which stakeholders value.



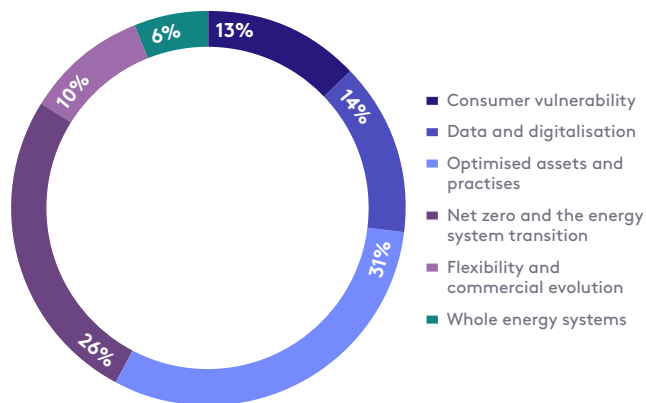
Our Innovation Performance

Continued

Our innovation pipeline (Continued)

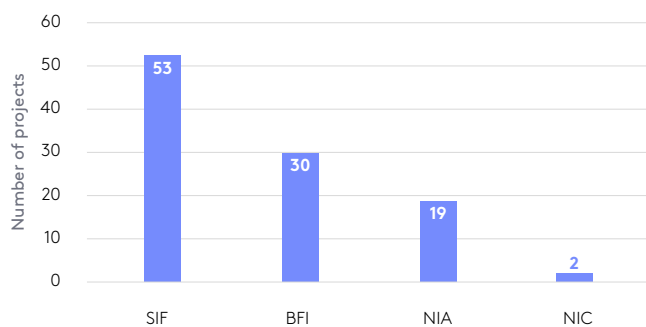
The three themes in which we had most projects were optimised assets and practices (31%), net zero and the energy system transition (26%) and data and digitalisation (14%).

Figure 9: Distribution of our projects across our six innovation themes.



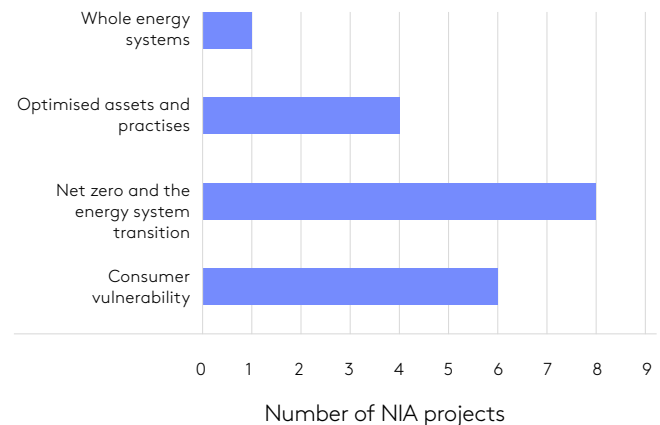
During the regulatory year 2023/34, we delivered 104 projects. Figure 10 shows that NIA projects represented 18% of our innovation portfolio (19 projects), while SIF accounted for 51% of projects, Business Funded Innovation (BFI) for 29% and NIC for 2%.

Figure 10: Distribution of our innovation projects across funding streams.



The primary themes of our 19 NIA projects are shown in Figure 11, with net zero and the energy system transition (8 projects) and consumer vulnerability (6 projects) being the most represented themes.

Figure 11: Distribution of NIA projects across themes.



Customer Vulnerability Project Highlights

We aim to deliver the greatest possible support to those in our communities who need it most. We define vulnerability as a situation which can arise when aspects of the energy market combine with someone's personal circumstances, or the circumstances of their environment, to create conditions where they are more likely to experience hardship.

Our Consumer Vulnerability Strategy ensures that support for vulnerable customers is delivered by design across all our activities, both in our normal operations and in the transition to net zero. Innovation plays a key role in this strategy, and helps deliver best value and excellent service for all our customers. We work closely with other organisations to develop innovation projects which maximise the reach, and scope of support we provide for these customers, ensuring we deliver social return on investment for our communities.

Our Innovation Performance

Continued

Customer Vulnerability Project Highlights (Continued)

Our customers want us to continue helping people that are in vulnerable circumstances. Our strategy has been shaped by extensive stakeholder engagement and research. Through this engagement, we have defined the following key outcomes to focus on:

- **Using data and analytics to understand vulnerability:** Harnessing the power of data and analytics to inform, share, prioritise and tailor our customer vulnerability approach.
- **Digital inclusion:** Working with third parties, trusted partners, and communities to proactively provide innovative solutions to reach our digital excluded and hard-to-reach customers.
- **Leaving no one behind in the transition to net zero:** Collaborating to make sure our vulnerable and fuel poor customers will have the best opportunity to participate in the evolving flexibility and distribution system operator (DSO) markets.
- **Understanding and informing policy:** Proactively participating in and influencing regulatory initiatives, such as the call for input for engaging domestic consumers in energy flexibility, to make fairer access to the network, reduce the cost of decarbonisation, and enable local energy markets.

We have a strong track record of delivering innovation activities focusing on fuel poverty, inclusiveness, and fair access to the transition to net zero. We are also focusing on supporting those who may be left behind in the energy system transition within projects such as Spotlight, Socially Green and Power Protect.

Spotlight tackles the challenge of identifying customers who are more likely to live in vulnerable circumstances. Traditionally our industry relies on broad demographic trends, which limits the ability to focus our efforts and support the most vulnerable members of our communities. Spotlight combines the latest advancements in data analytics with new data sources to identify those who are in need of more support on a more granular level. Targeted support for these customers will enable substantial societal advantages including reduced stress during outages, relief from financial debt, and a contribution to reduced carbon emissions through participation in the energy transition.

Socially Green is seeking to identify different customer segments to understand what support our vulnerable and disadvantaged customers need during the net zero transition. We have conducted a comprehensive review of activities in this sector so far, while exploring all identified gaps. The project also includes the development and trial of tailor-made flexibility products and engagement mechanisms which deliver inclusive flexibility services specifically designed for hard-to-reach customers. This also aims to demonstrate the necessary commercial arrangements necessary to acquire a societal return on investment once flexibility is successfully secured.

Power Protect developed and trialled a new service to offer portable battery packs to vulnerable customers who are dependent on electricity to power medical equipment and experiencing a power cut for an extended period of time. Whilst a simple idea, it was a significant undertaking, building a robust process that ensures the customer's needs are supported during power cuts. The project proactively identified vulnerable customers who were eligible and dispatched batteries. Power Protect increased the safety of the most vulnerable customers and alleviated the stress of their medical equipment not working, or their medical equipment's battery running out during power cuts.

Net zero & Energy System Transition Project Highlights

As an electricity network, we are responsible for powering people's homes, businesses and, increasingly, their vehicles and heating as they look to decarbonise. Sitting at the core of energy dependent transport and heating sectors, it is essential that we facilitate the timely and cost-effective roll-out of LCTs and to remove barriers impeding the net zero transition. The path to net zero is unknown and the projects we have selected for our report highlight our commitment to supporting our customers as they transition to a net zero society.

Emerge aims to reduce the time it takes for domestic customers to switch to LCTs and reduce the disruption from multiple home visits during potential upgrades. Recognising that a fuse upgrade could be a blocker to the replacement of a gas boiler with a heat pump in an emergency breakdown event, we worked with Octopus Energy to explore what is required to enable appropriate third-party meter operator organisations to undertake fuse upgrades for customers.

Collaborative Local Energy Optimisation (CLEO) will provide core planning datasets via an online, self-service energy planning tool to support the planning process for our local authorities. This local area energy planning self-service tool will allow local authorities to layer local input such as decarbonisation strategies and action plans, local market trends, social inclusion policies and transport plans upon our network infrastructure data, helping them make the best choices for their communities.

Our Innovation Performance

Continued

Net zero & Energy System Transition Project Highlights (Continued)

Heat Risers tackles a pressing issue in heat decarbonisation, focusing on multiple occupancy buildings. It delves into understanding and overcoming connection barriers hindering the transition to low carbon heating systems. By investigating complex factors such as customer understanding, policy intricacies, and scalability challenges, the project aims to develop actionable solutions to accelerate sustainable and equitable decarbonisation opportunities. Heat Risers will address these challenges by developing a conceptual decision-making framework, recognising the need for tailored solutions based on specific building characteristics and network considerations.

Flexibility & Commercial Evolution Project Highlights

The theme of Flexibility and Commercial Evolution is pivotal in shaping the future of UK Power Networks, aligning with the nation's commitment to net zero. This theme recognises the need for a resilient and adaptive electricity distribution network, emphasising the importance of innovative projects that enhance flexibility, commercial viability, and sustainability.

The following three projects exemplify the strategic initiatives undertaken to maintain a reliable electricity distribution network in the face of evolving energy demands and market dynamics.

Flex Heat Networks addresses the infrastructure capacity challenges posed when integrating low carbon heat networks onto the electricity network. Heat networks will play a critical role in achieving net zero, but their integration comes with new challenges for our existing infrastructure capacity. The Flex Heat Networks project looks to harness the potential flexibility of heat networks, specifically through energy storage and demand-side management. By designing heat networks with thermal stores, the project aims to reduce peak demand by 20-40%, offering a more efficient use of existing electricity network capacity. This not only benefits network operations but also eliminates the need for costly network reinforcements. Enabling flexible connections to heat network operators ensures higher certainty for capacity planning, facilitating a faster transition to low-carbon heating and delivering societal benefits.

Park and Flex focuses on leveraging the flexibility of electric vehicles (EVs) to balance the electricity system. By exploring the feasibility of Vehicle-to-Grid (V2G) technology in public car parks, the project taps into the untapped potential of parked EVs as both chargers and power sources. This initiative not only addresses transport emissions but also contributes to grid stability. The V2G technology's ability to participate in various market mechanisms, including DSO flexibility services and wholesale market trading positions it as a valuable asset.

Park and Flex underscores the potential of V2G technologies to support network needs, reduce peak load, and offset the necessity for grid reinforcement, fostering a robust business case for commercial investment.

Shift 2.0 delves into dynamic and locational pricing as an innovative approach to alleviate secondary peaks, herding behaviour, and network congestion as more and more customers adopt LCTs. The rapid growth of LCTs necessitates innovative solutions to address network challenges and mitigate potential impacts on customer bills. Through a two-phase strategy, the project explores the scale and timing of these challenges, testing dynamic price signals to expose network users to real-time load conditions. Identifying regulatory, commercial, and technical barriers, Shift 2.0 aims to establish feasible pricing mechanisms, determining enablers, roles, responsibilities, business models, and data flows. By embracing dynamic and locational pricing, the project envisions a more responsive and commercially viable electricity distribution network that complements flexibility procurement strategies.

The Flexibility and Commercial Evolution theme in UK Power Networks signifies a strategic shift toward an adaptive, sustainable, and customer-centric energy landscape. Through initiatives like Flex Heat Networks, Park and Flex, and Shift 2.0, the industry is not only embracing innovation but also redefining the way electricity distribution networks operate, ensuring they remain reliable, flexible, and economically viable in the face of evolving energy paradigms. These projects embody a commitment to net zero goals while delivering tangible benefits to both the energy sector and its end-users.

Whole Energy System Project Highlights

Adopting a Whole Energy System approach means looking beyond our own networks and building our understanding of how we interact with, and impact on the wider energy system. Therefore, our approach to innovation focuses on:

- Pursuing activities that deliver an overall benefit to society, even if these do not directly benefit the electricity sector.
- Not pursuing activities that show negative whole systems benefits, even where the electricity sector benefits are positive but outweighed by disbenefits in other sectors.

Within the energy sector, the benefits of a whole systems approach are both financial and environmental, and therefore tied to the transition to net zero. There is a need for a well-organised and integrated system approach which considers multiple decarbonisation pathways and increases resilience. This whole systems approach will allow environmental targets to be achieved despite changing circumstances and the inherent uncertainties of net zero.

Our Innovation Performance

Continued

Whole Energy System Project Highlights (Continued)

Ultimately, we believe that our whole systems strategy can deliver the transition to net zero at the lowest whole system costs for our customers.

In order to make the step change to consider the wider energy system, we have focused on longer-term innovation activities tied to the four core aspects of the whole systems approach:

- **Whole system planning:** Enabling national and local forward planning and investment for resilience and decarbonisation across energy boundaries.
- **Whole electricity:** Innovating to enhance interactions with the Energy System Operator, transmission operators and other distribution operators across the electricity system to benefit customers.
- **Whole transport:** Innovating to understand and overcome barriers to the decarbonisation of road, rail, water and air transport.
- **Whole heat:** Innovating to identify the most effective solution for heat, focusing on energy efficiency, heat networks and understanding the role of hydrogen in low carbon heating.

Three projects that highlight our whole systems approach include:

Constellation is a world first innovation initiative, which will demonstrate a novel approach to protection and control by leveraging the public 5G network and introducing local intelligence in DNO substations. In the future, DNOs will rely on services provided by distributed energy resources (DER) to operate their networks optimally and reliably. Constellation will use a whole systems planning approach between electricity and telecommunications sectors to facilitate the reliable connection of increased DER on to power distribution networks. The project will also protect the use of smart services to reduce the risk of system wide instability events by de-risking the likelihood of sudden and widespread DER curtailment and/or disconnection.

NeatHeat aims to assess an alternative clean heating solution, Tepeo's innovative Zero Emission Boiler (ZEB), and test a first of its kind type-of-use-tariff that allows customers to use clean heat at a lower cost. We have partnered with OVO Energy and Tepeo to support several households on their decarbonisation journey by installing and trialling the ZEB over the course of a year. Throughout the trial we will be monitoring the performance of the ZEB to understand the charging pattern and test various optimisation mechanisms that will provide flexibility to the network. Ultimately, NeatHeat will enable maximising the use of existing electricity network infrastructure and reduces costs to customers.

