Innovate UK

Ofgem Strategic Innovation Fund (SIF)

Annual Report 2023

Innovate UK's work to deliver the SIF in 2023, in partnership with Ofgem

Foreword

This is an emotional forward for me to write, my last heading up the SIF and my last working for Innovate UK. As such I thought I'd reflect on what the SIF community has accomplished in the last year, the highs and the lows, and give you an honest account of what has been an immensely difficult, but hugely rewarding year.

Firstly, I have to thank the SIF team. It's not been easy. As the programme has scaled across the 12 challenges in Round 1, 2 and 3, we've encountered an enormous volume of work. Much of which you will read about in this annual report. Not just in the core operational execution of the fund but also several high impact strategic initiatives such as our Culture of Innovation study (an essential enabler of change), innovator support function, commercialisation playbook and exploring options for different types of finance to help innovators scale. We've been supported in these activities by some great companies, the execution of which has helped us unpack potentially enormous strategic impacts at a sector wide level.

I also want to extend a massive thank you to all our colleagues in the energy networks. We rightly challenge the Energy Network Operators to move faster, to do more, to think and do differently. When we started the SIF, network innovation was in a tricky place, and without the Networks leaning in, we'd not be where we are today. History will judge us all on what we did, not what we said, and the Networks have done a lot, working incredibly hard in partnership with the SIF to manage a large portfolio of really game changing projects. I know it has not been easy and I am hugely grateful to all the individuals in the Networks who have embraced the agile (and sometimes the less agile) ways of working the SIF requires.

And to the Ofgem team, what an immense effort. We all like to complain about the regulator, it's an easy stance to take. But within the regulator are some truly exceptional people who have vision, tenacity and wisdom. They've helped guide the SIF and the Networks forward, but also transformed how Ofgem view innovation, an immensely challenging but critically important task. Most importantly, they've listened, learnt and adapted. They've made tough decisions, but with a level of humility that has been hugely welcome. I'm very grateful to the wider Ofgem Innovation Hub team. They've been exceptional.

We've also been supported by both the Energy Networks Association and the Energy Innovation Centre throughout. We've all been on a journey of development, personally, and organisationally. We've seen organisations that have been stubborn at times, learn to be open to ideas and new ways of working. We've seen what used to be butting heads, turn into constructive relationships, where we can still challenge each other, but find common ground in the challenges we face as a sector and as a species.

And finally, to the innovators. There would be no SIF without you. You've opened your arms to the opportunity, injected some bright sparks, and helped push the boundaries of each round further and further. We will always need more boundless, fearless innovation. Whilst we might like to think that we know what the problems are, the problem is always different from someone else's perspective. As such we must continue to cast a very wide net when it comes to both problems and ideas, you can never have enough.

To conclude, innovation is not really about technology, projects, products or services. It is about people. And if we create the conditions for people to be fearless against immense external challenges, we enhance the likelihood of everyone's success. Climate change is indiscriminate, it will level us all unless we continue to work urgently and collaboratively to address it.

I'm very proud to have led the SIF, but I'm more proud of the people who have worked so tirelessly to help the SIF be the success that it is. You have all helped increase our chances of long term survival, on this beautiful planet we call home. Thank you.

Matt Hastings

Deputy Director, Ofgem Strategic Innovation Fund, Innovate UK

About the SIF

Decarbonising Great Britain's energy networks is a huge undertaking – and it is urgent. We have to develop and deploy new ideas to drive the transition – on a large scale, as fast as possible, and at the lowest cost to energy consumers.

In 2021 Ofgem established the Strategic Innovation Fund (SIF) to respond to the joint Government and industry challenge to fully decarbonise the UK's electricity system by 2035.

Delivered by Innovate UK, the SIF is a five-year funding programme of around £450 million, designed to find the highest-potential projects that will deliver the greatest impact, supporting them from ideation through to realisation.

VISION OF THE SIF

- To facilitate the UK's transition to net zero, at lowest cost to the consumer.
- To position the UK into the 'Silicon Valley' of energy, making it the best place for high potential businesses to grow and scale in the energy market.

