Strategic Innovation Fund

Annual Report 2024

Innovate UK's delivery of the Strategic Innovation Fund (SIF) in 2024, in partnership with Ofgem

Foreword

It's been a transformative year for the energy system. In my first year leading the Ofgem Strategic Innovation Fund (SIF) we've seen our new government launch Mission Control, the creation of the National Energy System Operator (NESO) and the publication of the Clean Power 2030 Action Plan. These exciting changes focus our attention acutely on the near-term challenges of climate change. As the largest energy innovation fund in the UK, the SIF is a pivotal tool for the delivery of the government's 'clean energy superpower' ambition.

We've listened to feedback from our stakeholders and transformed the SIF in the last year to create more opportunities to access funding, streamlining our process and introducing more flexible timelines. This is to help energy networks and partners accelerate delivery of projects and speed up the energy transition.

Ensuring the learning and evidence from these is shared with Ofgem and government, as projects progress, is essential, so this year we've also restructured to put greater focus on insights and impact. This will be critical in creating the right conditions for the scale up, commercialisation and roll out of the biggest and most transformative ideas, as we approach 2050. This will ultimately deliver better value for our most important stakeholders, the people who use and pay for our energy networks.

We are now on a critical pathway for delivery of a decarbonised electricity system by 2030, which is essential for meeting net zero targets and securing clean, affordable energy. Energy networks are right at the heart of net zero. Energy is the second largest contributor to our emissions in UK, and electrification of heat and transport will increase demand.

The SIF is pivotal in this transition. We are driving transformative innovation and holding energy networks accountable whilst fostering the innovation needed to drive change at the necessary pace. To meet these challenges, gas and electricity networks must step up their efforts. This means bringing us more big, transformative, game changing ideas, fostering a culture of collaboration and innovation. Working more closely together, embracing external ideas and technologies, and focusing more on deployment of cutting-edge solutions so that tangible benefits for customers are delivered. To put it simply, how do we make the networks super net zero friendly whilst being affordable to consumers?

Working on the SIF is a unique privilege and I'm immensely proud of the volume and pace of work that's been delivered by the team this year. We've made big changes and maintained high standards of delivery. In 2024 we have reviewed more than 270 new ideas from innovators, and approved over £104m of funding including a further 12 large-scale Beta demonstration projects. We've also supported 33 companies with venture capital, growth accelerator and equity funds engagement and, as we improve the efficiency of the application process, we have turned around informal decisions on the latest Discovery projects in just 27 days. None of this would have been possible without our brilliant team partnering across Innovate UK and Ofgem, and the support of our wider network of friends and partners. Thank you!

The projects we fund in the next few years will shape the future of our energy system, it is only in learning by doing that we will overcome complexity and deliver the huge benefits a cleaner optimised energy system can bring us. Transforming our energy system requires leadership and courage from all of us.

Let's do this!

Jodie Giles

Deputy Director, Ofgem Strategic Innovation Fund at Innovate UK

The SIF to date

Figures as at the end of 2024.

234
projects funded

191
projects completed

70+
SMEs provided with extra support

43
projects currently live

339
different organisations funded

>£5.9bn
potential cost savings by 2035*

>12.2 MtCO2e
potential emission savings by 2035*

* General illustrative figures, based on projections and recognising that many projects may not progress to full rollout

£270.36m
Total funding

£229.64m
SIF funding committed

£40.71m
additional contributions

£16.48m
Discovery SIF funding

£33.88m
Alpha SIF funding

£179.28m
Beta SIF funding

137
Discovery projects

75
Alpha projects

22
Beta projects

270+
ideas submitted in this year's calls for ideas

30+
companies participated in venture capital, growth accelerator and equity funds engagement

We have over
2000
unique listeners to our Bright Spark Podcast*

Engaged with
192
new companies in this year's call for ideas

*Subscribe to our BrightSpark podcast channel to hear more stories from the SIF

About the Strategic Innovation Fund (SIF)

Decarbonising Great Britain's energy networks is a huge undertaking, and it is urgent. Government has a priority to 'make Britain a clean energy superpower' and has committed to zero-carbon electricity supply by 2030. The government is driving this through the creation of Mission Control and National Energy System Operator (NESO) who have recently published their Clean Power 2030 report. This is part of the government's commitment to reach net zero by 2050, reducing the UK's greenhouse gas emissions. Energy use remains at the heart of net zero. Large volumes of the UK emission from energy use, such as transport and heating; with increasing electrification of heat and transport demand on the energy network will increase. Ensuring networks can facilitate decarbonisation across our energy system will be vital to achieving net zero.

Innovation will be critical. We need vision, delivery capability, and investment on a large scale, with rapid innovation and at the lowest cost to consumers. This is an opportunity to make the UK a global hub for energy innovation, making it the best place for business to grow and scale. This is why the Ofgem Strategic Innovation Fund was established in 2021, as a programme with funding of **£450m+ over five years**, to drive innovation and transformation in energy networks.

SIF Vision

Accelerate the UK's transition to net zero at lowest cost to the consumer and make the UK the best country for energy business to grow and scale

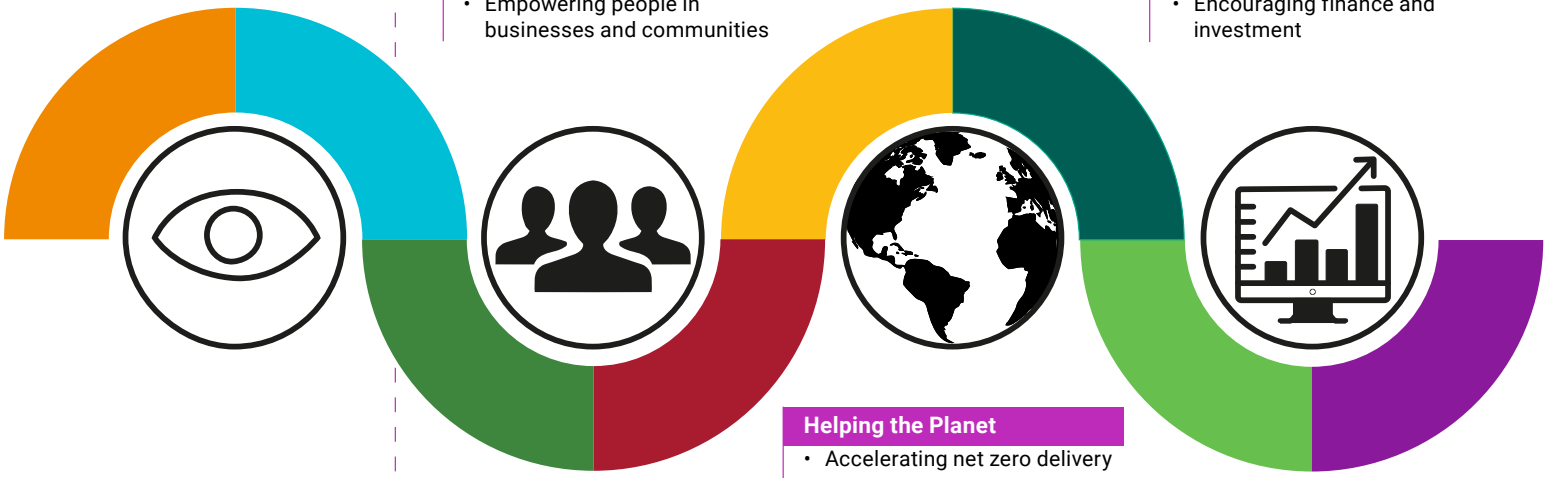
SIF Mission

Helping People

- Ensuring value for money for energy consumers
- Creating transformative products and services
- Empowering people in businesses and communities

Helping Businesses

- Enabling diverse collaboration to deliver change
- Supporting the best ideas to grow and scale
- Encouraging finance and investment



Helping the Planet

- Accelerating net zero delivery
- Enabling energy security
- Making energy systems more resilient and robust

For more information about the Strategic Innovation Fund visit: www.ofgem.gov.uk/sif