Trading Connections is investigating a novel approach to

increase the speed of connections to the network. The project aims to enable appropriate visibility of the UK Power Networks connections queue and facilitate commercial discussions between customers around trading queue positions if the benefits can be demonstrated. We will do this by carrying out best-in-class engagement with customers, stakeholders, other industries and Ofgem to define the requirements for how the solution will work, how data will be exchanged, and how we will ensure the system will conform to security, data privacy and regulatory requirements. This project has the potential to facilitate the energy system transition by providing greater visibility of connection queues and facilitating quicker and more efficient connection to the distribution networks.

Data & Digitalisation Project Highlights

Data and digitalisation have emerged as crucial enablers on our net zero journey, driving innovation, efficiency, and resilience across the electricity network and meeting evolving customer needs. As the future energy system grows increasingly dynamic, supporting the adoption of new data methods becomes ever more important, and digital initiatives will play a pivotal role in optimising network operations.

While data and digitalisation constitute a distinct innovation theme in our strategy, they underpin and enable many other strategic innovation themes, as evidenced throughout this report. The projects selected for our data and digitalisation theme underscore our commitment to enhancing operational efficiency and providing our customers with valuable data and self-serve tools.

Satellite is exploring how satellite and AI solutions can mitigate vegetation-related power outages and simultaneously optimise our vegetation management plans. Traditionally, utilities face significant expenditure and operational challenges in maintaining clearance between vegetation and power lines, a critical task for minimising disruptions and ensuring safety.

Powercast is an initiative designed to address the challenges faced by customers of UK Power Networks during planned or unplanned power outages, particularly those reliant on EVs for transportation. Powercast, in collaboration with its delivery partner ev.energy, has developed an innovative data sharing and notification system. This solution enables real-time communication with EV customers, providing them with alerts about planned and unplanned power outages in their vicinity. By empowering customers with timely information, Powercast allows them to proactively manage their EV charging needs, mitigating the impact of power cuts and ensuring uninterrupted access to transportation.

Our Innovation Performance

Continued

Data & Digitalisation Project Highlights (Continued)

HV Auto Quote will empower customers to explore connection options independently, streamlining the connection process. We will provide a self-service tool that offers customers enquiring about connections between 300 kVA and 1 MVA a quotation, and budget estimates for connections from 300 kVA to 2.5 MVA. A key focus of the project is to enable the automation and standardisation of the quotation process. This entails the development of algorithms to assess the cost of traffic management, a critical component in connections planning. This project will perform the necessary analysis and change to put connection offer requests in the hands of the consumer, allowing them to see the cost of different options interactively, reducing time to deliver connection offers and improving service delivery.

Proactive Optimised Assets & Practices Project Highlights

The Proactive Optimised Assets & Practices theme represents a pivotal approach to sustaining a robust electricity distribution network. As the demand for clean energy and digital connectivity rises, it becomes imperative to embrace innovative projects that increase reliability and efficiency in the power sector. By integrating innovation projects under the theme of Proactive Optimised Assets & Practices, we address the challenges of evolving energy needs, enhancing safety protocols, and elevating customer experiences, thereby contributing to a sustainable and resilient power infrastructure.

Three key projects include:

Project Stratus is a groundbreaking initiative seeing a series of smart transformers installed across our network, designed to actively control voltage in the LV (Low Voltage) network. This innovation facilitates the seamless integration of high-penetration LCTs without compromising the stability of the network. By dynamically adjusting voltage levels, the smart transformer ensures optimal performance, contributing to a greener energy mix and a resilient power distribution system.

Our **Automated Tunnel Data Capture** is enhancing safety and improving monitoring activities in confined spaces, such as tunnels. The project is deploying robots equipped with advanced sensors and cameras to detect potential issues within tunnels, ensuring early identification and resolution of problems. This not only enhances asset reliability but also significantly improves safety measures in challenging environments, contributing to a proactive and optimised asset management strategy.

Reskub aims to transform the customer experience during planned power interruptions. By offering an alternative source of power and internet connectivity to customers during pre-arranged power outages, this initiative minimises disruptions. The project not only prioritises customer satisfaction but also showcases the adaptability of power networks to evolving consumer expectations, reinforcing the commitment to a customer-centric, resilient, and optimised power infrastructure.

The Proactive Optimised Assets & Practices theme underscores the commitment of UK Power Networks to innovation, sustainability, and customer satisfaction. Through pioneering projects like the ones mentioned above, UK Power Networks is not only addressing the challenges of today, but also proactively shaping a resilient and optimised energy future. By prioritising reliability, safety, and customer experience, these initiatives exemplify the transformative impact of innovation in maintaining a robust electricity distribution network that can meet the demands of a dynamic and sustainable tomorrow.

Most of the Proactive Optimised Assets & Practices projects mentioned above commenced as NIA during the previous regulatory period and, in line with our RIIO-ED2 strategy, are covered by UK Power Networks' funded innovation programme as of April 2023. This is one of the ways UK Power Networks demonstrates the commitment to innovate, delivers benefits and shares learnings by investing our own funds on initiatives with lower uncertainty.

Our Innovation Performance

Continued

The results we are delivering

At UK Power Networks, we are focused on delivering value from our innovation work to networks, customers, and wider society. It is essential for us to measure the benefits of any innovation funding in a consistent way across our three networks.

From years of innovating, our experience has shown that benefits from innovation take varying durations to materialise post-project.

This is usually dependent not only on the technology readiness level of innovations and how they have been demonstrated in projects, but also on the level of commercial and business adoption readiness.

In 2023/24, we have continued to track benefits from our strongest innovative solutions developed in previous projects, to capture the value being delivered to customers. We also rolled out some innovations from our projects to BAU. We measured benefits from 16 solutions, which delivered £132m between April 2023 and March 2024, as shown in Table 1.

Table 1: Innovation benefits delivered in the regulatory year 2023/24.

			BENEFITS DELIVERED (£M)
DATE OF SOLUTION ROLLOUT	SOLUTION NAME	EXISTING/NEW SOLUTION	2023/24
01/04/2015	Automated Power Restoration System	Existing in RIIO-ED1	9.83
01/04/2015	LPN Interconnection		0.32
01/04/2015	Curtailed Connections		101.68
01/04/2017	Joint Shell		0.10
01/04/2017	The Perfluorocarbon Tracer (PFT) fluid filled cable leak location		1.35
01/04/2018	Timed Connection		8.23
01/04/2019	Primary Outage Restoration Tool (PORT)		0.95
01/04/2019	Pressurised Cable active management		2.35
01/04/2020	Smart Traffic Lights Kent		0.66
01/04/2020	Infrared Imaging Camera		0.14
01/04/2020	Remote Portable Switch		0.65
01/04/2021	Smart Connect		3.43
01/04/2021	Jumper Cutter		1.19
Total – from RIIO-ED1 solutions			130.88
01/11/2023	Arc Aid	New in RIIO-ED2	0.16
01/11/2023	Emerge		0.001
07/11/2023	LV interconnected pairs		0.78
Total – from new RIIO-ED2 solutions			0.94
Total benefits from innovation – 2023/24			131.82

Proactive Optimised Assets & Practices

Highlights of our Innovation Project Portfolio Customer Vulnerability

Spotlight

Background

Achieving a net zero energy system and economy will impact various communities and sectors differently. The UK government's net zero strategy aims for a just transition, ensuring fairness in costs and benefits distribution. UK Power Networks is committed to maintaining exemplary customer service and aims to be a force for good in the communities it serves.

As part of its RIIO-ED2 business plan, UK Power Networks has committed to supporting vulnerable customers across three focus areas: increasing the number of customers on the Priority Services Register (PSR), supporting fuel-poor (FP) customers, and assisting those at risk of being left behind, Leaving no one behind (LNB), in the energy transition.

To achieve this, the first crucial step is identifying vulnerable customers, especially considering factors like rising living costs, digital exclusion, increased inflation, and higher energy expenses. Current identification methodologies in the industry are not as advanced as those in consumer sectors such as retail and telecommunications. Spotlight addresses this limitation by focusing on identifying PSR, FP, and LNB customers at a household level, leveraging new data sources from sectors including telecommunications and finance. Additionally, it aims to optimise engagement approaches with these customers, using data insights to choose the most effective channels for various needs across vulnerability categories.

Experience to Date

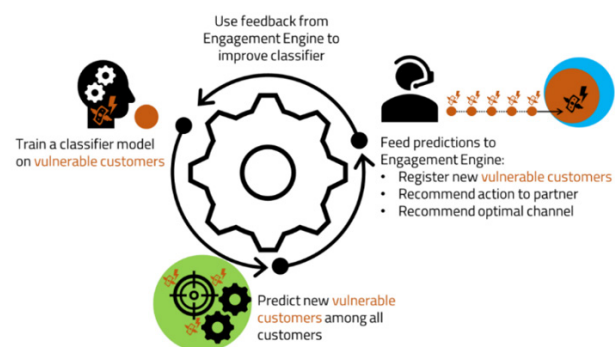
Spotlight is delivered in collaboration with CKDelta, dedicated to harnessing data modelling and machine learning to pinpoint vulnerable customers with precision.

To date, we have consolidated various internal and external data sources, including PSR data, demographics, census, and more, into UK Power Networks' data lake. This integration process involved rigorous data cleansing, quality checks, and processing to enable a data-driven approach to identifying vulnerable customers.

We carried out the necessary data protection assessments and put robust measures in place to ensure all personal data is securely managed. We have also prioritised scalability for future data and adopted an agile delivery methodology, as outlined in Figure 12.

This agile approach ensures early benefit realisation and facilitates flexible and efficient development, ultimately expediting our progress toward the project objectives.

Figure 12: Spotlight Agile delivery method.



Future Developments

Spotlight's future developments are geared towards advancing data modelling methods previously validated in industries such as retail, telecommunications, and technology, tailoring them to address vulnerability in the electricity distribution sector. Key aspects include:

- **Household-level Vulnerability Detection:** Leveraging machine learning, this initiative aims to detect vulnerabilities at the household level, surpassing current capabilities.
- **Utilisation of Proprietary Mobility Data:** Exploring the potential of proprietary mobility data in tandem with external sources to discern household demographics and vulnerability conditions, providing valuable insights for effective support.
- **Scalability and Flexibility:** Establishing a robust data pipeline with dynamic decision-making, frequent data refreshes, and scalability for future inclusion of data sources, for scalable machine learning model management and open-source languages for adaptability.
- **Customer Engagement:** Testing to identify vulnerable customers more accurately, enabling targeted engagement strategies.

Highlights of our Innovation Project Portfolio Customer Vulnerability

Socially Green

Background

Socially Green, initiated in November 2020, aims to foster an equitable and just energy transition by identifying vulnerability and exploring potential service areas.

The project assesses the needs of current and future disadvantaged customers, facilitating the adaptation of services for a sustainable and fair energy landscape. By identifying customer segments, understanding their support requirements through the net zero transition, and reviewing sector activities comprehensively, Socially Green aims to uncover gaps and build key cross-sector partnerships.

The project also involves developing and trialling flexible products and engagement mechanisms tailored for hard-to-reach areas, showcasing inclusive flexibility services.

Experience to Date

To achieve the project goal, we developed the Socially Green mapping tool and the services delivery framework. These not only informed our RIIO-ED2 Consumer Vulnerability Strategy but also empowered us to promote inclusivity by providing services such as flexibility to our hard-to-reach customers, thereby contributing to a more sustainable future.

One important aspect of Socially Green is hard-to-reach flexibility, which aims to secure flexibility services from vulnerable or disadvantaged customers, ensuring that no one is left behind.

We recognise that households facing hard-to-reach circumstances may encounter barriers such as lack of access to capital, building constraints, digital literacy challenges, health disabilities, and geographic constraints, making it less likely for them to benefit from new energy services. In response, we engaged with customers and communities to offer education, support, and insights to shape our flexibility services. Based on the results of our market engagement, our hard-to-reach flexibility comprises two trials:

The summer trial, concentrated on targeting a broader group of hard-to-reach customers to encourage participation in flexibility tenders. The trial focused on data utilisation and establishing procurement arrangements. It introduced a Hard-to-Reach (H2R) Flexibility Top-Up per qualified Meter Point Administration Number (MPAN), to compensate flexibility providers for services to hard-to-reach households.

Figure 13: Project Timeline.

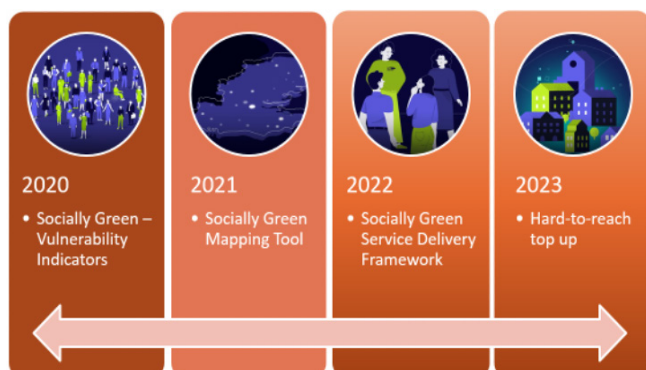


Figure 14: Empowering Inclusivity: Bridging Gaps with the CV Top-Up Trial for Hard-to-Reach Customers.



Highlights of our Innovation Project Portfolio

Customer Vulnerability

Socially Green

Continued

In the innovative autumn trial, our goal was to make a substantial impact on hard-to-reach customers by introducing Energy Efficiency (EE) as a flexibility service. To achieve this, we collaborated with social housing providers in constrained areas, installing energy efficiency upgrades in hard-to-reach homes, aiming to provide sustainable flexibility services.

The trial aimed to educate customers about flexibility services and markets, facilitate engagement, derive benefits from their involvement in the flexibility market, and serve as a proof of concept to encourage similar activities in the future.

Figure 15: Empowering Communities: Enhancing Energy Efficiency and Flexibility in Hard-to-Reach Homes.