Innovate UK's mission for the SIF

HELPING PEOPLE

- Reducing costs for energy consumers
- Creating new products and services
- Engaging people across industry and society

HELPING THE PLANET

- Reducing carbon emissions
- Improving energy security
- Making energy systems more resilient

HELPING BUSINESS

- Helping the industry create an innovative energy system
- Generating economic growth
- Encouraging finance and investment

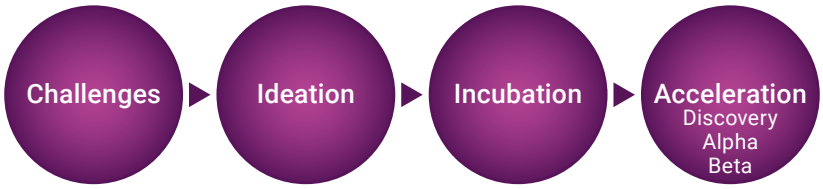
INNOVATE UK'S AND OFGEM'S STRATEGY IN DELIVERING THE SIF:

- **Encouraging innovation alignment** – between different funders, across different industry sectors, and in line with regulatory change
- **Being responsive** – making sure that projects are targeted at challenges and can develop in an agile way
- **Enabling commercialisation** – helping innovative ideas find markets across the UK energy system and internationally

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

How the SIF works

Giant Leap Together



The SIF innovation process

To achieve the SIF strategy, Innovate UK and Ofgem use an end-to-end innovation process called Giant Leap Together

This is a model for identifying challenges and developing ideas, forging partnerships, and exchanging the knowledge needed to find and nurture innovation with the highest potential to meet today's energy challenges.

Giant Leap Together has four main phases, which run on an annual cycle

- **Challenges:** Innovate UK and Ofgem work with industry to develop challenge areas for projects to focus on
- **Ideation:** innovators come forward with new ideas that could become projects targeted at the challenges
- **Incubation:** consortia form, project teams shape proposals and apply for funding
- **Acceleration:** projects gain funding approval and begin work on Discovery projects – with potential to go on to further funding phases in the future

The SIF's focus on innovation **challenges** ensures that the projects funded are targeting the most pressing issues facing energy networks in the transition to net zero.

Every year a fresh set of challenges are defined, evolving from the previous SIF challenges and increasing with specificity each round.

The Round 3 Challenges are geared towards the energy system changes, and scale up of delivery low carbon assets in order to achieve a net zero power system by 2035. Key themes include effective integration of long duration storage, utilising energy flexibility to accelerate heat decarbonisation, and exploring the opportunities presented by power to gas and sector coupling.

SIF Innovation Challenges to date

Round 1 Challenges	Round 2 Challenges	Round 3 Challenges
Whole system integration	Supporting a just energy transition	Whole system network planning to facilitate faster and cheaper network transformation and asset rollout
Data and digitalisation	Preparing for a net zero power system	Novel technical and market approaches to deliver an equitable and secure net zero power system
Zero emission transport	Accelerating decarbonisation of major energy demands	Enabling power-to-gas [P2G] to provide system flexibility and energy network optimisation
Heat	Improving energy system resilience and robustness	Unlocking energy system flexibility to accelerate electrification of heat

This year for Round 3 Innovate UK opened the SIF up to an even wider audience through a Call for Ideas that was run over summer 2023. Starting with launch webinars individually addressing each of the Round 3 challenges, followed by innovator surgeries, ideation workshops and an educational series aimed at organisations new to the SIF.

The **ideation** activities resulted in 437 individuals engaging with the SIF, leading to 270 novel ideas proposed (192 of which were from organisations new to network innovation), and 97 pitching sessions arranged with interested networks. We will see how many of these exciting ideas progress to **incubation** stage and evolve into SIF proposals for submission later this year.

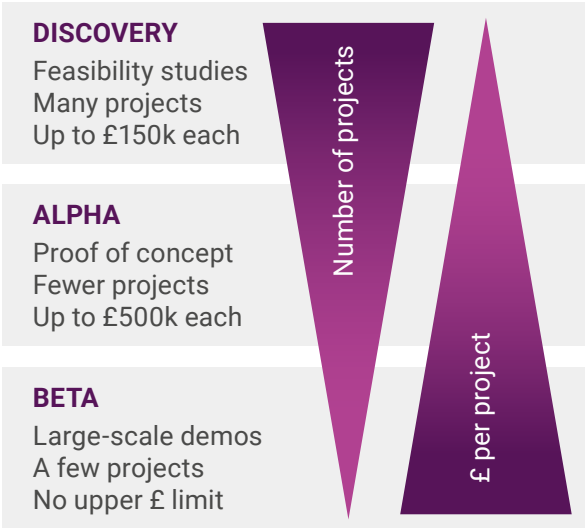
In the **acceleration** stage, SIF projects approved for funding begin a journey with three phases:

- **Discovery:** feasibility studies, lasting 2-3 months
- **Alpha:** proof of concept projects, lasting 6 months
- **Beta:** large-scale demonstrator developments, lasting up to 5 years

The aim is to find many potential ideas and identify those with the greatest promise as quickly as possible, giving them the support they need to become business-as-usual.