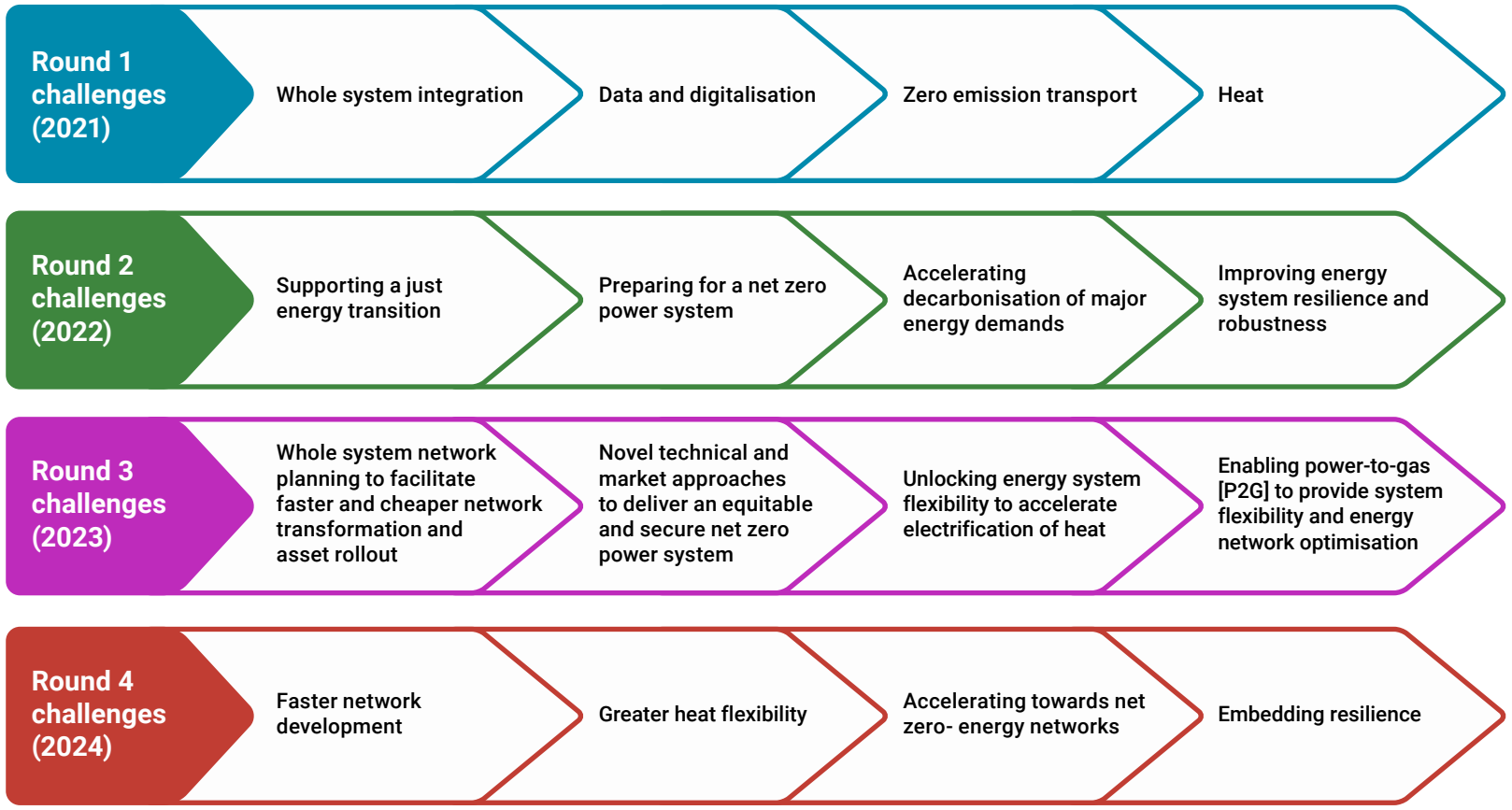
How the SIF works

Delivered in partnership between the energy regulator Ofgem and Innovate UK, the SIF is part of the energy networks price control mechanism (specifically, RIIO-2) managed by Ofgem.

Every year Innovate UK and Ofgem collaborate with industry, consumer groups and other stakeholders to identify the most pressing issues faced by the energy networks in addressing decarbonisation.

These are then developed into annual challenge areas to provide innovators with direction and focus to develop ideas to address the identified issues. The diagram below shows the challenges to date:

SIF annual challenges



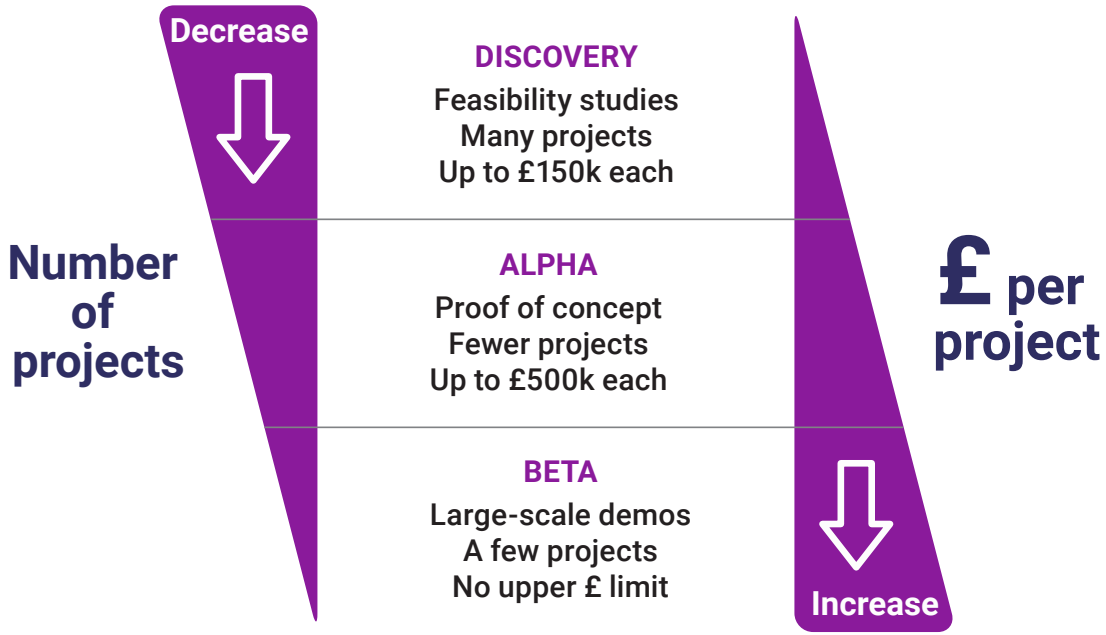
Find out more about our Round 4 Innovation Challenges on the Ofgem website

Driving transformative energy innovation

Challenge setting is followed by the ideation phase. Ideation is all about finding the biggest and most transformative ideas to address the challenges and problem statements we publish annually. Innovate UK runs a series of ideation workshops for innovators to learn more about the problems networks face, discuss potential solutions, and learn more about what previous innovation projects have taught us. During these workshops, Innovate UK hosts a range of innovators and subject matter experts, to build ideas with the highest potential to meet the energy challenges. Then begins the process of matching the successful innovators with energy networks to forge partnerships, exchange knowledge and develop an application for funding.

Successful ideas can be submitted into any of the three phases; Discovery, Alpha and Beta. Discovery is for short (up to five months), feasibility-style projects. There will be fewer Alpha projects, which will be longer (up to eight months) proof-of-concept and detailed design projects. Beta is for a small number of large collaborative demonstrator projects, lasting up to five years, that will lead to scale-up and commercial deployment. Projects can apply 'straight to' Alpha or Beta if ready and collaborations exist, but it is advisable to speak to the SIF team if selecting this route. At each phase a project competes for progressively higher levels of funding, with fewer projects going through to subsequent phases. The aim is to find lots of ideas with higher risk and identify those with greatest potential quickly, giving them the support they need to become business-as-usual as fast as possible. Whilst some projects finish at Discovery or Alpha phase, all projects have the potential to identify valuable insights and learning.

Strategic Innovation Fund Phases



Accelerated Strategic Innovation Fund application process

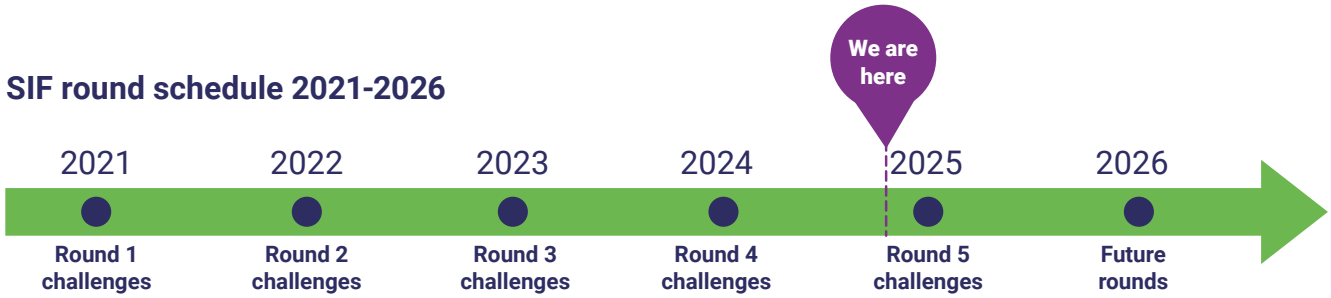
From 2021 to 2024, there was one funding round for each SIF phase per year. Successful projects would proceed straight from Discovery to applying for Alpha and then for Beta. From October 2024, the way SIF funding rounds are run changed. Following extensive engagement with stakeholders, **we have made the SIF more flexible and created more opportunities to apply.**

Instead of projects having one chance annually to apply for each phase, there will be three chances each year for all phases, Discovery, Alpha and Beta. The application window will open every four months, for around four weeks at a time – opening at the end of January, end of May, and end of September. This will allow the energy networks more opportunities to bid into the SIF and much greater flexibility to decide on the best time to submit or progress their idea.

We have introduced flexible start dates and durations. Project teams can decide which phase to apply to depending on progress. The new approach allows project teams to decide their own start date to suit the project and their resources. Projects will also be able to deliver within a flexible window of time.

In addition, we have reviewed internal processes and have sped up the funding assessment process, so applicants receive quicker notification of their funding decision. Projects will be able to move through their life cycles faster: the shortest route from Discovery funding award to Beta funding award can now be completed in 23 months, saving up to eight months compared to the previous process - all of which supports acceleration to decarbonise the UK's energy system.

SIF round schedule 2021-2026



Driving innovation, insights, and influence

Ensuring the SIF delivers lasting value for GB energy consumers

The SIF programme is designed to drive network innovation, deliver net zero and provide lasting value to GB energy consumers. As we develop and grow the SIF programme, we will extract the insights and impacts of the projects we fund.