Future Developments

In our commitment to an inclusive transition, UK Power Networks is integrating Vulnerability by Design principles into our flexibility services and prioritising hard-to-reach flexibility within our program. While progress has been made with the summer trial, further refinement is needed to ensure scalability and robustness. Presently, we are collaborating with flexibility aggregators to strengthen the process and increase scalability.

Additionally, we plan to set up a follow up project to reconnect with other social housing associations involved initially, to extend our reach and promote EE as a flexibility service. These efforts allow us to prioritise inclusivity in energy services.



Highlights of our Innovation Project Portfolio

Customer Vulnerability

Power Protect

Background

There are over 130,000 households on UK Power Networks' PSR where someone is medically dependent on electricity. For these customers, a sustained period of time without power may seriously impact their health conditions.

It is our ambition to deliver industry-leading support that maximises the value delivered to our customers in vulnerable circumstances. Innovative solutions are required to support vulnerable customers during power outages to ensure the delivery of excellent customer service while restoring power, in both planned and unplanned power cut scenarios.

Customers who are medically dependent on electricity are categorised under PSR needs codes 1-4. The needs codes are divided into customers that require the following electrical equipment:

- Nebuliser and apnoea monitor
- Heart, lung and ventilator
- Dialysis, feeding pump and automated medication
- Oxygen concentrator

Throughout 2023, the Power Protect project developed and trialled a new service to offer portable battery packs to customers who:

- Are medically dependent on electricity, and
- Experience an unplanned power cut, and
- Are expected to be without power for more than four hours.

Figure 16: Project Lead Rona Mitchell stands next to the three battery units trialled in 2023.



Experience to Date

Last year, we developed and tested a robust process to provide our eligible customers with batteries in specific circumstances. This included establishing close collaboration with teams across our business: customer services, dispatch, and network operations. The trial took place in our London, Maidstone, Canterbury and Bury St Edmunds regions.

As part of the trial development, UK Power Networks collaborated with the Research Institute for Disabled Consumers¹ (RiDC) to conduct research to understand the needs of targeted customers through surveys, in-depth interviews, and trials. The results from the surveys and interviews conducted in 2023 are published on our website². The detailed recommendations that came from the in-depth interviews fed directly into the Power Protect procedure before the trial began.

UK Power Networks is now in the process of rolling the service out to all regions and increasing the hours of operation to 24/7. We have also engaged with other DNOs to share our learnings and approach to support their ambitions to roll out a similar service offering to their customers.

Figure 17: Battery Units from Clayton Power, Power2Go and APKI were trialled in 2023.



¹ Home | RiDC <https://www.ridc.org.uk/>

² <https://d1oyzg0jo3ox9g.cloudfront.net/app/uploads/2023/10/UKPN-survey-findings-report-2.0.pdf>
<https://d1oyzg0jo3ox9g.cloudfront.net/app/uploads/2023/10/UKPN-follow-up-interview-outputs-2.0.pdf>

Highlights of our Innovation Project Portfolio

Customer Vulnerability

Power Protect

Continued

Future Developments

The last key activity of Power Protect is to complete a second phase of work with the RiDC. This is a trial with ten customers from their panel to robustly test our Power Protect service and provide feedback.

Whilst we are satisfied that the Power Protect service suits the majority of the most vulnerable customers on our PSR, we wish to understand more deeply how medically dependent customers might benefit from the service, and if there is anything we can do to improve the service for those with more complex needs.

In terms of a wider business utilisation, there is an opportunity to work with the market to develop a battery unit that better meets the needs of customers and DNOs. Following specific guidance sought from the Institution of Engineering Technology (IET), the battery model selected for enduring use is not as suitable as some other batteries on the market.

We are currently engaging with an organisation who developed a unit via an EIC trial that will be more suitable.

Figure 18: Battery units on charge at a depot, ready to be deployed to customers.



Highlights of our Innovation Project Portfolio Net Zero & Energy System Transition

Emerge

Background

The decarbonisation of domestic heating systems is a key focus in the transition to net zero, with demand for heat pumps in the UK expected to accelerate over the RII0-ED2 period.

There is a risk however, of DNOs becoming a barrier to this rollout, as the installation of heat pumps is highly dependent on the successful upgrade of domestic supplies. For heat pump installations that require a fuse upgrade, it is essential that UK Power Networks completes this work in a timely manner. This is expected to become a growing challenge due to increasing demand for fuse upgrades, triggered by rising numbers of both heat pump installations as well as other LCTs.

This challenge is further compounded as 80% of domestic boiler replacements occur during a boiler breakdown, a particularly stressful time for customers, presenting a very narrow once in a 15-year opportunity for a domestic household to switch to a low carbon alternative.

Looking to prevent DNOs from becoming a blocker to heat pump uptake, UK Power Networks partnered with Octopus Energy to deliver the Emerge (Emergency Fuse Upgrades) project. Emerge aimed to reduce the time it takes to switch to low carbon heating and improve the customer journey in response to emergency upgrade events, by enabling appropriate third-party meter operator organisations to undertake fuse upgrades for their customers on behalf of UK Power Networks.

Experience to Date

During the project, 23 installers from Octopus Energy were given training in how to complete fuse upgrades across UK Power Networks' licence areas. As part of the project trials, Octopus Energy provided 46 new LCT applications in our area for review by UK Power Networks to access suitability for the trials, of which eight fuse upgrades were completed. The key factors that prevented fuse upgrades from being actioned were either due to ineligibility against pre-defined criteria such as only specific types of plastic service cable should be considered, or ensuring that properties with looped services to other properties are not considered. One other factor was that some photos taken by the LCT installer to assist in verifying site eligibility were not clear enough to use.

The trials successfully demonstrated that engineers from a third-party meter operator could safely and correctly upgrade a domestic fuse when completing a new LCT installation in a customer's property. The project also showed that the customer journey for both heat pump and EV charge point installation customers could be significantly improved using this process, with the overall customer journey from initial application to the fuse upgrade occurring being reduced from approximately 36 days down to 23 days.

The project has also shown that strong financial savings can be achieved as a site visit by an engineer to the customer's property can be avoided, since the installing company is visiting the customer's property anyway to complete an LCT installation. It has been shown that as long as an LCT installing company gains the necessary fuse upgrade accreditation from the DNO, then customer time and money can be saved. The project has estimated that the cost for completing this fuse upgrade has been reduced by approximately 75% due to the reduction in labour time.

To achieve these strong results, several important pieces of work were undertaken. One crucial aspect was the training of Octopus Energy's installation engineers. Doing this required UK Power Networks to review and update existing processes and training documentation to enable third party engineers to complete the work whilst ensuring both the engineers and the customer's property is always kept safe.

Highlights of our Innovation Project Portfolio Net Zero & Energy System Transition

Emerge

Continued

This review was essential as it identified that some fuse upgrades should not be eligible depending on the type of service cable that feeds a customer's property or how it is installed or configured. It was determined that since this project was trialling this method, it was not necessary to provide full training for all types of work that may be encountered.

The project also developed other ancillary tools required to enable the work to take place, such as the development and testing of a digital product to automate the assessment and approval or rejection of the work, a bespoke training and accreditation programme, and a commercial and operational framework for deployment to business as usual.

Future Developments

The project demonstrated that the Emerge concept has potential to improve the customer journey while installing LCTs, whilst also reducing DNO costs, however additional improvements are also being considered such as whether the site eligibility criteria should be expanded. The solution is now being rolled out more broadly across the business, with the service now being offered through the business as usual system for new connection applications – Smart Connect.

Fuse upgrades have already started to be completed by Octopus Energy on behalf of UK Power Networks, plus UK Power Networks are expanding the service by partnering with other LCT installers. A call was put out by UK Power Networks to several meter operators to identify businesses willing to become partners on this, and commercial discussions are now underway with three additional companies.

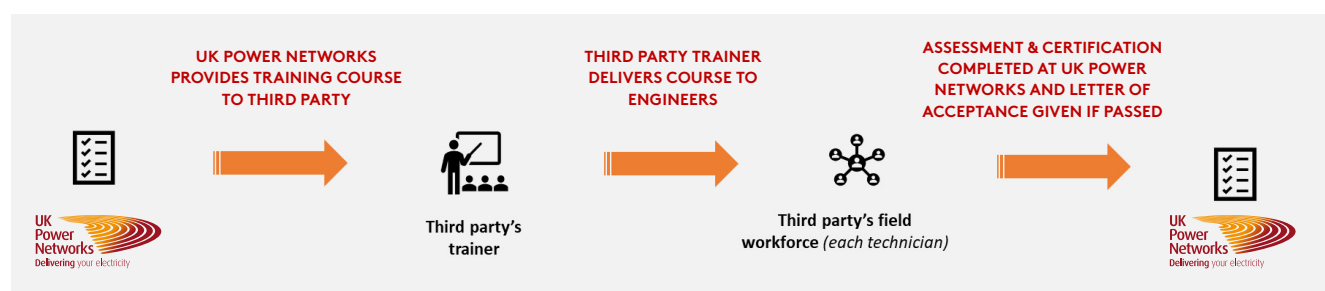
This is valuable for UK Power Networks and society as it is estimated there will be over 11,000 eligible fuse upgrades during RIIO-ED2 due to growing volumes of LCTs being connected with potential for a significant number more to be completed in the future. Creating these partnerships will help ensure that UK Power Networks is not a blocker to net zero by delaying customers from connecting LCTs which is important as it.

We are investigating whether this innovative process can be adopted by the wider industry to ensure it is rolled out nationwide. This is being facilitated through the dissemination of learnings, with presentations at the 2023 Innovation Summit, and through engagement with the industry via working groups facilitated by the ENA.

Figure 19: an Octopus Energy engineer completing a customer's fuse upgrade on behalf of UK Power Networks during the project trial.



Figure 20: New customer journey developed from the Emerge project trial to enable a third party to complete fuse upgrades on behalf of UK Power Networks.



Highlights of our Innovation Project Portfolio Net Zero & Energy System Transition

Collaborative Local Energy Optimisation (CLEO)

Background

Around 100 of the 133 Local Authorities (LAs) in the UK Power Networks region have declared a climate emergency, and over 300 across the UK have done the same. More than half (66 of the 100) of these have set an accelerated target to achieve net zero by 2030. Ofgem has set the expectation that local plans should be used to inform network planning and justify capital investment.

Each LA has different needs; understanding their needs and what plans would best suit the customers and communities in that area is a complex, time consuming and resource intensive process. Many LAs lack the expertise and experience to be able to identify, assess or consider the energy and technology impact on their development plans and vice versa.

An effective LAEP requires integration of various data sources and balancing of various dependencies and constraints to achieve net zero goals. Not only do LAs lack the resources and expertise to build LAEPs to meet evolving industry standards, but they also face difficulties in assessing the impact that the energy plans have on social equality and lack the capacity to engage effectively with other local, regional, and national energy system stakeholders.

UK Power Networks has built a team that will engage with all 133 local planning authorities on their climate plans each year of RIIO-ED2. They will offer a three-tiered support service utilising a framework, to assess and develop action plans and deliver investments where a prescribed level of certainty is achieved in period.

This team and the LAs they serve will require the tools and data to perform this activity and collaborate effectively. The project aims to provide a web based geospatial software application free of charge to users. The software will enable Local Energy Planners to use various layers of data to analyse and design ways to decarbonise their areas using LCTs that best suit their constituents' needs. The tool will provide clear visibility of the impact of these plans and help them make informed decisions.

The tool empowers Local Energy Planners to engage confidently through the process of conducting LAEPs and collaborating with UK Power Networks' net zero team through the tiered assessment framework. UK Power Networks will then use the completed and validated LAEPs to improve energy network forecasting over the next 25 years. With more confidence in the forecasting based on robust and validated energy plans, UK Power Networks will be able to act on reinforcing the energy network to support the plans.

Experience to Date

Using a process of human centred design throughout the project, users have been instrumental in the design and iteration of the tool and the datasets published within, since the start. The tool now known as [Your Local Net Zero Hub](#) was first released as a beta version for testing in July 2023 to 11 LAs that had registered interest to be involved in the beta. They had early access to the features and the first round of datasets to support their LAEP and decarbonisation planning journey.

Since then, the functionality available to beta users has been evolving and improving through the delivery of the planned product releases until March 2024. In parallel with the product improvement has been a thorough user engagement approach that has made Your Local Net Zero Hub available to all 133 LAs in October 2023.

It is no small feat to engage and drive adoption of new software and LAEP support services with 133 organisations who are all at very different stages of their net zero ambitions. Embracing this challenge, the UK Power Networks DSO, Local Net Zero Team ran a series of regional engagement sessions for all customers to benefit from a better understanding of the variety of services that are available to customers. The engagement was a great success with over 62% of LAs signing up and using the software and data.

Following the initial engagement and registrations, the project team has included a schedule of fortnightly training sessions for customers to attend. These training sessions focus on key challenges faced by users and explain how the functionality and datasets can help them address those challenges.

Challenges like:

1. How to use the Hub to plan investible projects
2. Using Data Stories to engage stakeholders and residents
3. Uploading your local data

These sessions haven't only benefited customers, they have been instrumental in providing feedback to the project team to help shape the software, which have led to design decisions and influenced the product roadmap.

Your Local Net Zero Hub includes a breadth of functionality and delivers against the original and the evolved requirements defined by the Local Authorities, energy partners, and community energy groups.

Highlights of our Innovation Project Portfolio Net Zero & Energy System Transition

Collaborative Local Energy Optimisation (CLEO)

Continued

Included are over 60 different datasets that are either, third party open or shared, UK Power Networks' data, or modelled by our delivery partner Advanced Infrastructure. Combined, the data and functionality empower users to:

- Learn about energy planning concepts
- Build decarbonisation projects at a property level for their areas
- Manage stakeholder consultations on decarbonisation plans
- Compare DFES scenarios for their areas and their own plans
- Identify long-term scenario modelling for their areas

Figure 21: Screenshot of Your Local Net Zero Hub.