At each phase, a project competes for progressively higher levels of funding, with fewer projects going through each time.

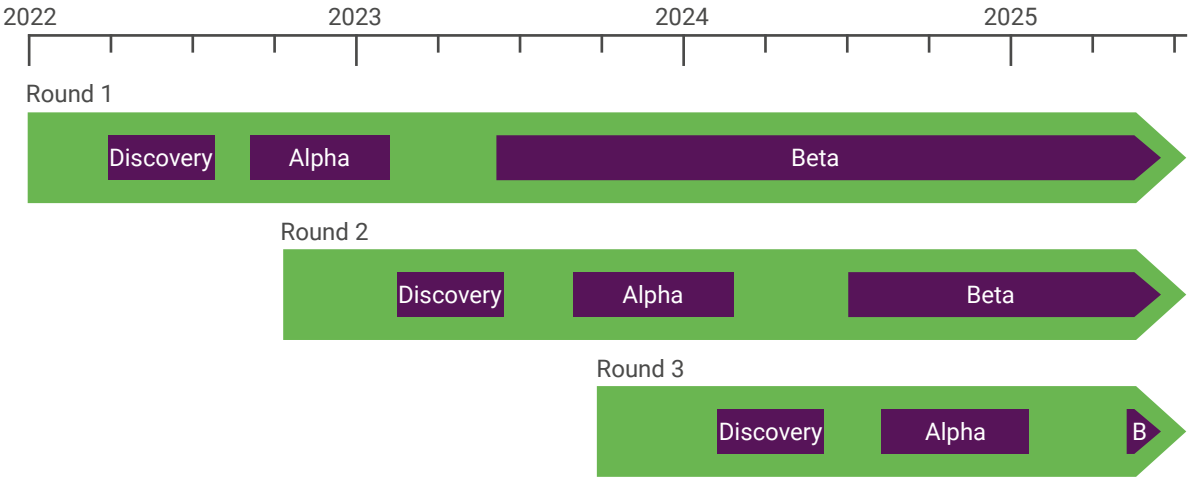
Each SIF project must be led by one of the regulated energy network companies. Projects must be collaborative, involving partners. Partners can be innovative businesses, other energy networks, local authorities or academic.



All projects have the potential to generate valuable learning. Some will go no further than the Discovery phase and some will end after Alpha. Those that go on to Beta will typically be able to invest millions of pounds in real-world demonstrator projects.

Progress to date

A new round of the SIF begins each year and runs in parallel with the previous rounds. The SIF is generating a growing portfolio of projects which are at different phases of the Discovery/Alpha/Beta journey. This is how the timings work:



12
Strategic Innovation Challenges launched

£114m
SIF funding committed

439
third party ideas reviewed

1700
stakeholders signed up to the SIF newsletter

£35.5m
additional contributions committed

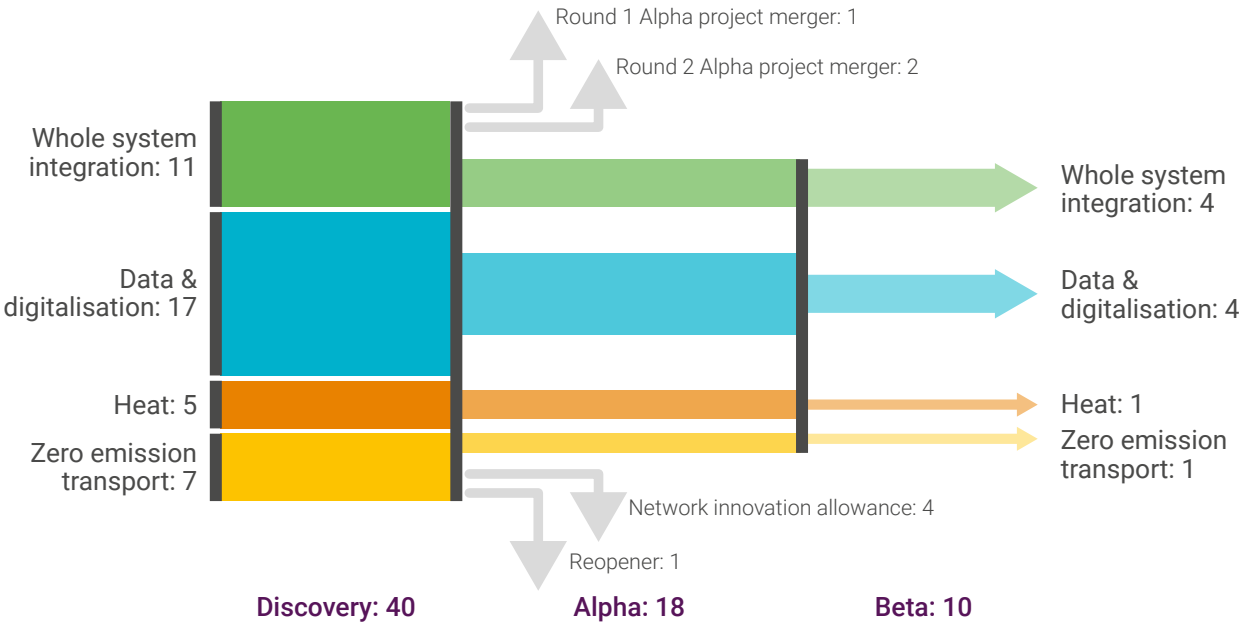
432
applications received

631
project partners funded

121
projects funded

Sign up to receive the SIF newsletter and keep up to date with our programme of activities: https://ukri.innovateuk.org/ofgem-sif-subscription-sign-up

SIF Round 1: Demonstration stage reached



Round 1 was launched in March 2022, focussing on the agreed challenges of, Whole system integration, Data and digitalisation, Zero emission transport and Heat.

From the original 40 projects funded at Discovery, 18 projects went onto the Alpha phase. In July 2023, 10 projects went on to successfully secure a further £95.3 million of funding for their Beta phase, not only a significant step forward for the SIF, but also in the drive for decarbonised and affordable energy.

Across the three phases approximately £49.1m has been secured by projects exploring the transition to a more hydrogen-based system. Including £33.3m for National Gas Transmission led work to adapt existing gas compression units for use with hydrogen, enabling this low carbon alternative to natural gas to be fed into networks. A further £9.9m of funding has been allocated to investigate the viability of using hydrogen to fuel heavy duty transportation.

The chosen projects have all shown a real potential to be widely adopted by the networks, helping to transform Great Britain's energy systems in line with Government net zero targets and benefit energy consumers in the coming years.

Whole system integration

PROJECT ONE

CrowdFlex

The CrowdFlex project, led by National Grid ESO, aims to further explore household energy flexibility as a national resource to help decarbonisation. Flexibility over when and how energy is used can help align energy demand to energy generation, improve coordination across the network and reduce stress on the energy system, while reducing consumer energy bills via incentives. Working with partners including Octopus Energy and OVO Energy, the project aims to build a forecasting model of domestic demand and flexibility, based on large-scale consumer trials, with the objective of establishing energy flexibility as a resource and informing new product design.

PROJECT PARTNERS

National Grid Electricity System Operator Plc – *Lead*
Amazon Web Services
Centre for Net Zero Ltd
Element Energy Ltd
National Grid Electricity Distribution PLC
Octopus Energy Ltd
OHME Operations UK Ltd
Ovo Energy Ltd
Southern Electric Power Distribution Plc

"We believe there is a huge opportunity during this transition to build a smart flexible energy system by enabling consumers to act as a new source of flexibility, supporting more low-carbon technologies and reducing consumer costs. The CrowdFlex demonstrator is a major step towards a national domestic flexibility programme." ***Carolina Tortora, Head of Digital Transformation & Innovation Strategy, at National Grid ESO***

PROJECT TWO

HyNTS Compression

Hydrogen as an alternative to natural gas is key to ensuring that energy demands are met for heat, power, industry, and transport in 2050. Repurposing the existing UK gas assets (valued at £6.5 billion) is a key step in ensuring the UK's transition to net zero at the lowest cost for gas consumers.

The HyNTS Compression project will consider the opportunity to repurpose the current compression assets for use with hydrogen, and the system modifications which would be required. Determining the most cost effective and efficient route to compress hydrogen is vital to keep costs of transitioning to a net zero energy system to a minimum, and therefore costs to consumers, through to 2050. The cost of a new compression system is at least £40 million per unit, and there are 70 units on the National Transmission System today.

Gas networks both in the UK and globally will benefit from the work the project is doing to provide safe, hydrogen ready solutions to repurpose existing natural gas compression systems. The variability in production of green hydrogen will mean that compression is crucial to ensuring hydrogen can be moved through the gas network, both transmission and distribution.

Repurposing gas compression units for use with hydrogen could save tens of millions of pounds, per unit. With around 70 compression units currently deployed around the gas transmission network. Thereby drastically reducing the network costs for transporting hydrogen by pipeline for use cases including maritime and aviation fuels, heavy goods vehicles and industrial heat.