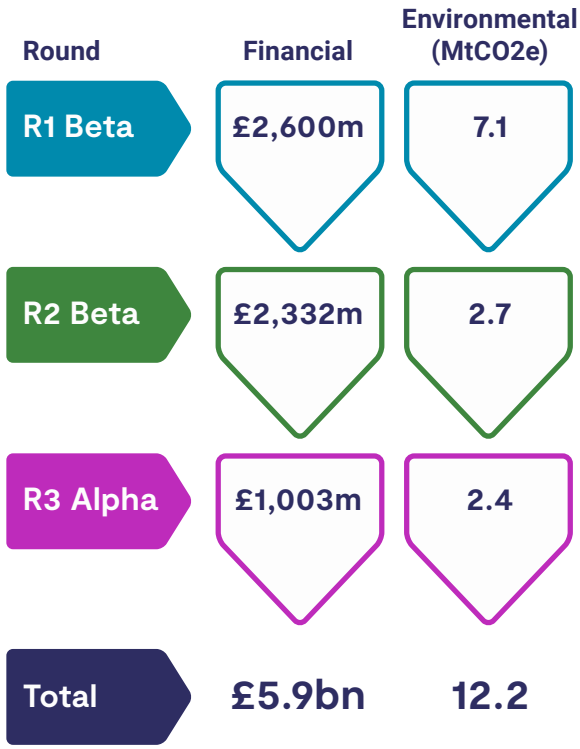
This will help us to understand the valuable benefits of SIF projects, and identify further innovation opportunities. Our ambition is to improve the granularity of our intelligence on SIF benefits, to ensure we can provide impactful narratives that highlight success, identify challenges, and inform the net zero transition. We will also deliver more actionable learning to policymakers, regulators and the wider energy sector, enabling more concise and focused decision-making to support wide scale adoption and deployment of solutions.

We are building strong relationships with project leads and key stakeholders across industry, to embed and capture insights within our processes and cultivate knowledge sharing. With a more targeted approach to analysis, we will increase our contribution to key industry activities such as consultations, reports, and innovation strategies. This work will position us to help address the most pressing challenges to achieve net zero.

This report highlights key insights against the core themes shown in the graphic below. On the next page, you will see an overview of our Beta phase projects; for more information on specific projects see the SIF Project Directory.

Further to the insights, project teams are required to quantify the net present value (NPV) of any financial and non-financial benefits, including environmental, social and/or carbon reduction benefits. The quantifiable value of these is useful for measuring the potential value to consumers as a result of SIF investments.

Estimated Consumer Benefits[1]



This graphic represents our current snapshot of the estimated benefits that consumers are set to gain from the delivery of SIF innovation projects. To contextualise these values, we have estimated the following representative examples.

- The Eastern Green link 1 (EGL1) project is a £2.5 billion, consumer funded, electricity transmission project aimed at transporting power to two million homes via a subsea cable[2]. The proposed financial savings from SIF projects would be the equivalent of purchasing two of these infrastructure projects and having almost an additional £1 billion to reinvest into other network projects.
- The Office for National Statistics documents emissions from the UK's 2022 electricity supply as 55 MtCO2e[3]. The potential carbon savings from SIF funded projects if they were all scaled up is the equivalent of offsetting 22% of the emissions produced through the supply of electricity in 2022.

Informing future public investment in innovation

To support future sector requirements, SIF has provided support to the Department for Energy Security and Net Zero (DESNZ), to support the development of the Energy Innovation Needs Assessments (EINAs).

The EINAs are a research programme commissioned by the UK government to produce evidence and analysis, identifying potential energy innovations that could play a crucial role in the future UK energy system, whilst also creating national economic opportunity.

The EINAs are conducted roughly every five years. They are used to guide public sector investment in low-carbon technologies, identifying where business-as-usual activities and barriers within existing markets may not produce the optimal innovation outcomes.

Innovate UK and Ofgem are delivering the energy networks component of the EINAs with support from the Carbon Trust, for DESNZ. This will ensure that network innovation, often overlooked in previous assessments, is prioritised as a critical enabler of decarbonisation and economic growth through the energy transition.

The EINAs involve extensive stakeholder engagement, workshops with technical experts, and detailed modelling to assess the technical, economic, and system-wide impacts of a range of shortlisted energy network technologies.

A deep dive economic potential assessment has been conducted on a shortlist of energy network innovations to better understand how, and when, cost improvements or deployment scale-up might be best achieved.

Our report will be finalised in spring 2025, and published in line with the wider publication of EINAs by DESNZ. Collectively these will be used to inform future public funding allocations and innovation strategies that will help shape the energy networks of 2030 through to the 2040s.

1. The indicative values presented in this graphic are a consolidated view of the cost benefit analyses (CBA) submitted by project teams. Whilst we encourage project teams to be ambitious with their projects, we are conscious that our internal analytics for measuring impact need to be further developed.
2. https://www.easterngreenlink1.co.uk/news/subsea-superhighway-moves-closer-to-construction
3. https://www.ons.gov.uk/economy/environmentalaccounts/methodologies/measuringukgreenhousegasemissions

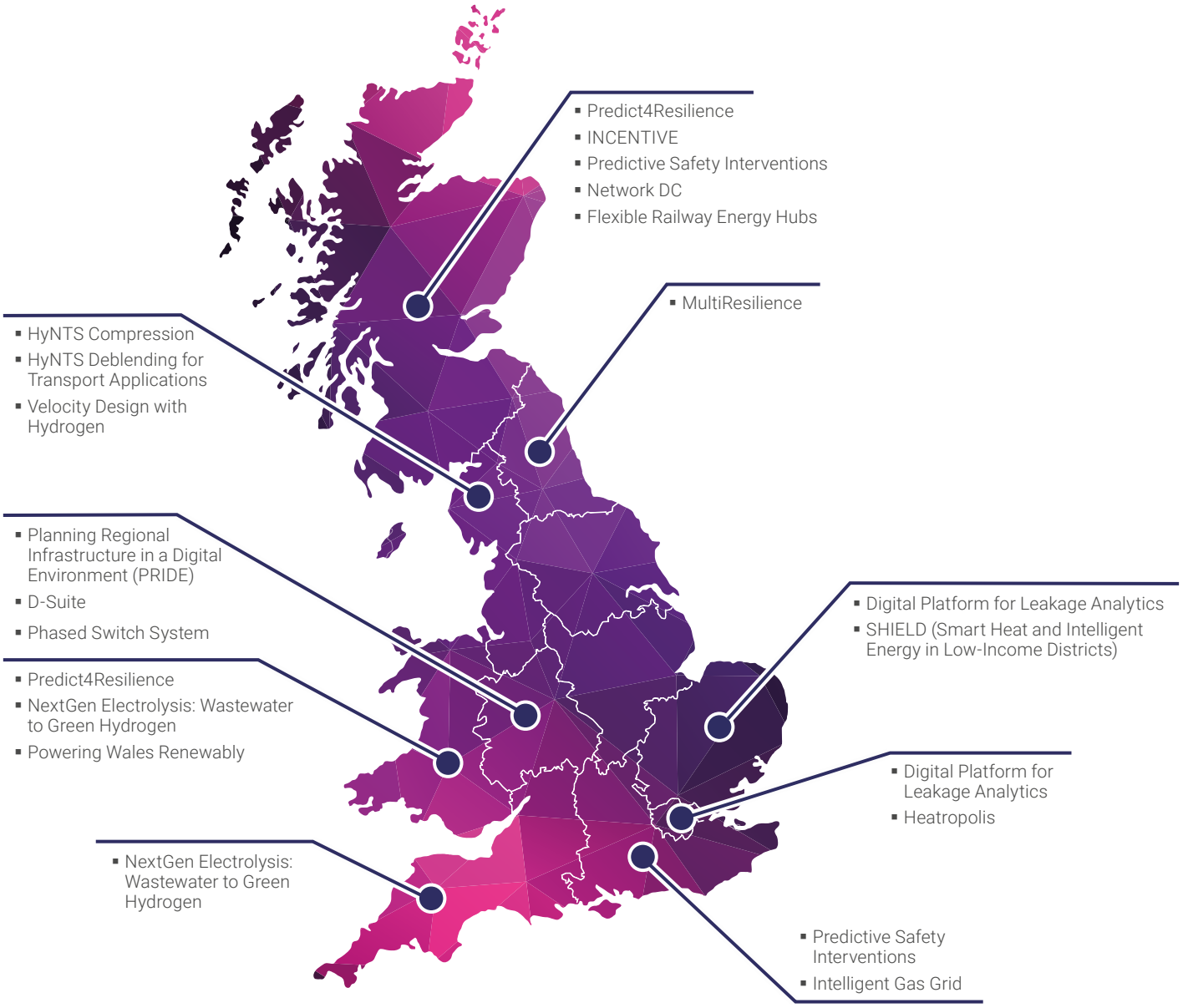
Beta phase demonstration projects

Mapping our large-scale Innovations

This year the SIF has funded a further 12 Beta demonstration phase projects, bringing our total to 22 across the first two rounds of challenges. The map on the right lists project locations, although many have nationwide coverage. For more information on specific projects see the SIF Project Directory.

Nationwide project:

- Crowdflex
- CReDO+ Climate Resilience Demonstrator
- Black Start Demonstrator from Offshore Wind (BLADE)
- SF6 Whole Life Strategy



Accelerating connections for a net zero energy transition

Millions of new low-carbon technologies need to connect to our energy system whether they are large or small, industrial or domestic, and whether generating, storing or consuming energy. Making our networks super net zero friendly to accelerate these connections is fundamentally what the SIF innovation projects are all about. This is why accelerating connections is our first focused theme in this year's annual report.