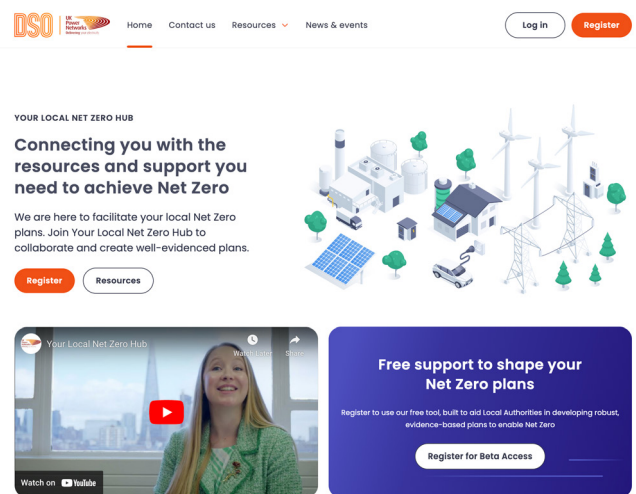
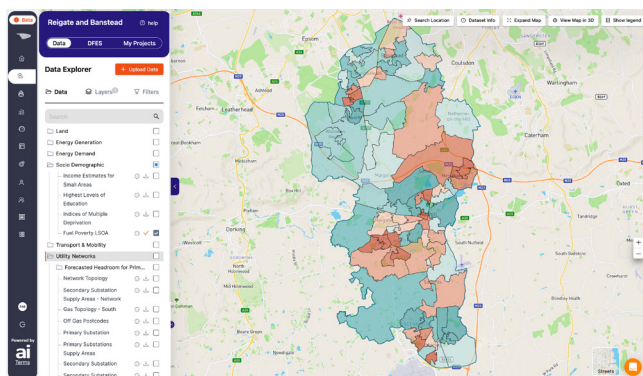


Figure 22: Your Local Net Zero Hub Product Features.



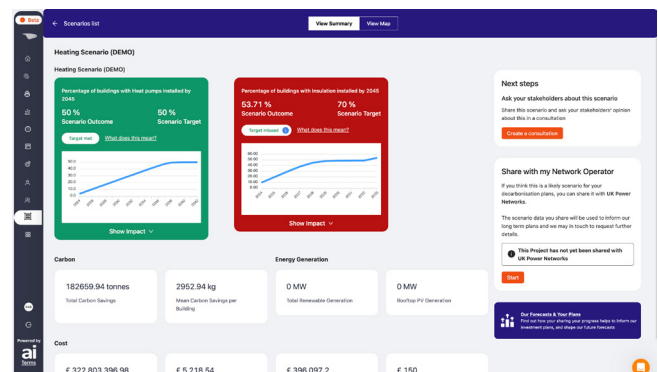
Future Developments

The software development activities completed in March 2024 with the project transitioning software from beta to live later in the year. However, here are still many areas that have been identified for further enhancements, including user interface, product, and data improvements that could be included in the software. These are being managed following the agile process of definition and prioritisation.

They will also be further validated with users and will form the basis of an ongoing product roadmap. Some examples of the proposed enhancements include:

- **Enhanced potential analysis** – To assess data improvements on existing datasets and explore additional for the placement of technologies, and to provide a wider view of potential impacts
- **Shared plans** – To provide an improved experience and clear view of data shared between a LA and DNO, to support joint understanding and feedback
- **Scenario enhancements** – To provide better tools for DFES comparisons, and provide more localised scenario outputs

Figure 23: Decarbonisation Scenario Comparison.



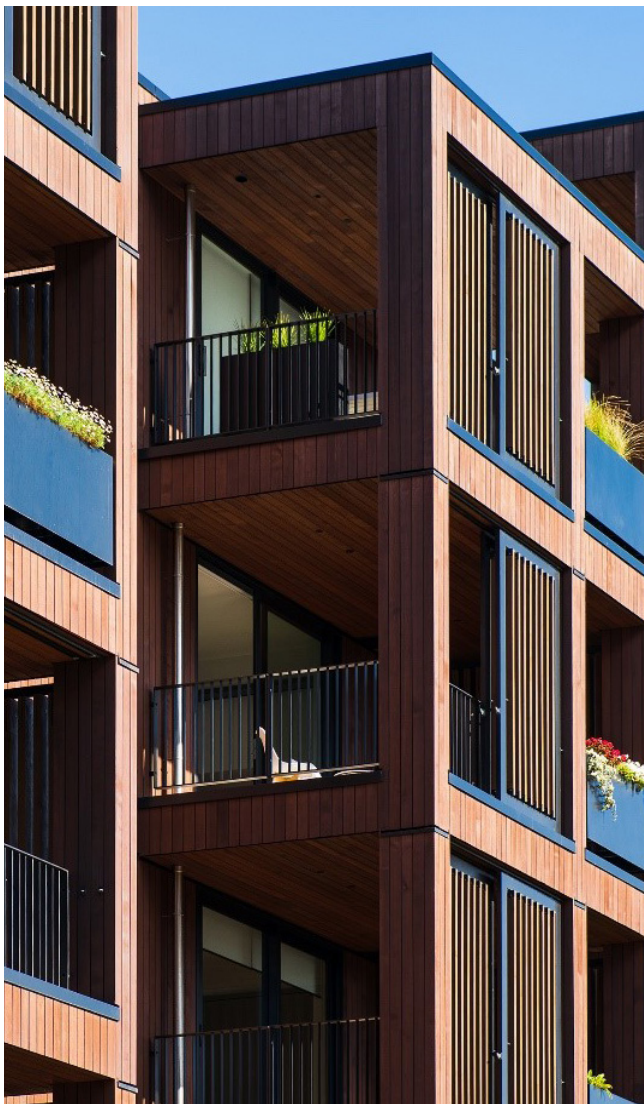
Highlights of our Innovation Project Portfolio Net Zero & Energy System Transition

Heat Risers

Background

Heat Risers is a SIF project and is currently in Round 2. The project's focus is to understand the connection barriers to heat decarbonisation in multiple occupancy buildings, with the aim of developing actionable solutions to overcome these barriers and accelerate sustainable and equitable decarbonisation opportunities.

Figure 24: Multi occupancy buildings.



Experience to Date

Heat Risers has been delving deep into the challenges hindering the journey towards heat decarbonisation in multiple occupancy buildings. After thorough research and engagement with the market, we have identified several key barriers that often lead customers to abandon their decarbonisation efforts. The most significant hurdles include:

- 1. Customer understanding:** many customers are in the dark when it comes to understanding heat decarbonisation solutions and the associated electrical connections costs
- 2. Policy and processes:** complex policies and processes surrounding electrical connections in multiple occupancy buildings add another layer of difficulty
- 3. Scale and responsibility:** the scale and lack of understanding of responsibility of electrical connection costs within multiple occupancy buildings

A major obstacle we have identified is the strain on internal building networks caused by individual heat pump installations in each flat. This results in prohibitive costs for both building owners and individual customers. Understandably, this financial burden often steers customers towards carbon-intensive alternatives or makes them give up on decarbonisation projects altogether.

In the worst cases, the expenses for electrical upgrades can reach tens of thousands of pounds per flat. Complicating matters further, the responsibility for these costs, particularly for upgrades to internal building networks like risers and laterals, is often unclear. In the UK Power Networks' area alone, we've identified approximately 62,000 multiple occupancy buildings likely to require such upgrades, exacerbating the issue.

Adding to the complexity, the diverse characteristics of multiple occupancy buildings make finding universal solutions challenging. Hence, tailoring solutions based on specific inputs about the building, project, and network becomes crucial.

To address these challenges, Heat Risers has developed a conceptual decision making framework (DMF). This DMF aims to clarify the best heat decarbonisation solution for multiple occupancy buildings and estimate associated costs, including internal building network upgrades such as risers and laterals, as well as external network or substation reinforcement costs. The tool also identifies cheaper or more effective alternatives, such as communal heating systems, and advises against imminent changes if a district heating network is planned for the area.

Highlights of our Innovation Project Portfolio Net Zero & Energy System Transition

Heat Risers

Continued

Envisioned for use by UK Power Networks' Connections Engineers and/or external stakeholders like installers, electricians, and building consultancies, the DMF will facilitate streamlined solution design by providing a holistic view of the building and network. This approach will improve education, engagement, and understanding of network requirements, streamlining the connections process for smoother project implementation.

Future Developments

Heat Risers is gearing up for new developments and testing solutions in the upcoming SIF beta phase, pending successful application. This phase will focus on refining and implementing the DMF, aimed at clarifying optimal heat decarbonisation solutions and estimated associated costs for multiple occupancy buildings.

Additionally, the project will explore potential routes to market for any internal network upgrades, while tackling regulatory and policy barriers. We are also committed to exploring various tools tailored for both internal and external use cases. All solutions will undergo validation in real buildings to ensure their effectiveness.

Figure 25: Heat Pump Technology.



Highlights of our Innovation Project Portfolio Flexibility & Commercial Evolution

Shift 2.0

Background

The rapid growth of LCT alongside new electricity tariffs and wider energy market signals are likely to cause challenges. These challenges include secondary peaks, herding behaviour and congestion in certain parts of the network, and a risk of higher network costs, which could ultimately impact customers' bills.

Shift 2.0 was established to look at innovative solutions such as dynamic and locational pricing to address these challenges, and how any options can complement flexibility procurement. The project is divided into two phases. Phase one involved thorough desk-based research to understand how smart charging could alleviate network congestion. Phase two focused on testing dynamic price signals to mitigate these effects.

Key objectives of the project included:

- Understanding the scale and timing of secondary peaks and herding behaviour
- Exploring how locational and dynamic price signals can solve the problems of secondary peaks and herding behaviour. Specifically by exposing network users under a particular substation to price signals that reflect the actual or expected load on the substation in close to real-time
- Identifying regulatory, commercial, and technical barriers that need to be overcome in designing effective pricing mechanisms
- Determining the enablers, roles and responsibilities, business models and data flows to make dynamic and locational pricing a feasible solution

Experience to Date

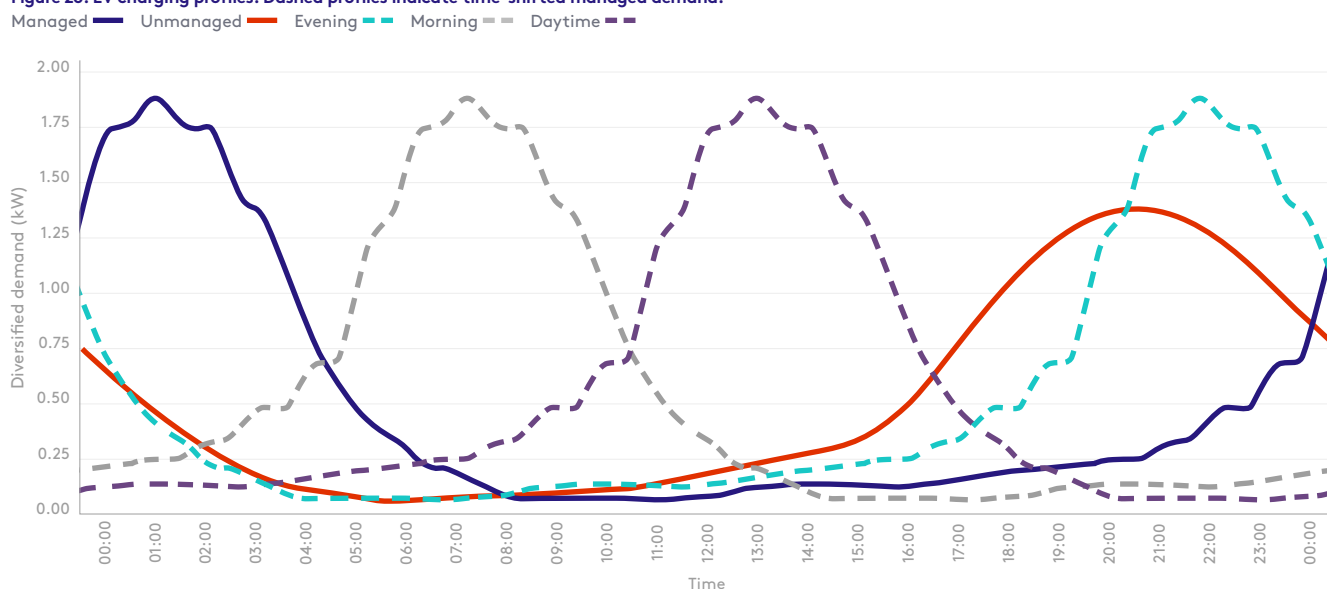
The project built a forecasting model which replicates the methodology and inputs from our Strategic Forecasting System in a simplified way. This model allows for more flexible investigation of how adjusting various input profiles could impact our forecasted reinforcement needs up to 2050, especially with shifts in customer charging behaviours driven by day-ahead wholesale prices.

We have analysed the effects of low-price events occurring in the morning, daytime, and evening on managed charging profiles. Based on forecasted wholesale price data, our assessments indicate that evening low price events pose the biggest risk. During these times, managed charging schedules could potentially clash with existing household demand peaks.

The EV charging profiles used in the model are shown below Figure 26, and include:

- **An unmanaged charging profile** – relating to the demand that materialises from EVs which plug in and charge immediately (typically resulting in an evening EV peak)
- **A managed charging profile (in solid dark blue)** – relating to the EV demand seen through Project Shift, i.e. with smart charging shifting the demand to the overnight period
- **Additional managed charging scenarios** – new potential EV charging demand profiles that could be seen in the event of low/zero price events at alternative times of the day

Figure 26: EV charging profiles. Dashed profiles indicate time-shifted managed demand.



Highlights of our Innovation Project Portfolio Flexibility & Commercial Evolution

Shift 2.0

Continued

Our initial findings revealed that wider market signals such as low wholesale prices could result in increased peak demand compared to our current forecasts.

Our engagement with smart charging providers has confirmed that their current offerings are likely to respond to changes in the day-ahead wholesale prices, with some already scheduling smart charging demand to coincide with the evening system peak driven by these wider pricing signals.

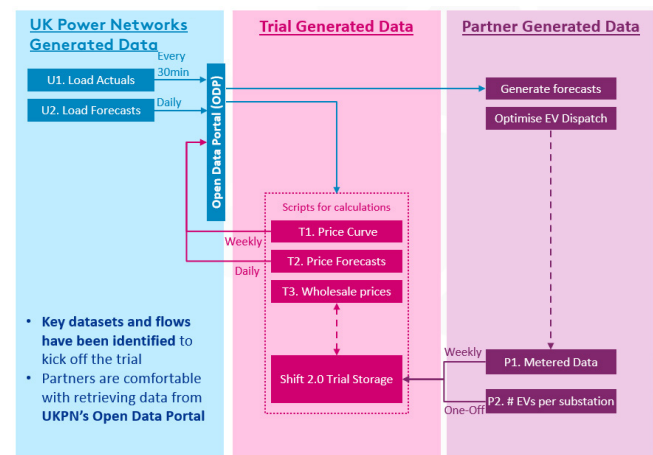
The second phase of Shift 2.0 (known as the 'Shift 2.0 Trials') builds on the findings of the above-described modelling, to trial a dynamic and locational price signal that incentivises smart load to shift consumption to periods where network loading is lower. Between November 2023 and February 2024, we worked with Baringa, ev.energy and Octopus Energy to develop:

- Several methodologies behind a price signal that would respond to forecast load at a given substation on the network. These methodologies were devised to incentivise movement of EVs to lower-load periods, to be feasible from an implementation perspective, and to allow flexibility aggregators such as ev.energy to respond.
- The technical architecture that is needed to develop such a price signal and send it to market participants.
- A plan for the implementation of the trial.

Future Developments

In the first part of the trial, UK Power Networks will send price signals out to market participants based on demand patterns that we currently experience at our substations. We then plan to adjust the nature of the price signal so that it responds to loads that we may expect to see under future market conditions where secondary peaks become more common. Specifically, as we hypothesise that low wholesale prices may cause secondary peaks in future, we will see if EVs can respond to price signals that imply that the overnight period has high levels of forecast loading. Figure 27 shows how we will manage and generate trial data.

Figure 27: Shift 2.0 trial data generation and data flow.



The learnings from this trial will feed into two main areas. First, in the short-to-medium term, we will consider whether the dynamic, locational price signal could be rolled out to other locations in UK Power Networks' areas to help reduce network load. This could be done either instead of or complementary to our existing flexibility procurement.

Second, we will consider whether the findings of the trial suggest that Distribution Use of System (DUoS) charges should be reformed to better-reflect local network conditions, and how these change in response to wider market signals such as wholesale prices. This could feed into Ofgem's DUoS Significant Code Review and help inform the future of GB energy market policy.

Highlights of our Innovation Project Portfolio Flexibility & Commercial Evolution

Park & Flex

Background

Park & Flex is a SIF project currently in Round 2.

The journey to net zero requires a fundamental shift in how we manage the electricity system due to increasing distributed renewable energy and electrification of demand. Flexibility becomes crucial to efficiently balance the supply and demand of electricity in a system that's increasingly reliant on intermittent renewable energy. LCT, such as EVs, are great sources of flexibility.

These vehicles not only address emissions from transportation, aligning with the UK's net zero goals, but also have potential to support grid stability. V2G technology unlocks this potential, allowing them to act as both demand and power sources, making them dynamic assets for the electricity grid.

V2G doesn't just offer flexibility; it also presents significant value opportunities. By participating in various market mechanisms such as DSO flexibility services and wholesale market trading, V2G can support network needs. It can help connect additional assets to the grid by reducing peak loads and serving as a power source, potentially negating the need for costly grid reinforcement.

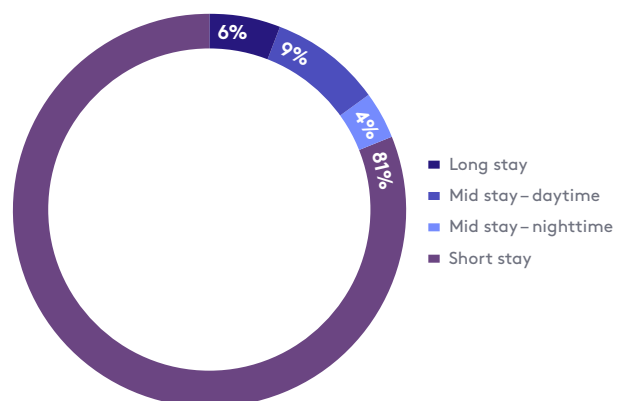
Park & Flex is exploring this potential by testing the feasibility of V2G in public car parks, harnessing the power of parked EVs. So far there has been limited research into this area and its potential value. As V2G charging offerings evolve, we anticipate even more diverse use cases, accelerating the adoption of these technologies.

Experience to Date

Park & Flex's primary goal was to uncover the flexibility capacity and potential value available in various public car park settings.

At the start of the discovery phase, we engaged with various stakeholders including car park operators and industry bodies to develop our understanding of potential archetypes and the wider EV car park ecosystem. Through utilising public car park data, we were able to assess the make-up of car park types across GB and extrapolate this to develop a view of flexibility potential at different car park types within UK Power Networks' areas. Car park archetypes were segmented based on average dwell time, vehicle turn over, and utilisation. They were then ranked based on the flexibility opportunity available, customer value, and scalability. We found that approximately 6% of public car parks are long stay, 9% are medium stay, and 85% are short stay Figure 28. We found by 2050 there would be: 4.3GW of flexible capacity with £6.6bn of potential value to be shared.

Figure 28: Breakdown of public car parks in UK Power Networks areas



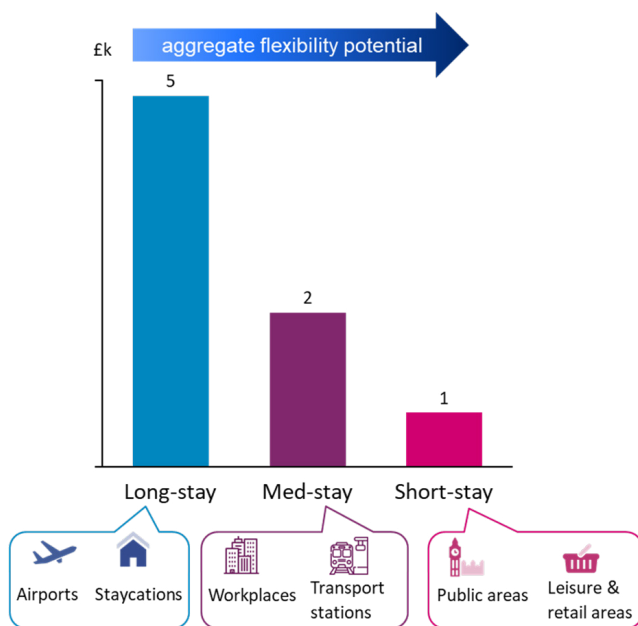
Our findings showed that car parks with longer dwell times, such as long- and medium-stay settings, like those found in airports or train stations, are likely to deliver higher value per customer. Conversely, short-stay settings present challenges due to limited V2G cycles, constraining assets from participating in more valuable revenue streams Figure 29.

Highlights of our Innovation Project Portfolio Flexibility & Commercial Evolution

Park & Flex

Continued

Figure 29: Gross value potential per charger across different car park settings (per annum)



While short-stay car parks offer larger aggregate flexibility, we propose trialling the V2G service in long-stay settings due to their higher value potential and consumer returns. If customers are not incentivised to participate in longer stay settings, then uptake in other shorter stay settings is likely to be even less.

The learnings to date have been integral to the customer proposition and business model development throughout the alpha phase whilst also providing an indication of the highest value, lowest risk setting for a trial. The objective of the alpha phase was to design and structure our business model and customer proposition, with the intention to apply this during the trial, to test consumer behaviour.

The alpha phase has focused on trial design and refining the business model development in high-value long-stay car parks, with airports key sites being explored. We determined the annual gross value potential per charger to be approximately £5k at a long-stay car park by stacking different value streams. We then concentrated on the trial design, accounting for different factors such as charger utilisation, to confirm the most applicable revenue streams.

Future Developments

The trial will adopt an agile approach to engage with consumers and test what incentives, rewards, and value structures maximises participation. The trial will also provide an insight into the optimal commercial structure between the delivery partners, including the site's energy supplier and Fermata Energy as the optimiser to ensure that there is sufficient value for a scalable, enduring customer proposition and business model.

The next steps for Park & Flex is to deliver a first-of-a-kind planned trial in a long-stay car park environment, ideally an airport, aimed at gauging consumer appetite for V2G proposition in car parks.

Looking ahead, the project envisions several opportunities:

- Sharing insights of V2G EV participation in DSO flexibility services and National Grid's Demand Flexibility Service (DFS) with wider industry
- Expanding trial scenarios to include other settings, such as medium or short-stay car parks to explore diverse use cases
- Experimenting with new business models and novel customer propositions across various car park settings to understand key drivers of consumer behaviour
- Running targeted consumer awareness campaigns and engage with EV and car park owners to further refine trial development

Highlights of our Innovation Project Portfolio Flexibility & Commercial Evolution

Flex Heat Networks

Background

Wide scale deployment of heat networks is seen as crucial for achieving the nation's net zero goals. Heat networks distribute heat (and cooling) from a central source to multiple buildings using a system of pipes, utilising various technologies such as heat pumps, gas combined heat and power, electric boilers, or waste heat. Shifting from gas to low-carbon, building-level heat pumps or heat networks for building heating will have a significant impact on the country's electricity infrastructure capacity. Heat networks represent only a small proportion of UK heat demand but is projected to increase to 20% by 2030. Most heat networks are driven by carbon intensive sources today, so as we shift away from fossil fuels, there is a requirement for new heat networks to be low carbon driven, meaning they will become increasingly more important in the drive to net zero.

The lack of electricity network capacity in urban areas is a major challenge for electricity distribution network planning. Heat networks with thermal stores offer significant flexibility to the local electricity distribution system by operating heat pumps during periods of low electricity demand and storing the generated heat for later use. By considering the potential flexibility of heat networks through energy storage among other low-carbon technologies, during the design stage, peak demand could be reduced by 20-40%, leading to a decreased need for building additional network capacity.

So, what's the benefit? Utilising the flexibility of heat networks would improve network operations, utilise existing electricity network capacity more efficiently, and potentially eliminate the need for network reinforcements. This benefits both the DNO by providing higher certainty for capacity planning and crucially for customers by enabling faster transition to a low carbon source of heating and the associated societal benefits from this.

Flex Heat Networks aims to explore the impact of fully or almost fully electric heat networks on the power grid and how to manage them flexibly to avoid unnecessary future reinforcements to achieve the following outcomes:

1. Better understanding of the impact heat network connections will have on the electricity network
2. New optimisation design methodology that accounts for optimisation variables that effectively balance electricity connection and reinforcement costs with performance efficiency
3. Test the feasibility of a real heat network to follow optimised load profiles and/or flexible services
4. Methodology to support both heat network developers and DNO network designers

Experience to date

We are now in the feasibility stage of the project working with our project partner, Arup, and selected Heat Network Operator (HNO) to conduct:

- Data gathering and analysis
- Baseline and optimisation modelling
- Techno-economic analysis
- Network modelling

Currently we are working with HNO, Equans, and their Queen Elizabeth Olympic Park site to provide us with comprehensive sets of data to conduct the modelling on its heat network and two energy centres.

This baseline modelling is almost complete, and we will have a view of the heat network's current thermal and electrical design, allowing us to determine and compare non-optimised vs optimised heat network profiles.

The model consists of numerous data inputs to provide a full picture of the heat network's current capability as a baseline for our optimisation analysis, including:

- Capacity constraints on the network
- Typical heat load profiles and plant operation profiles within the energy centre
- Design parameters for the energy centre and plant within it
- Operational variables such as network temperatures, season profiles, energy storage capacities and more

Highlights of our Innovation Project Portfolio Flexibility & Commercial Evolution

Flex Heat Networks

Continued

Future Developments

Through our optimisation, we expect to use real profile data from the HNO including sensitivity analysis, and connections data from our DSO connections team to test the trade-offs between electricity connection costs and optimal heat network performance. We will look at:

- **Network design** – how we could eliminate peaks and maximise energy in low-demand periods
- **Network plant and operational data** – exploring space utilisation and supporting technologies as well as data monitoring and optimisation
- **Electrical load profiles** – balancing profiles for an optimal profile throughout the seasons
- **Storage (such as thermal, batteries) and other mechanisms (like phase change materials)** – how this can be used to reduce peaks in electrical supply
- **Energy distribution** – how the energy stored can be delivered in the best way
- **Use of controls and energy monitoring** – how this can optimise existing assets

Once our optimisation is complete, we will conduct a techno-economic analysis to explore the impact on both new builds and retrofitted buildings and conduct a cost benefit analysis.