Offshore wind and inertia services

Historically, system inertia has been provided by the rotating generators of power stations, which continue spinning even when disconnected, allowing system operators to manage frequency response in real time. The **INCENTIVE** project, led by Scottish and Southern Electricity Networks (SSEN), tackled the critical challenge of declining grid inertia as inverter-based technologies replace these traditional spinning reserves, leading to higher costs and potential generation curtailment. Concluding in autumn 2024, the project investigated how offshore wind farms (OWFs) could deliver inertia using innovative INCENTIVE technologies. The project looked at approaches never before trialled with OWFs, including static synchronous compensators with supercapacitors, battery energy storage systems and synchronous condensers with flywheels. By integrating inertia services directly with OWFs, the project aimed to lower costs, minimise additional infrastructure needs, accelerate renewable connections, and enhance grid stability and reliability. Beyond cost savings through shared network and planning resources, the project also sought to create a liquid market for inertia services. As a ground-breaking initiative, the project provided clarity around the process of installing INCENTIVE solutions from a regulatory and commercial perspective. Specifically, it identified key routes to enabling market participation of these technologies and an understanding of the asset ownership options of such devices. The project also developed an understanding of the technical performance and specifications, and adjustments to technical markets/grid codes that could enable INCENTIVE solutions to operate within the inertia market.

Direct current circuit breakers for stability

As the UK aims to increase OWFs to up to 50GW of generating capacity by 2030, an extensive network of high-voltage direct current (HVDC) cables will be required to transmit this energy to shore. To improve efficiency and reduce the impact on coastal communities, a streamlined

approach with a minimal number of terminals for collecting and distributing this power is being recommended. While effective, this strategy introduces the risk of single points of failure, potentially affecting multiple wind farms. SSEN's **Network-DC** project, now entering the second year of its Beta phase, is addressing this challenge by investigating and demonstrating the use of direct current circuit breakers (DCCBs). These innovative devices, untested in GB and European markets, can safely and securely contain the effects of a single failure, preserving grid stability. The success of this SIF project could accelerate OWF connections, delivering significant benefits for renewable energy integration. During 2024, work has included a tendering process with equipment manufacturers, and review of regulatory and commercial barriers to the adoption of DCCBs has begun.

Temporary grid connections

The Alpha phase **Road to Power** project, led by National Grid Electricity Distribution (NGED), is exploring temporary connections. Originally focused on electrifying roadworks, following the Discovery phase the project scope has been expanded to include all construction projects, where mobile machinery is powered via temporary grid connections. The project will develop a self-service tool for these temporary connections, to reduce the time and financial barriers associated with the network connections needed to support electrified machinery. The project outputs could save approximately £828 million of network reinforcement costs by 2050, as well as facilitating the transition towards net zero construction sites by reducing reliance on diesel generators.

Meanwhile, UK Power Networks' (UKPN) **Wayl-ease** project aims to streamline the consent process by developing a transparent, public-facing record of permissions.Wayl-ease is creating a digital platform to connect network operators and landowners, enabling online engagement and efficient payment systems.

Several other projects within the SIF portfolio are actively working to accelerate new connections. To find out about these projects visit our SIF Project Directory.

Find out more about the Beta Projects on YouTube

Harnessing flexibility for a resilient energy future

Flexibility on both the demand and supply side is essential for managing the system efficiently and minimising costs. A flexible approach also presents consumers with an opportunity to actively participate in the energy system, potentially reducing their energy bills.

Building on the success of the Demand Flexibility Service Trials over winter 2022/23, the **CrowdFlex** project, led by NESO and awarded in December 2023, explores how large numbers of domestic households could become a reliable source of flexibility to support the national grid. This year, the project focused on trial designs and model development to advance its objectives.

Flexibility through scale

Since the summer of 2024, in collaboration with project partners OVO Energy and Ohme, the project has conducted over 38,000 consumer trials across Britain. These trials aim to identify patterns in customer behaviour when responding to notifications to either increase or decrease their household energy usage. Showing whether this flexible demand could support inflexible generation for example

during high or low periods of renewable generation. The data from these trials will be used to improve forecasting models of domestic demand and flexibility, supporting better decisions around whole system scenarios. Trials will continue over a two-year period.

The project is exploring the use of incentives such as a utilisation payment and an availability payment. These are a nominal fee per kWh for participating in flexibility, which compensates consumers for keeping home assets like electric vehicles (EVs) plugged in.

This allows EV batteries to support grid balancing and recharge automatically during low demand. The first winter trials, running until March 2025, will provide valuable insights, including the influence of locational network capacity, weather variations, seasonal supply challenges, and increased heating demand. Of particular interest is the impact on constraint-managed zones, with project partner SSEN examining how this flexibility service can complement the flexibility offerings of distribution service operators (DSO).

Large car parks as a flexibility source

Focusing on DSO flexibility is critical for enabling a more responsive and resilient energy network, especially as we integrate greater amounts of renewable energy and electrification. By leveraging flexibility services, DSOs can better manage network constraints, absorb excess local generation, and enhance grid stability, paving the way for a cleaner energy future. Against this backdrop, the **Park & Flex** project, led by UKPN, successfully progressed through its Discovery and Alpha phases. This innovative initiative explores how electric vehicles (EVs) parked in large car parks can provide flexibility services, and participate in ancillary markets, addressing local network constraints, and facilitating the absorption of high renewable output through Vehicle-to-Everything (V2X) technology and smart charging. Project findings indicate that up to 4.3GW of flexible capacity could be accessed in large car parks within the UKPN region by 2050. This capability represents an opportunity to reduce system costs and accelerate the connection of low-carbon technologies via bi-directional charging in car parks.

The proof of concept phase further indicated that 22kW bi-directional V2X chargers deployed in long-stay car parks, such as those at airports, could generate annual revenues of £4,000 to £5,000 for car park owners by 2024, with a nominal internal rate of return of 10% from an investment of around £12,000. Although the potential for significant V2X revenue, estimated at £370 million across GB, was identified, unlocking these benefits will require approximately £430 million in additional private sector investment for chargers, replacements, and market access, amounting to £1.8 billion on a GB wide scale.

While these findings show promising commercial opportunities, broader investments in V2X technology to deliver widespread societal benefit is needed.

To find out about other projects exploring flexibility visit our SIF Project Directory.

Advancing whole system strategic planning for future networks

As Great Britain's energy system transitions to net zero, strategic planning on an unprecedented scale is required to determine where and when assets and networks will be developed. This planning spans multiple levels, from high level strategies aligned with government policy and transmission network design to distribution networks and the decentralised, local energy solutions that power communities. Coordination across these levels is vital to ensure a smooth and efficient whole system transition. The catch is the planning is only as good as the delivery that follows.

The systems and computational techniques underpinning this planning must be both sophisticated and interoperable. With millions of new distributed assets connecting to the grid, managing capacity and enabling coordinated services such as flexibility, planning tools must handle complex and interconnected demands. Standardised data transfer between planning layers will be essential to align efforts and optimise the energy system as a whole.

Energy system modelling

Ofgem recently consulted on the governance of a Data Sharing Infrastructure (DSI), designed to enable energy sector participants to exchange data in a standardised format. The DSI is expected to play a pivotal role in supporting strategic planning, forming the backbone of NESO's Virtual Energy System. Advanced computational techniques, such as artificial intelligence and probabilistic modelling, as demonstrated in the SIF Discovery project **Probabilistic Modelling for Energy System Planning**, led by NESO, will be essential. In the Discovery phase, the project identified that the high computational cost of analysing each deterministic pathway to net zero limits the extent to which optimal planning decisions can be implemented. These types of tools will facilitate rapid, iterative network needs analysis, risk-based options assessment, and optimised planning decisions, ensuring a more efficient and responsive approach to system development.

Empowering local authorities

NGEDs project **Planning Regional Infrastructure in a Digital Environment (PRIDE)**, which completed its Alpha phase in Spring 2024, has successfully advanced to the Beta phase of the SIF. PRIDE aims to empower local actors, such as local authorities, by helping them create digitised decarbonisation pathway plans tailored to their areas. Critically, the project will also develop governance models that ensure these local plans effectively integrate into the regional strategies being developed by NESO in its new role as Regional Energy Strategic Planner (RESP).