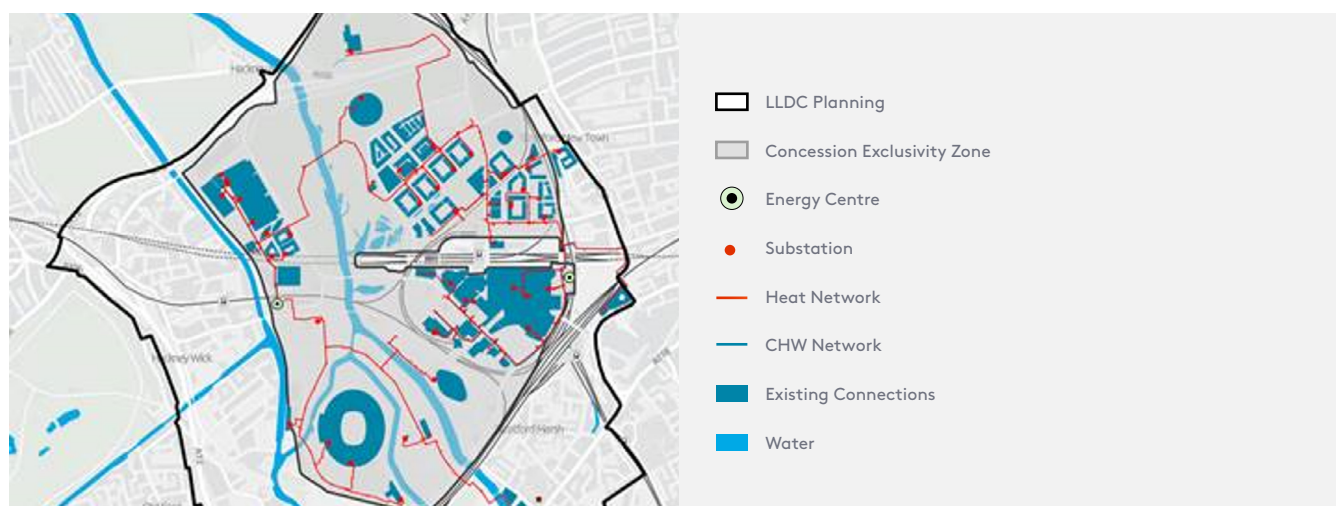
Collaborating with our UK Power Networks colleagues throughout, multiple teams are being engaged from Connections, DSO/Forecasting, Network Planning and Flexibility to understand requirements and feed into an initial trial design.

Figure 31: Standing tall: Kings Yard Energy Centre's three thermal stores.



These are valuable assets that can balance renewable supply of heat with demand.

Figure 30: Operated by Bring Energy, both the Kings Yard and Stratford City Energy Centres sit proudly in the community providing 93MW of installed heating capacity and 57MW of installed cooling capacity across the Queen Elizabeth Olympic Park, making it one of the UK's largest district heating networks.



Highlights of our Innovation Project Portfolio Whole Energy System

Trading Connections

Background

When a customer receives a quote for an electrical connection, they join the end of the connections queue. This is the case at all voltage levels, although in many cases at low voltage, there is nobody else in the queue.

Once in a queue, customers have no facility to change their queue position. This means they must wait to get to the front of the queue to connect, even if they are ready to connect immediately.

Whilst there is significant variance across regions, where reinforcement is required, the time customers may have to wait to energise can range from three months to three years. This duration is mostly driven by the amount and complexity of reinforcement required.

There is an existing initiative by the ENA to improve and accelerate customer connections and UK Power Networks is closely involved with this. The main feature of this approach is that customers in the queue have a set of milestones that they must achieve in order to keep their queue position. If customers who are not ready to connect fail to meet their milestones, they will lose their spot in the queue completely, therefore shortening the queue for those behind.

This means that the queue will move faster and customers ready to connect will not be stuck behind customers who are not ready. However, this system does not enable customers to know how much capacity is available on the network or to move themselves from their existing queue position.

More information about the existing ENA initiative is available here: [Improving and accelerating customer connections – Energy Networks Association \(ENA\)](#)

The Trading Connections project plans to develop a solution to:

- Enable appropriate visibility of the UK Power Networks' connections queue; and
- Facilitate commercial discussions between customers around trading queue positions if benefit can be demonstrated.

Experience to Date

This project started in early 2024, and is very early in the delivery phase.

We teamed up with academics from Cambridge's Energy Policy Research Group to conduct a literature review of the economics of queues and to examine the experience of different jurisdictions grappling with similar issues. This work is ongoing, and findings will be published later this year.

Future Developments

A key part of Trading Connections is to understand the requirements of connection customers. The project team will be carrying out engagement activities with customers, stakeholders, representatives from other industries and Ofgem. This will start towards the end of 2024 and will continue through the different phases of the project.

The results of the literature review and the engagement will be used to finalise a conceptual design for the Trading Connections approach, which will mark the end of the first phase of this project. If successful, a second phase will be carried out to build and trial the novel system which enables visibility and facilitates trading of queue position. This would involve comprehensive trialling of the digital solution to demonstrate that it meets the requirements set out in the first phase.

If the project is successful, the solution will be deployed into BAU operation and the solution will be available for all UK Power Networks' connections customers. The learnings from this project, if successful, could then be taken up by other DNOs and the approach could then be used across the UK.

Highlights of our Innovation Project Portfolio Flexibility & Commercial Evolution

Constellation

Background

Constellation³ is a Network Innovation Competition funded project led by UK Power Networks and delivered in partnership with ABB, GE, University of Strathclyde's Power Networks Demonstration Centre (PNDC), Siemens and Vodafone.

The project aims to demonstrate how novel protection and control solutions located locally within DNO substations can be used to:

- Facilitate the connection of more DER to power distribution networks.
- Protect smart services by de-risking the likelihood of sudden and widespread DER curtailment and/or disconnection.

This world first innovation initiative is essential to facilitating net zero through enhancing the core of the distribution network – substations. It will introduce a first of its kind local intelligence at the substation level that complements existing functionality, in a sustainably cost-efficient manner for our customers.

In order to become an enabler for net zero, the project is set out to develop innovative ways that release more network capacity to connect DER by making our protection systems more dynamic. The project will also ensure our network remains resilient in a future where we will have an increased reliance on smart services provided by DER by enhancing the communication systems and developing local intelligence at the substations.

To achieve these goals, the project will be developing the following innovative solutions:

- **Local Active Network Management (ANM)** – Resilience to DER operation against loss of communication.
- **Wide area protection** – Provide resilience to distributed generation (DG) operation to prevent transient instability events.
- **Adaptive protection** – Dynamically assessed protection settings releasing more network capacity.

Experience to date

The project began in 2021 and spent the first year working out the requirements and designs for the digitalised substations and Constellation solutions. We summarised our learnings in a technical report⁴. We then focused on identifying suitable sites for the trial on the live distribution network and preparing the strategy for the different phases of testing⁵.

1. In 2023, the project focused on two key activities: preparation of the distribution network and PNDC facilities for the upcoming Constellation trial; and
2. Testing the Constellation solutions in isolation during the factory testing and testing them as a system during the PNDC trial.

In preparation of the distribution network and PNDC facilities for the upcoming Constellation trial, we have conducted the following activities.

Site design: In order to prepare the UK Power Networks' distribution network trial areas for the Constellation trials, the electrical and civil work in each individual site needed to be designed. The site design has focused on production of drawings to support site works. We have also updated the network architecture design including the Remote Terminal Unit (RTU) device and one phasor measurement unit (PMU) device in the architecture.

Procurement of hardware: We have successfully procured most of the equipment required to conduct the distribution network trial. We have also placed orders for all the required equipment as per the completed designs and we shall continue to monitor any new requirements as the designs continue to be developed.

Installation and commissioning: We have completed the installation and commissioning of a number of intelligent electronic devices (IEDs) at the Maidstone Grid substation. These include devices on the panel of the bus sections, the 33kV feeders, and the transformer incomers. Additionally, the installation and termination of ethernet cabling (RJ45 and fibre optic cables) has been done from all panels at Maidstone Grid switch room to the Constellation cubicles which are hosted in the telecoms room.

³ Constellation Project Homepage <https://innovation.ukpowernetworks.co.uk/projects/constellation/>

⁴ Constellation Deliverable 1: Details of System Design and Architecture

⁵ Constellation Deliverable 2: Description of Trial Design and Site Selection Criteria Process for Methods 1 and 2

Highlights of our Innovation Project Portfolio Flexibility & Commercial Evolution

Constellation

Continued

PNDC test environment: Figure 32 shows the under-construction PNDC test environment which includes the following key subsystems:

- **Substation servers** – two grid site servers and two DER site servers have been installed and commissioned including software installation of the hypervisors and virtual machines. Some of the software running on the virtual machines will be updated at a later date to reflect latest software releases.
- **Real-Time Digital Simulator (RTDS)** – the simulator runs Maidstone and Thanet distribution network models which have been already implemented based on UK Power Networks' Long Term Development Statement and PowerFactory model data. This simulator will be the main system providing the power system test scenarios seen by the solutions under test. The RTDS also integrates with the various subsystems through communication standards, namely IEC 61850, C37.118 and DNP3.
- **5G coverage equipment** – the equipment provides 5G slice connectivity to the test environment. Communication between the 5G routers and 5G dot system was successfully established. Further work is under way to establish 5G communication between the routers over the 5G slice.
- **Layer 2 and 3 communication** – switches and routers required to establish the local and wide area communication have been installed for the devices which have been delivered. Work is currently under way to configure the virtual local area networks (VLAN), routing, firewalls and secure remote connectivity between the PNDC test environment and project partners.

Future Developments

To ensure the developed solutions are functioning in line with the intended design and to fully de-risk them prior to commencing the distribution network trial, efforts continue to be put into the PNDC trial where various testing activities will be carried out such as functional and performance testing.

Site works also continue to be carried out to ensure the distribution network sites are ready to commence the network trial once the PNDC testing has successfully concluded. These works include upgrading existing infrastructure on site as required by the network designs as well as the installation of new equipment where necessary. They also include the installation and configuration of the Constellation cubicles in those sites in order to host all the innovative solutions developed by the project.

We will also be launching the Open Innovation Competition where we will be reaching out to industry innovators to identify new ideas that could be incubated as part of the project to maximise the benefits to our customers. We will also be conducting two major research activities focusing on the commercial implications of interoperability solutions and overall system reliability in light of distributed control topologies.

Figure 32: Constellation PNDC test environment (Under Development)



Highlights of our Innovation Project Portfolio Flexibility & Commercial Evolution

NeatHeat

Background

While heat pumps are expected to be a core part of the electrification of heat, a one size fits all approach does not work for heat. Installing heat pumps in homes with limited internal space and no outside space, such as terraced housing, can be challenging. Even in homes where external wall space is available, heat pump installation comes with significant disruption. Radiator replacements and pipework upgrades may make heat pumps an unattractive proposition for customers in such housing archetypes.

This project is investigating the potential of zero emission boilers (ZEBs), specifically smart electrical storage heaters, as an alternative to carbon-intensive gas boilers in areas where a heat pump is unsuitable for the reasons described above.

To determine the applicability and implications of using ZEBs at scale, we are using a combination of qualitative customer research, interviews with subject matter experts, and analysis of installations to understand the impact on customers in terms of time, disruption and cost. In parallel, we are undertaking quantitative analysis of data, such as supply point half-hourly consumption and dedicated asset monitoring, to understand the impact on the network.

The project is delivered in partnership with Ovo Energy, an energy retailer initiating a first-of-its-kind type of use tariff, charging participants a lower set rate of electricity, no matter when the ZEB is in use. The manufacturer of the ZEBs, Tepeo, will lead the installation process and all matters related to the product.

Experience to date

We are now in the final stage of data collection, analysis and insights generation. Our target to install 30 ZEBs was achieved following >2,000 registrations of interest, with c.300 qualified candidates progressing to survey stage (within UK Power Networks' area, range of house types, heat demand, heating system compatibility etc).

We conducted 124 telephone surveys and 53 home surveys. Our goal was to recruit a range of house types, customers and include properties with other LCTs. This range is now represented in the project with homes ranging from flats to detached buildings, pre-1960 to post-2000. An example of installation is shown in Figure 33.

With several ZEBs operating for more than 12 months, we have found that the flexibility available from using thermal storage for home heating has led to greater than 95% of total energy consumption being outside of the four most expensive hours provided by the NeatHeat tariff. We are demonstrating that the use of flexible storage can support the transition to electrified heating, without impacting times of peak demand on the electricity network.

As seen in Figure 34, the vast majority of ZEB charging is completed outside of the peak price periods built into the tariff. Between 15:00 and 20:00 when the tariff is the highest, we see very little charging, while most of the charging takes place between 00:00 and 4:30, and between 11:00 and 14:30 when the tariff is the lowest.

Figure 33: Example of ZEB installed during the NeatHeat project



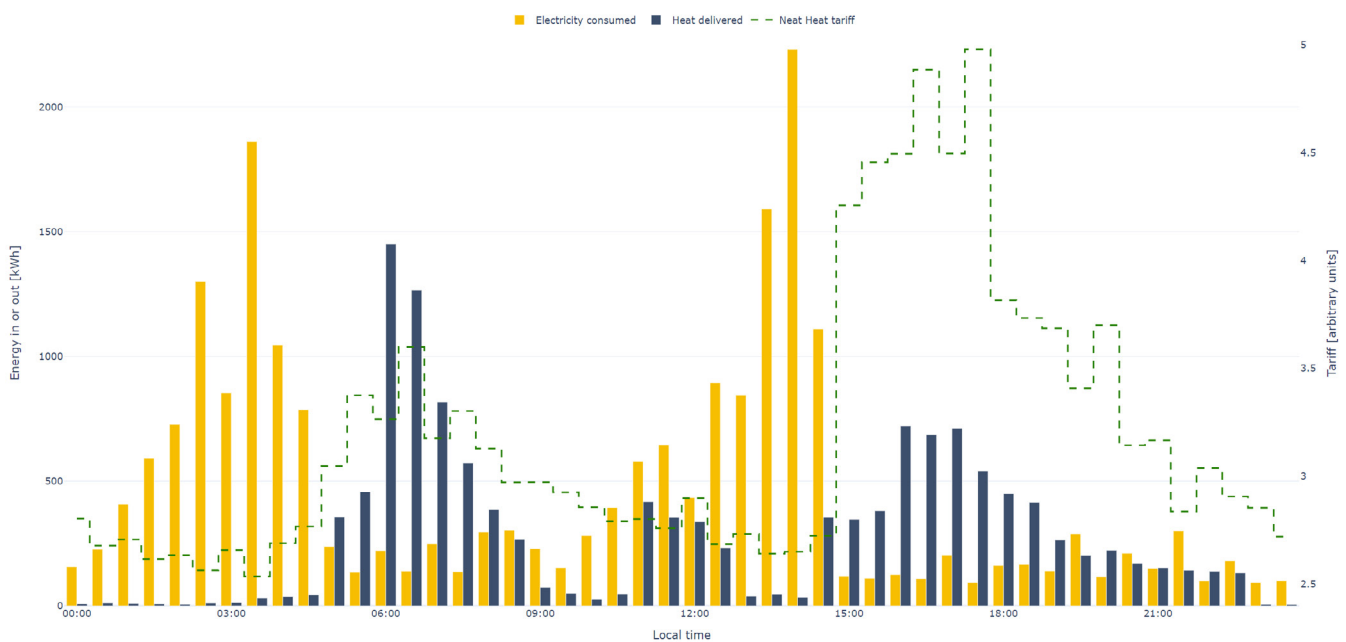
Highlights of our Innovation Project Portfolio

Flexibility & Commercial Evolution

NeatHeat

Continued

Figure 34: Example charging & heating performances in line with NeatHeat tariff pricing (NB-prices are converted, representative values, not retail prices).