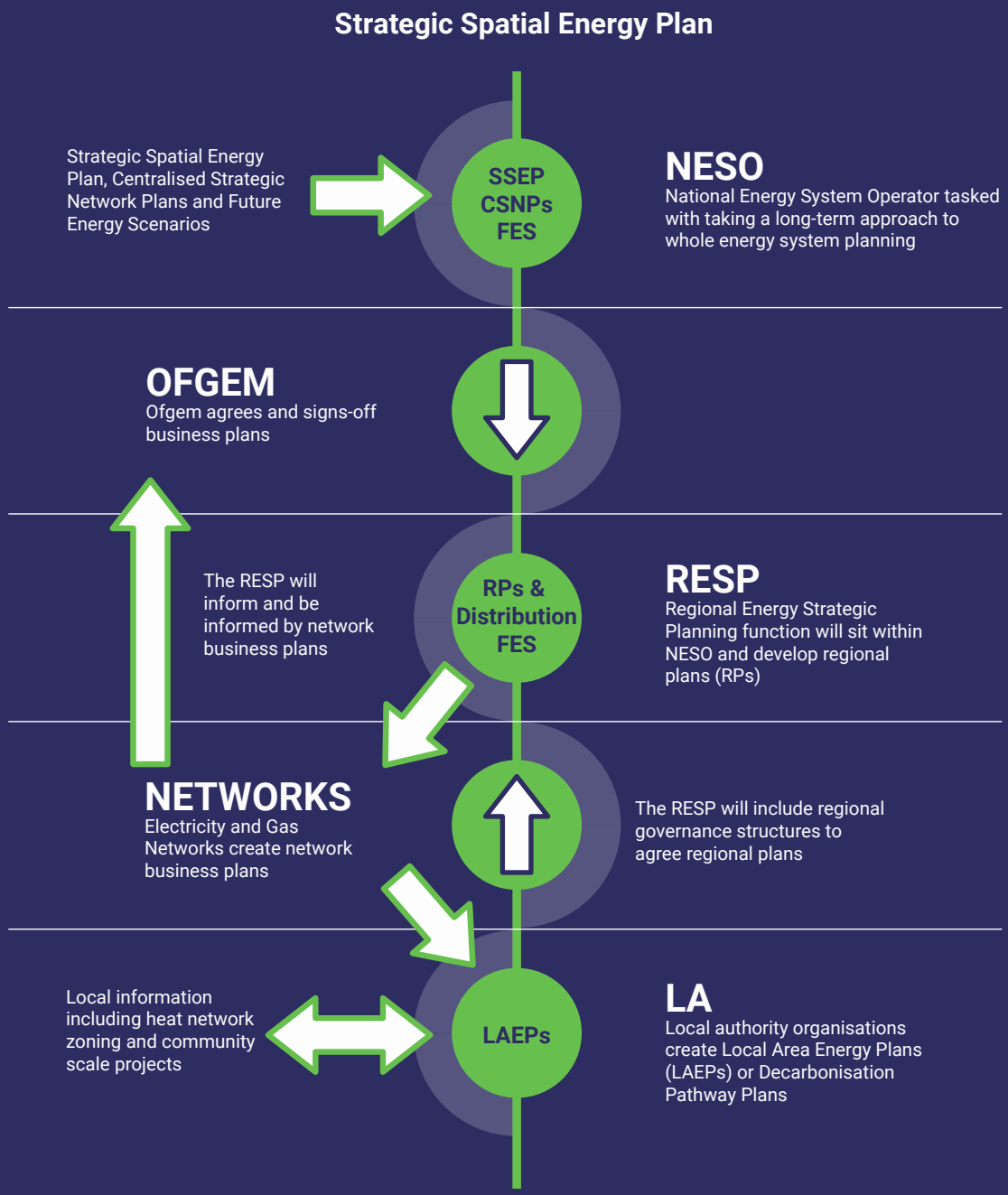
By aligning local and regional efforts, PRIDE will enhance strategic decision-making and coordination, enabling the energy system to deliver on net zero targets more effectively. This governance approach ensures that

decarbonisation plans are cohesive and actionable across all levels, driving progress through collaboration and system-wide optimisation. During the Alpha phase, PRIDE was able to test and demonstrate the value of digital tools to support cost-effective energy planning between networks and six participating local authorities.

Accelerating renewables in Wales

Powering Wales Renewably (PWR), like PRIDE, completed its Alpha phase and has successfully moved onto Beta. Led by NESO and partnering with both electricity distribution and transmission networks, the gas network operator, and the Welsh government, PWR will develop a digital twin. This will provide a common interface to accelerate the integration of new generation and demand into the electricity system in Wales. The innovation in the project will provide NESO with new insight and tools to enable it to embed the new RESP function into business as usual activity. PWR will carry forward work from the Alpha phase, focusing on the need for a hierarchical spatial aggregation method to align and correlate top-down and bottom-up spatial planning approaches.

To find out about other projects advancing whole system strategic planning for future networks visit the SIF Project Directory.



Disclaimer: Diagram includes information which is subject to change and consultation.

Enabling a decentralised and just energy transition

Net zero cannot be achieved by offshore wind connecting to transmission networks alone; it will be just as crucial to develop solutions on the demand and local generation side. There is a challenge for the distribution network to enable millions of new renewables connections whilst maintaining system stability and optimisation. At the same time, homes and businesses across the country need to be encouraged to switch to EVs and heat pumps and manage their demand in more flexible ways. Making sure the transition is fair in terms of who pays and benefits is critical. Networks will need to work with partners and engage in new ways to build consent, ensuring benefits are realised for everyone, including the poorest in our society.

Community energy centres

The **Rural Energy and Community Heat (REACH)** project, led by NGED, will focus on the distributed edges of our energy system during its Alpha phase. The project will look at where the 'thin ends' of the wires in our distribution network face capacity challenges from new generation and demand loads. REACH aims to explore the concept and scalability of a community energy centre that integrates new generation technologies, storage for load balancing, and EV charge points in areas without existing charging infrastructure.

By using intelligence from local substations and data from individual homes at the street or feeder level, the energy centre will optimise its operations. Projects like REACH have the potential to enable faster integration of low-carbon technologies, easing connection challenges in advance of network upgrades and, in the long term, reducing the need for extensive system improvements. This could address the challenges identified during the Discovery phase in providing sufficient electrical capacity to rural communities, enabling the adoption of low-carbon technologies.

Optimising low-voltage technologies

Similar to REACH, SP Energy Networks **LV Optimiser (LVOE)** project tackles challenges at the low-voltage feeder level of the network addressing where the growing adoption of low carbon technologies, such as domestic solar panels, batteries, heat pumps and EV chargers places new demands on local energy systems. LVOE focuses on innovative low-voltage power electronic devices designed to improve voltage quality and address imbalances, overcoming limitations in traditional fuse-based protection. The Discovery phase developed a novel control algorithm for an LV optimiser, which addresses LV voltage quality and imbalance.

By integrating these devices with AI algorithms, the project aims to optimise the placement and operation of power electronics devices, enabling dynamic network management. This approach will support the widespread adoption of low-carbon technologies at the feeder level, ensuring a more resilient and adaptable energy system.

Affordable heating for households

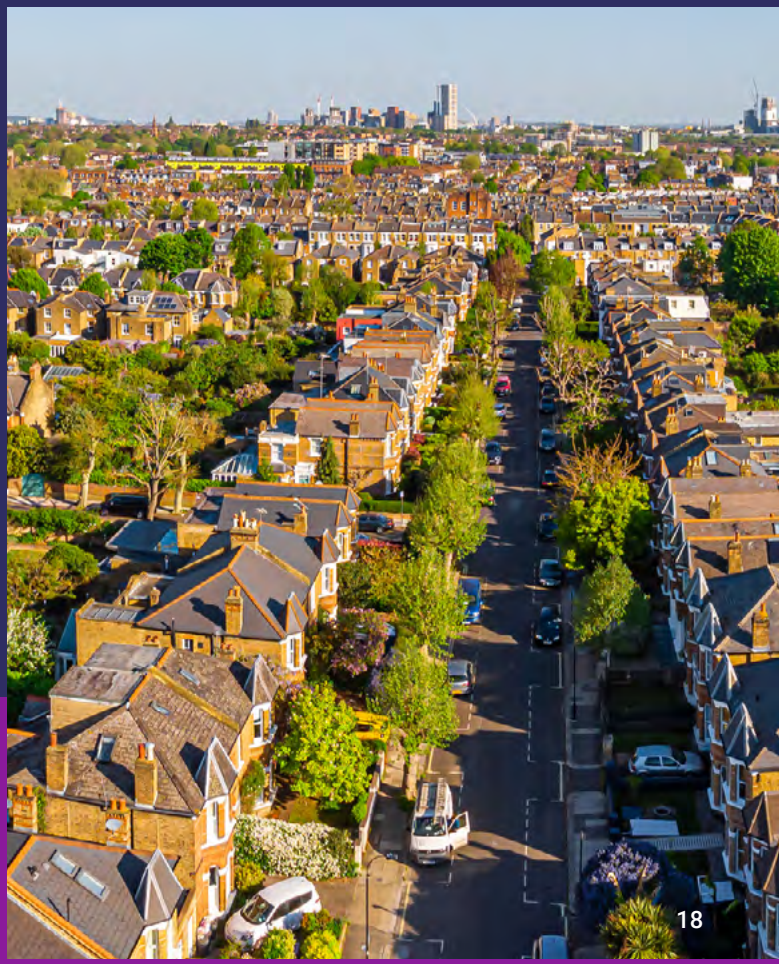
Project **SHIELD**, led by UKPN, is also focused on street and household levels by delivering affordable heating solutions for homes and integrating a smart local energy system to support grid services. The approach combines photovoltaics, battery storage, and the use of waste heat from data processing. During the Alpha phase, the project refined the design of an energy services company (ESCo) to support the commercial model and service delivery, while also identifying tenants interested in participating in the Beta phase trial rollout.

Where gas and electricity networks intersect

While REACH and LVOE focus on highly localised energy systems, Northern Powergrid's (NPG) **Cross Vector Energy Hub** takes a broader approach by examining the interplay between gas and electricity networks where they intersect. This project seeks to optimise the energy system holistically, ensuring that consumer demands are met efficiently. By enabling different energy vectors to support one another during periods of peak demand, the project aims to unlock system-wide benefits and enhance overall resilience. In the Discovery Phase, the Cross Vector Energy Hub project demonstrated the value of grid co-optimisation using green hydrogen for long-term storage and gas for fast, dispatchable peaking services. While initially aimed at Network Utilities, the tools proved equally valuable for third-party developers and energy planners, including local councils.

For more information about the Strategic Innovation Fund visit: www.ofgem.gov.uk/sif

To find out about other projects enabling a decentralised and just energy transition visit our SIF Project Directory.



Advancing system resilience, strength and robustness

Currently the energy system focuses on a traditional centralised model but as it transitions to a more distributed and decentralised structure, the grid faces increasing challenges in maintaining reliability. The ability to withstand and recover from shocks while keeping the lights on is becoming more critical and complex. Additionally, evolving political dynamics and a changing climate present new challenges to the energy networks. Resilience is the ability of the grid to adapt, recover and continue functioning after a disruption such as extreme weather, security threats or asset faults. In contrast, robustness is the inherent durability to withstand stress without significant loss of functionality.