Here we see the vast majority of ZEB charging being completed outside of the peak price periods built into the tariff e.g. between 15:00-20:00. The ZEBs are, however, delivering heat when needed in the morning and evening.

Future Developments

With all installations complete and data being gathered through winter, the performance of the ZEBs will be monitored, and their operational data will be collected and analysed through to June 2024.

We can evaluate power consumption over time, the proportion of energy consumed during off-peak periods and will overlay the degree of decoupling between electricity demand and heat output. This analysis will be split by house type to provide sub-groupings and an assessment of the flexibility potential of thermal storage in different applications.

To ensure that the user experience is captured throughout the customer journey, multiple interviews are planned with all participants at the end of the project. Interviews were conducted with participants both prior to and following the installation of the ZEBs.

Highlights of our Innovation Project Portfolio Data & Digitalisation

Satellite

Background

Vegetation management is a critical activity for all utilities and is typically their largest operation and maintenance expenditure. Vegetation management costs have been increasing while customers and regulators expect reduced numbers of interruptions. The majority of tree trimming is planned and based on Light Detection and Ranging (LiDAR) surveys. LiDAR scans are typically run every few years, measuring the distance between the electricity conductors and the vegetation (clearances). Areas with lower clearances are prioritised for trimming.

Project Satellite, partnered with Boston Consulting Group (BCG), explored how a satellite and AI solution could be implemented at UK Power Networks to inform trimming plans instead of the LiDAR-based approach. Satellite leverages satellite imagery and AI to measure clearances between conductors and vegetation. It then conducts AI analysis to prioritise areas for trimming based on the clearance and other criticality factors. The solution aims to reduce the number of vegetation-related outages and optimise trimming spend.

Experience to date

The project covered 400km of UK Power Networks' overhead network in Rotherfield and Polegate. Clearances were measured for c.3,500 spans by identifying the closest vegetation to the conductor with satellite imagery. This measured both radial clearance (closest 3D distance from the conductor to the vegetation) and encroachment type (linear vegetation growth type, e.g., side growth, under growth, through growth).

The solution's clearance output was validated in the field by measuring the distance between the conductors and the vegetation for a random selection of spans. The solution's accuracy was measured at c.95%, which will improve further with continued AI training of the solution. The high accuracy of the solution when measuring clearances enables it to efficiently make operational decisions.

Figure 35: Successful validation of span selection and their radial clearances.

Radial clearance 0–1m 1–3m 3–5m >5m



The measured clearances feed into the solution's platform, which determines how much, where and when to trim. AI growth models, based on historical satellite imagery data, were run to predict when spans need to be trimmed.

Feeders are prioritised for trimming based on their clearance and criticality score, which is calculated from a range of factors, such as number of customers on a feeder, voltage, historical outage data. Tree trimming plans are created based on a range of constraints, including budgets available per year. This optimises spend to carry out the most critical trimming across the network while reducing the likelihood of vegetation-related outages.

Highlights of our Innovation Project Portfolio Data & Digitalisation

Satellite

Continued

The high accuracy allows the Satellite solution to deliver significant value compared to the LiDAR approach when rolled out across the whole network:

- After implementation, satellite imagery can be analysed in c.2 weeks to determine trim plans vs 6+ months for LiDAR analytics. It can also be run for spot checks in areas after storms to assess damage
- Data acquisition is significantly cheaper than LiDAR, enabling more frequent data collection. This means that faster growing vegetation can be captured in the trim plans
- Once the solution is set-up, vegetation-related outages, based on peer results, can be reduced by 25%+, from optimised trimming and improved prioritisation
- Satellite imagery covers the entire UK Power Networks area, including the LV lines (LiDAR only covers the HV network). Therefore, more expensive LV unplanned trimming budgets can also be prioritised.
- The overall cost-benefit analysis highlighted that there is potential to save c.£25m (Present Value) by using a Satellite and AI solution when compared to the current LiDAR approach over the next 10 years. This excludes potential incentives gained from reduced CIs and CMLs

Future Developments

The project was a pilot to demonstrate the feasibility and benefits. A roadmap for full scale implementation across the entire network is being created to maximise the value from the solution. The roadmap and rollout will be co-created and customised with our operational team.

Furthermore, enhancing the accuracy of clearance can be achieved through iterative training of the AI using data from multiple rounds of field validation, integrating these findings into the solution. Other solution functionalities can also be incorporated and tailored in our network. For example, the solution can be used to run post-trim audits to check if the contractors have achieved the required trim clearance. It can also detect hazards, enabling proactive mitigation measures. Specific plans tailored for spans containing pole-mounted transformers and underground termination cables, which are more susceptible to vegetation-related outages, can be generated.

These requirements surfaced during collaborative working sessions between the business owner and our project partner BCG, and were further validated during field assessments.

Highlights of our Innovation Project Portfolio Data & Digitalisation

Powercast

Background

Over 200,000 of UK Power Networks' customers rely on their EVs being charged to get to work, school, or even just running errands. We forecast this number could increase to over 3.6 million customers by 2030. This makes these customers more vulnerable when there is a power outage (planned or unplanned), meaning their EV might not get charged, leaving them unable to travel.

With increasingly frequent extreme weather events such as storms Ciara, Dennis, and Eunice, or heatwaves like the one in July 2022, the reliability of the electricity network is at risk. The challenge is ensuring UK Power Networks' customers are supported through unavoidable planned or unplanned power cuts as more people switch to LCTs, making them even more reliant on the electricity network. There is a risk that UK Power Networks could be a barrier to switch to an EV if customers are unable to reliably charge their vehicles when they need it.

To address this, Powercast, an innovative solution, has developed a data sharing and notification solution with delivery partner ev.energy. Powercast provides real-time data sharing and notifications to EV customers, alerting them about planned and unplanned power outages in their area. This gives them the opportunity to plan and make alternative plans to keep their vehicle charged.

Figure 36: User centred approach



Experience to date

The solution is live, with real time power outage data available through a new application programming interface (API) hosted on UK Power Networks' Open Data Portal. ev.energy has integrated the API into their mobile charging application, ensuring that registered users receive timely notifications via the app or SMS about outages affecting their property. Users are also notified once power is restored.

The journey of Powercast included:

1. User research interviews and surveys (Figure 36): This involved research interviewing six and surveying 100 of ev.energy customers in the UK Power Networks region. It was incredibly insightful to help design the scope and scale of the user trial.
 - a. SMS was the main type of notification users wanted (73%), but email (47%) and push notifications (50%) were also popular. This led to rollout of SMS to the ev.energy consumer engagement platform.
 - b. There was no demonstrable need to have a basic and enhanced customer experience for users identifying with PSR criteria.
 - c. Users mostly wanted start and end times of power cuts, status updates and whether the power cut was planned or unplanned.
 - d. Users were familiar and preferred the experience provided by ZapMap for finding public charge points.
2. Three-month user trial with 500 ev.energy users: Running a trial with real data and users provided significant learning and benefits. This approach allowed a progressive rollout from small numbers, steadily increasing to 500, allowing bugs and issues to be ironed out. The solution has moved from the trial to a production solution in business as usual. The learnings from this exercise can steer other charge point operators into some good practices for their own integrations.
3. Final Powercast API and ev.energy rollout: With the success of the trial, Powercast has launched a publicly available API, granting access to real time fault data from UK Power Networks. This API empowers third parties to create or enhance services and customer experiences, similar to what's been achieved with ev.energy. All EV drivers should have an opportunity to benefit from automated notifications. UK Power Networks aims to collaborate with other charge point operators to encourage the adoption of fault data in their customer applications.

Highlights of our Innovation Project Portfolio

Data & Digitalisation

Powercast

Continued

Future Developments

UK Power Networks is also keen to explore other use cases with other organisations like academic institutes for research and discovery purposes, or charity organisations focusing on consumer vulnerability.

Following the rollout of Powercast to ev.energy users, the process of continuous development continues. Ongoing feedback is being captured from users and used to develop the roadmap of feature requests and enhancements. Some of which include:

Notification centre

Users will be able to opt in and out of the Powercast feature automatically via a toggle in the notification centre. This will allow for a more seamless user experience. ev.energy will be able to send users an in-app pop up reminding them to turn on the Powercast feature. When the notification is clicked, users are taken straight to the notification centre, where the Powercast toggle can automatically be set to on.

Improved notification centre

As part of wider app improvements, ev.energy plans to expand the notification centre to specify the type of notification a user wants to opt in or out of. This means that for the Powercast feature, a user could individually toggle SMS/push and email on and off. This will replace the email based opt in-out process in place today.

Highlights of our Innovation Project Portfolio Data & Digitalisation

High Voltage Auto Quote (HVAQ)

Background

Applying for new HV connections can be time-consuming, labour intensive and costly. HV customers have expressed their dissatisfaction with the process as it leaves them in the dark on the progress of their application and lack of transparency on the price components of their quote.

Only a small fraction of generated quotes, about 20%, actually lead to any work being done as customers are under no obligation to proceed to work delivery after receiving a quote. Therefore, the existing process is inefficient and results in wasted efforts preparing quotes for customers.

With the drive to net zero, and growing demand for EVs and heat pumps, we are forecasting the need for HV connections is going to increase by 40%, adding more strain to the already inefficient process.

HVAQ aims to redefine our HV connection application process. It is an innovative project designed to give customers more control by developing a self-serve tool. This will allow HV customers to generate a quote within minutes, with clear prices and budget estimates between 300 kVA and 2.5 MVA and formal connection offers between 300 kVA and 1 MVA.

The objective is to reduce the time to quote from days to minutes and enable a larger volume of quotes to be delivered to customers. The tool also offers customers the functionality to test network capacity and connection options at their proposed site in advance of submitting a connection application.

Experience to Date

The HVAQ tool was integrated with UK Power Networks' Smart Gateway customer portal in 2023 to provide customers with a single portal to complete all applications for connection work.

This integration will also provide an enhanced and simplified customer experience when applying to connect to the network, with the customer journey starting from UK Power Networks' website once the tool goes live for customer use.

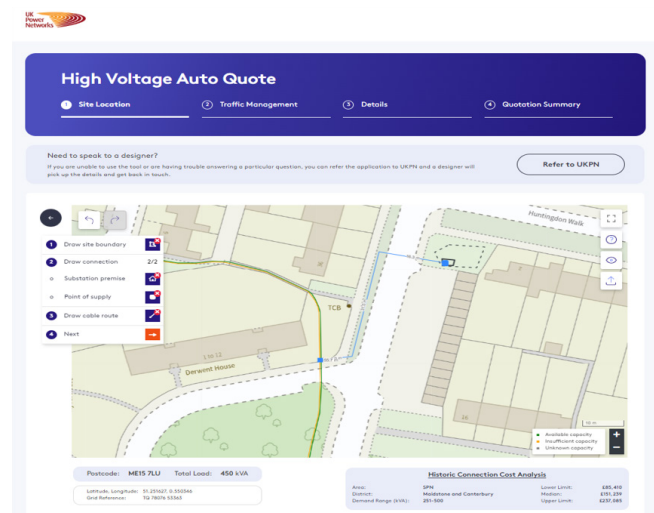
Development phase and system integration testing was completed in early 2024, with the user acceptance testing in progress. The end-to-end testing showed that the tool can generate a quote letter for customers, and we are continuing to enhance the tool to improve its accuracy.

The following lessons were learned during the development and testing phase:

- Network data quality and data vectorisation is a key pre-requisite to developing HVAQ
- Drive to improve overall customer journey and experience as part of HVAQ development
- Early customer engagement and feedback to shape the development phase

We are now in the final phase of testing and preparing for product launch. Our approach is to go live with the budget estimates and budget price ranges initially, followed by the connection offers. A phased go live approach helps mitigate post go live risks, allowing time to address post go live issues with HVAQ features and processes established.

Figure 37: HVAQ tool interface showing the map.



Future Developments

Currently, the tool is based on our South Eastern Power Networks (SPN) area, but we're planning to expand its capabilities to cover London Power Networks (LPN) and Eastern Power Networks (EPN) regions as well. As vectorisation data becomes available in these areas, we will continue to refine and improve the tool to serve even more customers across the board.

Highlights of our Innovation Project Portfolio Proactive Optimised Assets & Practices

Stratus

Background

Stratus commenced as an NIA project, and is now funded by UK Power Networks since the start of RII0-ED2. With the changing energy landscape, the way electricity distribution networks are managed and operated continues to evolve.

The volume and variety of DERs and LCT load connected to the network has significantly increased over the last decade. Therefore, the subsequent changes in demand and generation patterns, compounded by more inductive nature of the loads, has driven a need for change in the way electricity networks are designed and operated. For instance, the new load types can affect voltage and power factor, and therefore a more active network management approach is required.

Currently, the distribution transformers (11kV/LV & 6.6kV/LV) used on most GB distribution networks, perform basic voltage step-down, with no additional capabilities.

As such, networks can only actively manage the voltage at primary substation level. In the future, we expect variable profiles of generation and load through the day and seasons and therefore we need to be able to intervene at secondary level to tackle power quality challenges.

A smart transformer has the capability to regulate voltage and correct the power factor, and potentially resolve harmonic issues that arise from customers' equipment. The novel transformer utilises power electronics to provide the smart capabilities.

This solution can support the network from the secondary level, with the ability to provide dynamic voltage regulation and power factor optimisation. These transformers can help maximise the penetration of DER, while improving network stability, resilience, and visibility within the secondary network. When operating as part of a fleet, the solution can contribute to network stability by providing frequency control through dynamic modulation of consumer load.

Experience to Date

The first smart transformer (STX) for the trial (of the original eight planned) was deployed at the Browns Lane, Uckfield substation in November 2022. STX 1 has an advanced monitoring system; network data, including electrical and thermal parameters, have been recorded and analysed since deployment. Work to complete the scheduled number of STX units is expected to conclude by June 2026; in line with the project closure date.

The locations for the STX have been selected based on their suitability to test the full range of capabilities of the STX. Those capabilities will then be assessed on their ability to benefit both network operators (e.g. for increased LV visibility) and customers (e.g. voltage stabilisation).

In active mode, the STX regulates the output voltage to a value set by an engineer remotely via the cloud interface. In addition, the STX may regulate reactive power (no reactive regulation during the monitoring period) in the same way. The STX was in active mode 79% of the monitored period.

For the remaining period, where active mode was not possible (e.g. due to planned maintenance, unforeseen software error) the STX operated in passive mode. This means it continues to operate as a typical transformer would, without the additional smart functionality.

Since the STX has been installed, no statutory limits were violated, either in active or passive mode. Nor were any problems with power delivery for customers observed. In active mode, the STX provides a complete set of monitoring data. In case of any event ranked as critical, the STX automatically switches into passive mode. The STX stays in passive mode until all the fault and warning statuses are resolved.

Highlights of our Innovation Project Portfolio

Proactive Optimised Assets & Practices

Stratus

Continued

Future Developments

The project aims to install six additional units (beyond the first two units). Of the remaining six, four units will conform to the generation 1 configuration. The remaining two will conform to the generation 2 configuration, which takes learnings from the initial unit deployment and seeks to make enhancements to operation and performance. It will also utilise more recent upgrades in technology not previously available during the development of generation 1.

The project aims to test the units against a range of scenarios. Performance of STX will be measured against the following success criteria provided by the supplier.

The STX captures data that will support provision of reports on:

- Device performance on a monthly basis
- Load characteristics and short-term forecasting (after three months of operation)

Figure 38: Smart Transformer (Install1) at Browns Lane, Uckfield.



Highlights of our Innovation Project Portfolio

Proactive Optimised Assets & Practices

Automated Tunnel Data Capture

Background

Automated Tunnel Data Capture commenced as an NIA project, and is now funded by UK Power Networks since the start of RII0-ED2.

The current process of inspection requires many highly trained (both health and safety and engineering) personnel to carry out tunnel and shaft inspections. Specific competencies and training are required for operatives to enter these very high risk confined space environments.

The project aims to identify how automated techniques for capturing and processing inspection data can reduce the quantum of staff involved, leading to subsequent cost savings and a reduction in health and safety risks.

The comprehensive data capture and use of advanced analysis techniques, such as machine learning to identify change in condition of infrastructure and equipment in tunnels and shafts, will improve understanding of the deterioration and enable a more predictive maintenance regime to be adopted. This in turn may offer maintenance cost reductions and better managed deterioration and monitoring.

Experience to Date

The use of Boston Dynamic's 4 legged robot, Spot, has showed there is great potential to improve our maintenance and safety assessment procedures within underground tunnels.

The robot was able to navigate through confined spaces and hazardous environments, accessing areas that were previously challenging for human inspectors. This heightened accessibility ensures comprehensive inspections, enabling us to identify potential issues promptly and mitigate risks effectively in the future.

Additionally, the efficiency of robotic inspections stood out to us. The robot operated continuously and tirelessly.

Furthermore, we saw how the camera module developed by consultancy Arup was able to detect anomalies or defects in tunnel structures. This early detection capability empowers us to address maintenance issues proactively, mitigating potential risks and ensuring the integrity of the infrastructure. With the addition of machine learning, we could train the algorithm to detect even more defects in addition to the obvious ones that can be seen with the naked eye.

Figure 39: Boston Dynamic's Spot in action with Arup's camera module installed during phase 1.



Highlights of our Innovation Project Portfolio

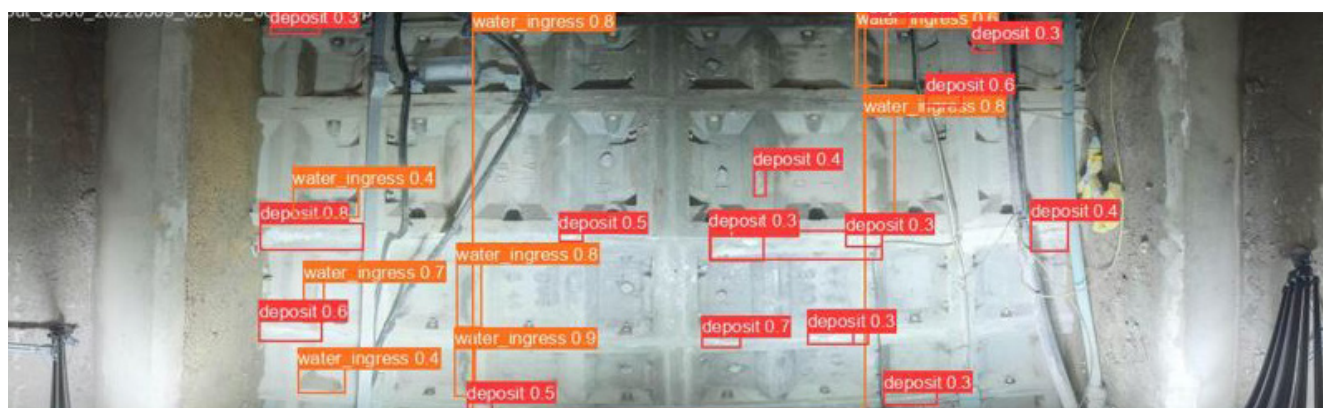
Proactive Optimised Assets & Practices

Automated Tunnel Data Capture

Continued

Figure 40: Example of machine learning in action where utilising AI, we can automatically detect faults and generate reports.

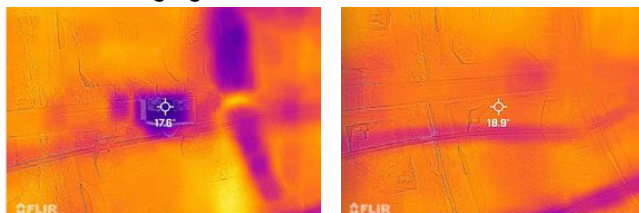
AI detection



Defects tracing



Thermal imaging



Future Developments

Having successfully completed the initial phase of our tunnel inspection project with Spot, Phase 2 will involve leveraging a fully autonomous robotic system by ANYbotics to further enhance our capabilities. Whilst Spot provided us with good results, the feedback was that it still required a human to operate it in the tunnel.

Phase 2 will entail further research and evaluation to identify the most suitable robotic platform that aligns with our specific inspection requirements and operational objectives. Once selected, we will embark on the integration process, ensuring seamless compatibility with existing infrastructure and inspection protocols.

Key components of this integration will include fine-tuning the robot's navigation and sensing capabilities, optimising its data collection and analysis functions, and implementing robust communication protocols to facilitate real-time monitoring and control.

Furthermore, comprehensive training programs will be developed to familiarise personnel with the operation and maintenance of the new robotic system, ensuring proficiency and adherence to best practices.

Throughout this transition, our commitment to regulatory compliance and safety remains paramount. We will continue to collaborate closely with relevant stakeholders and regulatory bodies to ensure adherence to all applicable standards and guidelines.

Figure 41: ANYBotics' ANYmal robot to be trialed in phase 2 for its autonomous inspection capabilities.



Highlights of our Innovation Project Portfolio Proactive Optimised Assets & Practices

Reskube

Background

Reskube commenced as an NIA project, and is now funded by UK Power Networks since the start of RIIO-ED2.

On a daily basis UK Power Networks is required to conduct work involving pre-arranged power interruptions.

In such cases, customers must be informed well in advance of the power interruptions so they can make plans during these periods without electricity.

It has also become more obvious after the COVID-19 pandemic lockdowns, that more customers prefer to work from home and require both a continuous power supply and an internet connection. Given the increased dependency on electricity of our customers, UK Power Networks' customers may complain about power interruptions as they cannot conduct their daily work, and this may negatively affect the customer's experience of our service.

To ensure a high level of customer service, an alternative source of power and internet connection could be offered to the customers during a pre-arranged power interruption.

The Reskube and Power Protect projects both involve battery packs to support customers during a power cut. The key differences between the two projects are the specific customers they support, the nature of the power cut involved, and the device they use as a power supply source. The Reskube device is aimed at customers who work from home and customers with young children during a planned power cut.

The battery unit provides 500W to power laptops, monitors, and tablets, and the integrated SIM card modem provides an internet hotspot connection. The Power Protect device aims to support our most vulnerable PSR customers, who rely on medical equipment such as continuous positive airway pressures, nebulisers, and feed pumps. This support is provided during unplanned power cuts, with a 2kW battery unit.

Experience to Date

We assessed requirements, including the identification of suitable devices, their specifications, and expected performance metrics. The project team then ensured the smooth integration of these devices into existing systems and workflows.

This entailed coordination with relevant stakeholders, such as operational teams and customer services, to address any compatibility issues and ensure seamless connectivity.

External stakeholders were also engaged to ensure the issuing process for the devices were well thought out for a smooth deployment.

Figure 42: Reskube Home Pro.



Highlights of our Innovation Project Portfolio

Proactive Optimised Assets & Practices

Reskube

Continued

Figure 43: Artist impression of home office with the Reskube device.



Looking ahead, the focus will be to continue streamlining and expediting the delivery process of the devices. Close collaboration with the SDC (Service Delivery Centre), Reskube and logistics partners will be maintained to ensure an optimised delivery of the devices.

Once the devices are delivered, the focus will shift towards their integration into existing systems and workflows. Rigorous testing will be conducted to verify functionality, compatibility, and performance, ensuring that they meet the intended requirements. Continuous monitoring and evaluation will be carried out to assess the impact of the devices on customer satisfaction.

Depending on the success of the three month trial, there may be opportunities to scale up the project across all licence areas with a larger pool of customers. Lessons learned from the trial will inform future deployment plans and ensure scalability for BAU.

UK Power Networks visited Cubik Innovation who are one of Reskube's innovation partners to inspect their low volume manufacturing facility. The visit showed that the facility was of really high quality and that they carry out very high quality standards to ensure the devices are deemed safe for domestic use.

Figure 44: UK Power Networks site visit to Cubik Innovation HQ.



Our Network Innovation Allowance Portfolio

Our Network Innovation Allowance Portfolio

REFERENCE	PROJECT NAME	RESEARCH AREAS	START DATE	END DATE	BUDGET
NIA_UKPN0059	Miles better fault location	Optimised assets and practices	01/05/2020	01/05/2023	£1,838,000
NIA_UKPN0062	Radio Teleprotection	Optimised assets and practices	01/08/2020	01/08/2023	£438,000.00
NIA_UKPN0069	Socially Green	Consumer Vulnerability	01/11/2020	15/12/2023	£1,000,000
NIA_UKPN0076	Neighbourhood Green	Net zero and the energy system transition	01/02/2022	29/02/2024	£818,000
NIA_UKPN0077	Emerge	Net zero and the energy system transition	01/02/2022	31/08/2023	£730,733
NIA_UKPN0078	Right to Heat	Consumer Vulnerability	01/02/2022	30/04/2025	£952,774
NIA_UKPN0079	Collaborative Local Energy Optimisation (CLEO)	Net zero and the energy system transition	01/03/2022	31/07/2024	£2,767,000
NIA_UKPN0081	High Voltage (HV) Auto Quote	Net zero and the energy system transition	01/09/2022	30/06/2024	£2,851,182
NIA_UKPN0083	NeatHeat	Net zero and the energy system transition	01/09/2022	30/06/2024	£473,000
NIA_UKPN0084	Power Protect	Consumer Vulnerability	01/10/2022	31/05/2024	£246,250
NIA_UKPN0086	Shift 2.0	Net zero and the energy system transition	01/10/2022	31/10/2024	£619,300
NIA_UKPN0087	Our View	Optimised assets and practices	01/10/2022	28/02/2025	£442,836
NIA_UKPN0088	Powercast	Consumer Vulnerability	01/11/2022	29/02/2024	£274,725
NIA_UKPN0089	Fluid Cable Care Phase 3	Optimised assets and practices	01/03/2023	30/09/2024	£809,433
NIA_UKPN0090	Flex Heat Networks	Whole energy systems	01/07/2023	31/08/2025	£501,600
NIA_UKPN0091	Satellite	Net zero and the energy system transition	01/09/2023	31/03/2024	£413,000
NIA_UKPN0092	Spotlight	Consumer Vulnerability	01/10/2023	31/01/2025	£1,650,000
NIA_UKPN0100	Trading Connections: Exploring a novel approach to connections queues	Net zero and the energy system transition	01/02/2024	31/08/2025	£773,000

Innovate with us!

We believe that collaboration is key for successful innovation, and our door is always open for new proposals. If you have an idea or want to collaborate with us, we would be delighted to hear from you.

Please get in touch at [**innovation@ukpowernetworks.co.uk**](mailto:innovation@ukpowernetworks.co.uk)