Forecasting weather-related faults

The **Predict4Resilience** project, led by SP Energy Networks has developed a software platform that provides fault forecasts ahead of any adverse weather events. Predict4Resilience is providing control rooms with predictions regarding the expected number of faults across Scotland and Wales, up to five days in advance. This allows for proactive placement of resources such as fault teams, welfare vans or replacement equipment in areas most likely to be affected, so that power can be restored sooner than currently possible. Since beginning in November 2023, the project has made significant progress integrating live weather data, implementing weather forecast bias correction, and enhancing, testing and evaluating models. The user interface for the platform has been designed, control room engineers have completed training and live trials with SP Energy Networks started in October 2024, with Scottish and Southern Electricity Networks expected to join the trials in early 2025. Trials will continue until summer 2026 to validate the platform's performance during winter and summer operations.

Planning for system resilience

UKPN **CReDo+: Climate Resilience Demonstrator**, awarded funding for Beta phase in September 2024, will develop a digital twin and data sharing platform to enhance resilience investment planning and reporting, understanding of infrastructure interdependencies and risk from extreme weather such as flooding or heat. This project aims to build climate resilience across the entire system by addressing the interconnections between energy, water, and telecommunications. It examines how power outages can trigger cascading impacts on these other critical sectors. At present, no single organisation is incentivised to take responsibility for ensuring resilience across all these systems, making this

collaborative approach essential. The Alpha phase of the project showed that simplifying messaging increases organisational adoption, stakeholder involvement is key, and better predictability is needed to resolve data gaps. Potential benefits from a cross-network adoption of the digital twin could be £4.4 billion NPV at GB level to 2080, alongside societal benefits to consumers from fewer service outages.

Restoring supplies after blackouts

Restoration in the event of a blackout is an essential element of system resilience in a net zero future, as the energy system moves away from current, fossil fuelled restoration sources. Awarded funding for Beta phase in September 2024, **Black Start Demonstrator from Offshore Wind (BLADE)**, led by SP Transmission, aims to enable offshore wind farms to restore the onshore grid following a blackout. As there are in excess of 77GW of offshore wind farms in development, BLADE Alpha phase identified that offshore wind farms built after 2028 must include built-in restoration capacity. Without this inbuilt mechanism, the future energy scenario will not meet the Electricity System Restoration Standard. The project will demonstrate to NESO what offshore wind farms can provide in terms of restoration and the need for NESO to evolve its wind restoration market requirements. Many offshore wind developers are currently unable to participate in the market due to lack of clarity on technical requirements and uncertainty of potential revenues

How to measure system strength?

With intermittent renewable generation on the grid, voltage changes occur which can lead to instability in the network and risk customer outages. The **System Strength Measurement and Evaluation (SYSMET)** project, led by SSEN, has advanced from the Discovery to Alpha phase this year. SYSMET is tackling the critical challenge of developing new methods to measure system strength as inverter-based technologies become more prevalent, altering traditional system dynamics. The Discovery phase saw identification of new definitions and metrics for the strength of small-and large-scale systems, as well as identifying innovative solutions for real-time monitoring of frequency scanning. The Alpha phase is now investigating both digital and hardware solutions to effectively monitor and manage system strength in the transition to net zero.

To find out about other projects advancing system resilience, strength and robustness visit the SIF Project Directory.

Supporting the decarbonisation of heat and transport

Decarbonising heating and transport presents opportunities and challenges for energy networks and consumers. Shifting to low-carbon heating in buildings can improve energy efficiency and reduce electricity demand, easing pressure on the grid. However, this transition must account for challenges such as seasonality, where heating demand peaks in winter, potentially straining the network. Similarly, decarbonising the transport sector significantly increases electricity demand but offers opportunities for flexibility. Optimising low-carbon technology use will help balance the grid, significantly reduce reinforcement costs, enable faster grid connections and offer more competitive pricing for consumers. However, managing increased demand and integrating these new distributed energy resources requires careful planning to maintain a resilient and efficient energy network.

Unlocking better heat networks

Low-carbon heat networks are one option for decarbonising heat. UKPN's **Heatropolis** project, awarded Beta phase funding in September 2024, will demonstrate novel commercial and technical arrangements to unlock heat network flexibility. The project will undertake three winter trial periods in London, ensuring better collaboration and planning outcomes between heat and electricity networks and reducing reinforcement costs. The learnings from the project's Alpha phase show that smart controls and thermal storage could reduce heat network peak demand by up to 85%. Stakeholders also confirmed that current market frameworks do not provide suitable commercial arrangements for heat network operators to invest in solutions that unlock flexibility for the energy system.

Flexibility through heat storage

The **Watt Heat** project, led by UKPN, has completed its Discovery and Alpha phases. This project explored the market for flexibility through heat storage technologies to mitigate peak electricity load, capture low energy prices, and enhance system flexibility. The project identified that thermal storage could significantly reduce peak demand, with an NPV of £3.7 billion in the UKPN region alone by 2050. However, thermal storage is not currently eligible for government grants or relief, which could deter trial participants from investing in the necessary technologies. Additionally, Energy Performance Certificates (EPCs) discourage the electrification of heating systems. Electric heating often receives lower scores than gas heating, creating a barrier for groups such as social housing providers to adopt electric heating.

Planning for space cooling demand

Innovative solutions are needed to decarbonise multi-occupancy buildings (MOBs) such as apartment blocks. There are significant barriers including high upfront costs and complex ownership agreements. UKPN **Heat Risers** project, after completing its Alpha phase, estimated potential savings of £2 million by 2070 in the UKPN region alone. These savings would come from reduced substation upgrades, as well as consumer savings from switching to more efficient heating technologies such as heat pumps in MOBs. However, addressing key policy barriers outside the energy network's scope is crucial. These barriers include ownership of structures, building management, and securing grants to support these decarbonisation efforts.

As Great Britain warms due to climate change, customer access to space cooling is leading to increased summer peak demands on the energy network. With 65% of offices and 30% of retail already using space cooling, Electricity North West's **Cooldown** Discovery project found that between 5% and 32% of GB homes will adopt space cooling by 2035. The project highlighted that this increased load could trigger network reinforcement due to summer peaks. In current distribution network planning, cooling demand is poorly accounted for and could provide flexibility during periods of network stress. The Cooldown project's Alpha phase examines cooling's impact on network capacity by refining uptake and demand projections, and creating new incentives for space cooling flexibility, reducing reinforcement requirements, and optimising customer value.

Hydrogen for road transport

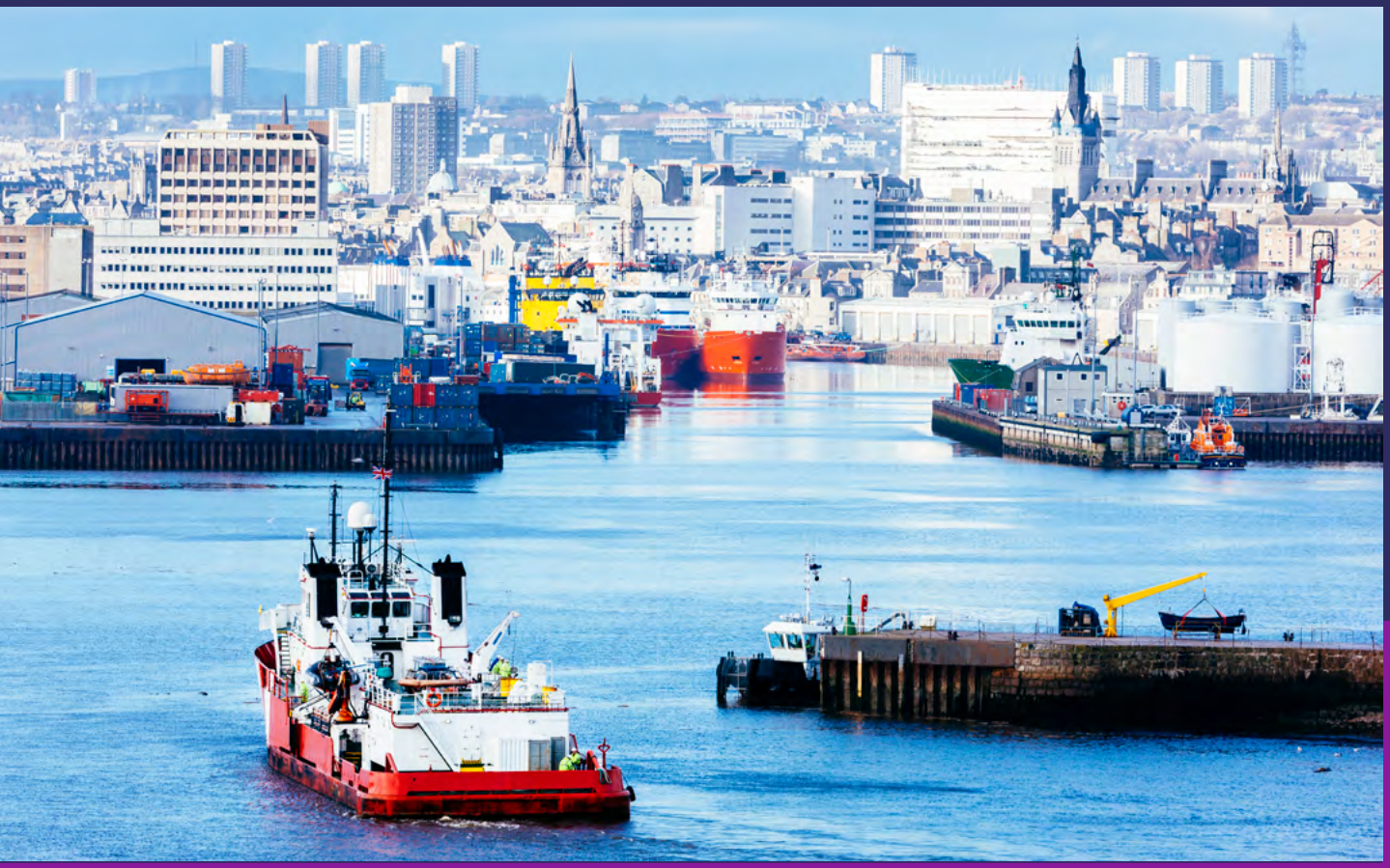
In our transport projects, National Gas's **HyNTS Deblending for Transport Applications** project focuses on the deblending of hydrogen gases from the high-pressure national transmission system. This will enable delivery of hydrogen fuel to transport, such as heavy goods vehicles, via refuelling stations. In its first year of Beta phase, the project has completed the design of the deblending system demonstration facility, which is located at the DNV site in Spadeadam. Fabrication of the deblending system is underway, led by partner HyET. The project has identified key regulatory and policy changes which will be needed to fully implement its findings. Government plans to allow hydrogen into the gas distribution network would need to be extended to the transmission network, alongside changes to gas safety and maintenance legislation to facilitate this.

Making rail a flexibility resource

Diesel trains consume 648 million litres of diesel per annum and emit 1.8 MtC02e. The government has set a goal of removing all diesel-only trains by 2040. Achieving this will require extensive work to electrify 448 kilometres of tracks and significant capital investment. However, the lead time for critical new projects to be connected to the grid is in excess of 15 years, which could significantly delay rail decarbonisation. SP Energy Networks' **Flexible Railway Energy Hubs** project aims to turn the largest electricity consumer in the UK, rail, from an inflexible load to a flexible demand. The project aims to demonstrate the first microgrid to interface with both the railway network and the electricity power grid, building on learning from a previous Discovery phase and Network Innovation Allowance (NIA) funding. Through the use of microgrid technologies and battery storage, by 2043 390 rail sites within the rail network could have a capacity of 1.9GWh total storage to provide grid flexibility.

Marine decarbonisation

The marine sector is vital for trade, tourism, transportation, and providing jobs and services to coastal and island communities across Britain. The **SeaChange** and **Electric Thames** projects are currently progressing through the Alpha phase. SeaChange, led by SSEN, will develop a tool to understand potential maritime energy demands as well as build a replicable model for exploring energy transition scenarios for the sector. The Discovery phase of the project confirmed that marine decarbonisation is a complex area, with variations in port size and no one fuel choice for vessel decarbonisation. Cost benefit analysis suggests that the project outputs could reduce network reinforcement costs by between £315 and £619 million, and reduce emissions from the fuel used in vessels and ports. In line with the Ports of London Authority's commitment to net zero from its operations by 2040, UKPN's Electric Thames project will develop a whole system planning approach to decarbonising the central Thames area and explore the potential benefits of Boat to Grid (B2G) charging. The Discovery phase highlighted the need for a 'green corridor', which will consider electricity load requirements at multiple locations to find the optimal solution (electrification or hydrogen etc), creating a decarbonisation framework that considers the needs of multiple users on the Thames. The earlier phase also saw intensive stakeholder engagement with vessel operators, quay owners and the Port of London Authority to understand the overall power requirements and ambitions. The project identified that 166 vessels will need to decarbonise to reach the Port of London Authority's ambitions. If these vessels install chargers in isolation and do not participate in flexibility markets, then the expected peak demand would be 226MW. From the Discovery phase high level analysis, a peak demand of 140MW is estimated with B2G charging and managed hydrogen generation, all of which will require significant network capacity. However, exploring a B2G flexibility service could reduce network reinforcement costs.



To find out about other projects which are decarbonising heat and transport visit the SIF Project Directory.

To find out more about our Beta projects watch their 60 second videos on YouTube.

Enabling digitalisation and repurposing of the gas network

As the UK increases deployment of net zero technologies, gas demand is anticipated to fall significantly. Parts of the gas networks may require repurposing, with initiatives like Project Union focused on creating a hydrogen transmission backbone to connect industrial clusters. For other areas of the gas networks, such as distribution, the future is less defined. For the SIF, the critical aspect is understanding the role of the gas network in the transition, and ensuring the infrastructure development and use is aligned to the net zero goals and delivers optimal consumer value.

Automating gas distribution

The **Intelligent Gas Grid** project, led by Southern Gas Networks (SGN), is driving innovation to modernise gas distribution networks. By leveraging advanced digital technologies, the project aims to reduce methane emissions through enhanced pressure management and increased biomethane injection capacity by maintaining optimal pressure levels. In turn this will detect pressure anomalies caused by super emitters or pipeline damage using AI and machine learning. These innovations will replace manual processes with automated systems, improving efficiency and customer service while minimising harmful methane emissions. This project not only addresses current challenges but also positions gas networks for future hydrogen integration. Since beginning in July 2023, the project has tested and approved prototype pressure monitoring devices developed by partner UtonomyOne, and these devices are now in trial at fourteen locations. The proof-of-concept anomaly detection models have also been completed.

Repurposing compressors

While the Intelligent Gas Grid project focuses on distribution networks, National Gas's **HyNTS Compression** project targets the National Transmission System (NTS) to facilitate the hydrogen transition by repurposing high-cost compression assets. By modifying existing compressors for hydrogen operation, the project offers a cost-effective alternative to replacements, which would otherwise cost over £60 million per unit. Technical demonstrations at the DNV Spadeadam facility aim to validate the feasibility of repurposing 65% of the UK's fleet of compressor engines for hydrogen use.

Hydrogen as a storage solution

The **HyScale Liquid Organic Hydrogen Carrier (LOHC)** project, led by SGN, aims to demonstrate the potential of LOHC systems for capturing, storing, and releasing hydrogen to meet long-duration storage needs. By connecting an LOHC system to an electrolyser and a hydrogen gas network, the project explores how hydrogen storage can be managed flexibly, leveraging periods of low electricity prices to reduce the cost of hydrogen production. This innovation supports the broader adoption of hydrogen across industry and for storage of low cost renewable power. LOHC systems offer a potential solution for regions lacking geological storage, providing an alternative for balancing inter-seasonal energy demands as renewable energy sources expand. Previous research funded through the Network Innovation Allowance has highlighted LOHC technology's ability to lower hydrogen costs through energy arbitrage and reduced capital expenditure, benefiting producers, gas distribution networks, and consumers alike. The project now advances toward a physical demonstration in the Alpha phase, addressing technical, economic, and operational aspects to validate the role of LOHCs in a net-zero energy system.

Adapting networks for hydrogen

SGN's **Velocity Design with Hydrogen** project is producing data from a test rig to establish safe design gas velocity limits to re-purpose gas networks to safely deliver 100% hydrogen. This

will support delivery of hydrogen through the gas network which could provide heat to industrial or domestic consumers near industrial clusters. Since beginning it's Beta phase in September 2023, the project has completed design and procurement for construction of equipment for erosion, vibration and noise testing, and undertaken particle transport tests at the DNV site at Spadeadam. The project has also modelled velocities for different blends of hydrogen using a digital twin of the test rig. The project's findings will contribute to the research programme enabling the Government's 2026 strategic decision on the role of hydrogen for heat.

Exploring hydrogen storage underground

The **EMstor** project, led by Cadent Gas, is exploring the development of an innovative geological hydrogen storage solution to support the planned East Coast Hydrogen Pipeline (ECHP) South. By enabling the storage of electrolytic hydrogen produced during periods of abundant renewable energy, EMstor will help balance supply and demand on the pipeline. This will ensure resilience against supply disruptions, and support cost-optimised hydrogen production for flexible power generators during peak electricity periods. The project focuses on repurposing disused hydrocarbon fields for hydrogen storage, a solution that could accelerate the deployment of the ECHP South network by removing reliance on distant salt caverns. Following the key opportunities identified in the Discovery phase, the Alpha phase will refine the technical and commercial viability of this approach, advancing regional hydrogen storage as a cornerstone for resilient, optimised power-to-gas systems.

Hydrogen from wastewater

The **NextGen Electrolysis–Wastewater to Green Hydrogen** project is led by Wales and West Utilities in partnership with HydroStar. The project is pioneering electrolyser systems that use less pure water sources, such as rainwater, storm overflow, and industrial wastewater, to produce hydrogen. During the Alpha phase, the project successfully generated hydrogen from nine different impure water sources, showcasing the potential to reduce operational constraints and costs. In the Beta phase, the technology will be demonstrated at two industrial customer sites, each providing distinct impure water sources, further validating its scalability and real-world applicability. This innovative approach aims to enhance resilience, lower costs, and enable adoption of low-carbon hydrogen across gas networks.

To find out about other projects which are enabling digitalisation and repurposing of the gas network visit the SIF Project Directory.

Driving commercial growth and widespread deployment

A key part of the SIF vision is to make the UK the best country for energy businesses to grow and scale. To support this, we have delivered several key workstreams during 2024 that are driving the evolution of innovation across the entire energy system.

Sector influence

Last year we informed you about some exciting work we were delivering around the Culture of Innovation within our networks, including our regulatory and wider stakeholders. We published a study including an innovation culture exemplar that can act as a statement of best practice for anyone in the sector. National Grid Group have recently refreshed their Innovation Strategy, and it's exciting to see a growing focus on innovation and culture embedded in their ambitious plans.

To find out more visit PA Consulting.

Innovation Playbook

Alongside the SIF's focus on fostering greater innovation across energy networks, we also recognise the importance of equipping innovative companies with resources of their own to help deliver a joined-up innovation journey. Last year we told you about the development of the Innovation Playbook, a resource that looks at historic innovation projects to assess the factors that contributed to, or hindered, their ability to successfully deploy. We have now published this. It's a valuable tool providing insights that can shape the success of innovation initiatives, serving as a best-practice guide for the early development and effective pitching of new ideas.

We will continue to iterate this playbook, alongside some of our industry partners, making it a 'living document' resource for innovators.

Encouraging more innovation

Bridging knowledge gaps

A significant barrier within the innovation ecosystem is the gap between an innovator's understanding of an energy network and the level of expertise needed to effectively address the network issue. Our evidence highlights a need for direct and targeted support for early-stage innovators to bridge this knowledge gap, alongside access to specialist energy system advice and expertise. That is why we are exploring the role of a network innovation support function, and how it could complement future innovation mechanisms, fostering a more connected and effective innovation ecosystem.

Enabling third party access, high risk and experimental Innovation

There remains a strong appetite for pursuing high-risk high-reward innovation. But often the experimental nature of these innovations poses too high a risk for an energy network to undertake within the existing innovation funding mechanisms. We are exploring whether third-party funding models alongside technical assistance could help. This could be without the need for direct involvement of an energy network, or it could be involved but in more of a mentorship role. This approach could mean innovators bringing more developed and derisked transformative ideas forward to networks and attracting new-to-sector innovators into this space.

Innovate UK's Innovation Culture work has been used by industry leaders such as National Grid Partners, the utility venture & innovation fund:

"Building on our innovation strategy refresh and using key sector resources like Innovate UK's Culture of Innovation exemplar, National Grid Partners have implemented a range of innovation culture initiatives over the past 6 months:

Setting up a Community of Practice for all innovation managers in the UK & US to share lessons learnt

Hosting our inaugural National Grid Innovation Day in London and the first NextGrid Alliance Summit in Boston, demonstrating our ambition to convene key stakeholders across the utility innovation landscape and drive the change required to enable the energy transition

Hosting online forums and talks, telling our story of innovation and raising awareness of new initiatives enterprise-wide

Introducing an Innovation Management Platform to provide transparency of National Grid's innovation activities and identify opportunities to scale

Introducing crowdsourcing in our operating model and making all colleagues an active innovation agent

With a stronger culture of innovation, we have managed to connect people and teams to collaborate and deliver impact and create spaces for knowledge transfer and continuous improvement."

Quote from National Grid Partners, *Innovation Strategy*

Supporting growth companies

Encouraging more innovators into network innovation is only a start. We need these innovators to deliver results through demonstration projects and we need to them to become successful commercially. As our portfolio of innovation projects start to deliver results, we want to see the commercial potential of early stage companies reflected in contracts they can win and funding they can secure.

Some innovators involved in our funded projects have gone on to raise significant private investment already. Nine SMEs participating in SIF projects have secured £38m of investment between them. We will continue to track the good news of these investments as well as keeping an eye on the barriers to attracting investment in the well-documented innovation 'valley of death,' and the factors leading to success.

Case study

SMPnet

Company background

SMPnet has emerged as a technology focused supplier to the energy sector, leveraging cutting-edge technology to drive advancements in grid management. The company's suite of products, under its flagship **Omega Suite**, has positioned SMPnet as a leader in congestion management, voltage stability improvement and flexibility sourcing.

Growth and achievements

- **Secured market traction:** SMPnet now boasts commercial agreements with two leading energy system operators: Northern Powergrid in the UK and a major distribution system operator in Spain. These partnerships are a testament to the real-world applicability and effectiveness of its solutions.
- **Attracted Investment:** Following its broader innovation journey, supported in part by the SIF, SMPnet raised $1.44 million (£1.14 million) in venture capital funding. This investment has accelerated the scaling of its operations and enhanced its capacity to meet growing demand.
- **Delivered impact:** The company's Omega Suite is already transforming grid operations by automating flexibility coordination, eliminating inefficiencies, and providing a scalable solution for network operators.

The SIF's role in supporting SMPnet

The SIF played a modest but meaningful role in SMPnet's journey by supporting the development of its broader suite of products, enabling the company to validate its technologies and refine its approach. This support contributed to SMPnet's ability to achieve commercial readiness and secure critical partnerships.

Founder's perspective

SMPnet's founder and CEO, Anastasios Rousis, reflected on the company's journey:

"At SMPnet, we've always believed in the power of our technology. Funds like the SIF allow us to test and trial potential solutions. With the SIF now offering more opportunities to get involved, it's definitely something we can consider for future projects we identify."

Summary

SMPnet's success story demonstrates the power of determination and innovation. The SIF is delighted to have supported the company's vision, resilience, and execution, propelling it to the forefront of the energy sector.

Deployment

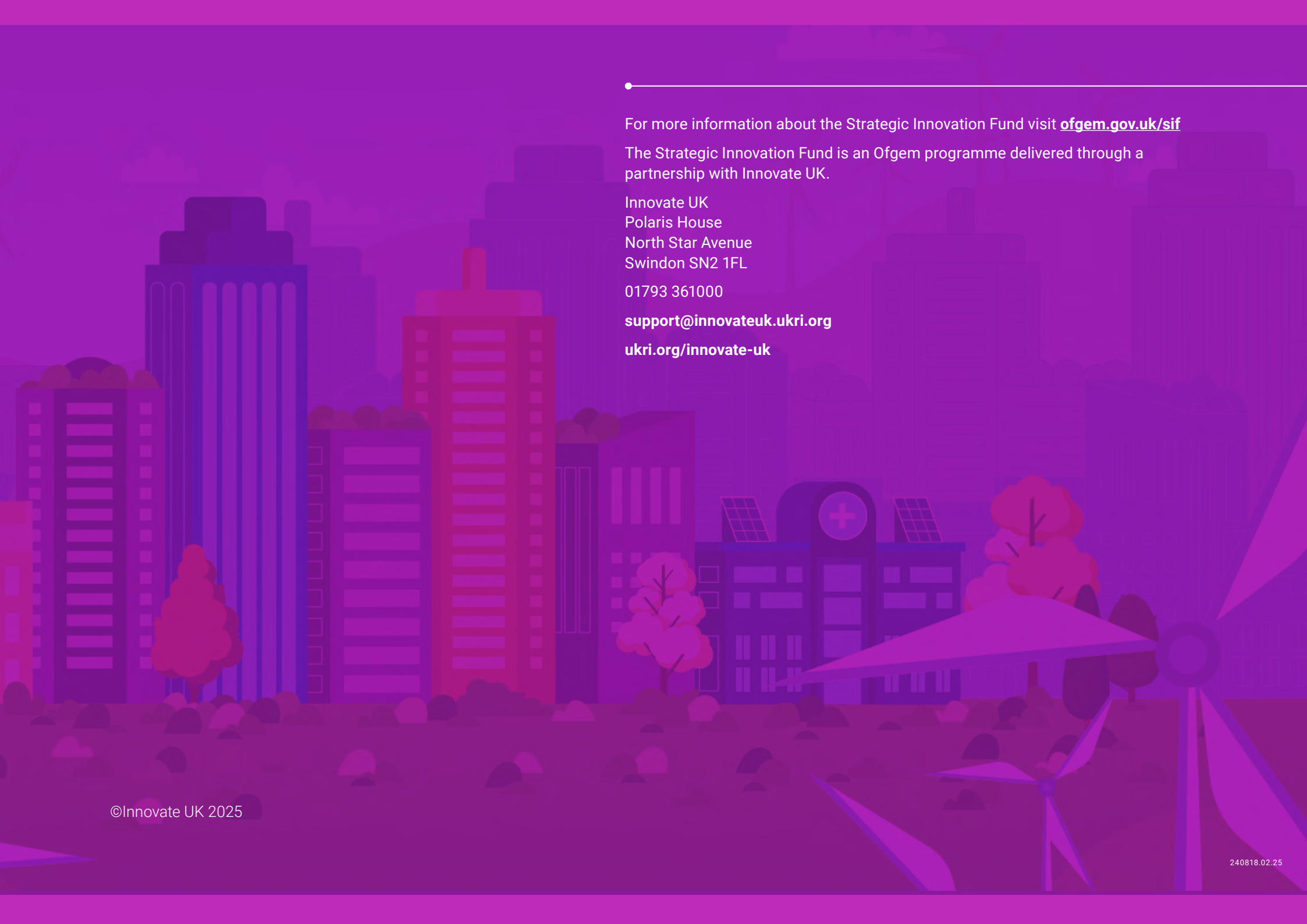
Advancing Innovation

With 22 active Beta projects underway, we are gathering valuable insights, not only about energy system innovation, but capacity for networks and their partners to commercialise the innovation we fund. Looking ahead to 2025, a key area of focus is on driving deployment of 'successful' innovation and obtaining value for bill payers. We will work with networks on the commercialisation of projects, their plans for business-as-usual roll out, and adoption of successful innovations across multiple networks beyond the end of Beta funding. We will be looking closely at previous innovation funding that has and has not led to successful deployment, learning lessons we can integrate into the SIF. We will invite networks to share their successes and be more accountable for the leadership of deployment beyond innovation funding.

A key deliverable in this effort will be the development of a framework allowing us to distinguish between different types of innovation. Not all innovation can result in a tangible deployment, for example some may inform policy. So the ability to analyse our portfolio of innovation and target our support is critical. Our ambition for this work is to introduce a more nuanced approach to how innovation activity is categorised and the role that incentive, regulation, stakeholders and consumers play in supporting diverse innovation pathways.

Deployment is going to be the single biggest challenge facing a net zero and clean energy power system. It will need the entire sector to pull together, in one direction, towards this common goal.

Sign up to receive the SIF newsletter and keep up to date with our programme of activities



For more information about the Strategic Innovation Fund visit **ofgem.gov.uk/sif**

The Strategic Innovation Fund is an Ofgem programme delivered through a partnership with Innovate UK.

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