PROJECT PARTNERS

National Gas Transmission Plc – *Lead*
Cardiff University
Cullum Detuners Ltd
DNV Services UK Ltd
Northern Gas Networks Ltd
Premtech Ltd
Siemens Industrial Turbomachinery Ltd
Southern Gas Networks Plc

PROJECT PARTNERS

SSEN Transmission – *Lead*
National Gris Electricity System Operator
The Carbon Trust
University of Strathclyde

PROJECT THREE

Incentive

INCENTIVE is investigating and demonstrating how offshore wind farms can provide inertia to the onshore electricity networks. This will provide grid stability and reliability at a lower cost, and reduce the need for additional infrastructure by co-developing and co-locating inertia services with offshore wind assets. Offshore wind turbines providing inertia to the energy networks is not an incremental innovation, but a step-change in thinking that could be replicated globally.

The project is focusing on three types of energy storage technologies for co-location; supercapacitors, large-scale batteries, and flywheels. These solutions have never been trialed in conjunction with offshore wind before, making this a first-of-its-kind project. Led by SSEN Transmission, the Project brings together developers, technology suppliers, academia, National Grid ESO, and Ofgem, to help build a cross-industry understanding of the INCENTIVE solutions.

PROJECT FOUR

Network-DC

The UK government has set targets to increase GB offshore wind capability to 50GW by 2030. The existing method for connecting offshore wind farms to the grid is inefficient both in terms of number of components required and the performance of those components. Without innovative solutions, the growing network of High Voltage Direct Current (HVDC) connections around Great Britain will be less flexible and responsive, resulting in higher assets and system operating costs.

This is an important project addressing the whole systems challenge by enabling the development of high voltage direct current (HVDC) circuit breaker specifications, an innovative technology untested in the UK and European markets.

This new technological approach has the potential to de-risk and enable the supply chain to deliver effectively and specifically to GB system needs, supporting the connection of multiple wind farms into a DC system, and containing the impact of any single failure safely and securely.

The Network-DC project led by SPEN, brings together international partners to accelerate the readiness of HVDC circuit breakers for installation into the design of the GB HVDC Network, supporting the transition to a net zero energy system.

PROJECT PARTNERS

SSEN Transmission – *Lead*
Carbon Trust Advisory Ltd
National Grid Electricity System Operator
Supergrid Institute
University of Edinburgh

Data and digitalisation

PROJECT ONE

Intelligent Gas Grid

Most towns have a network of gas pipes controlled by pressure regulator valves, known as governors, distributing gas to homes and businesses. There are over 26,000 governors in the UK network alone, and most are set manually at a governor station. Controlling gas pressures and flows within the network needs to be coordinated with gas demand. This will only become more important if we increase the prevalence of gases such as biogas and hydrogen being injected at disperse sites.

Led by Southern Gas Networks (SGN), this project team are using data, combined with machine learning and artificial intelligence (AI) techniques, to improve the forecasting abilities of both demand on the gas network, and required maintenance and interventions. AI and machine learning models have not previously been used for pressure management, making this project highly innovative.

The project partners have developed a unique active grid management system. This includes controllers which communicate with centralised software via the mobile phone networks. This can be retrofitted to existing governors to continuously adjust and maintain pressure to be as low as possible without going below the minimum pressures required.

Continuous automatic control of governors will remove the need for costly and time-consuming manual adjustment of the governors. This will also support the faster identification and fixing of network problems leading to improved customer service and a more reliable supply for gas consumers. It is estimated that if this approach was implemented across all the gas networks in Great Britain, gas leakage could be reduced by around 75,000 tCO_2 per year. This reduction in emissions would be a big step towards net zero.

Estimates of the cost of leakage across the entire of the GB network indicate that the value of gas lost could be in excess of £100M per annum. With methane being a potent greenhouse gas, their are many $MtCO_2e$ emissions savings that could be achieved by reducing the rate of leakage.

PROJECT PARTNERS

Southern Gas Networks Plc – *Lead*
Cadent Gas Ltd
DNV Services UK Ltd
National Gas Transmission Plc
Northern Gas Networks Ltd
Utonomy Ltd
Wales & West Utilities Ltd

PROJECT TWO

Digital Platform for Leakage Analytics (DPLA)

The Digital Platform for Leakage Analytics project led by Cadent Gas, with Guidehouse their technology delivery partner, aims to demonstrate a prototype for how data, analytics and innovative sensors can be used to identify, locate, and predict gas leaks in the gas distribution network. The system will enable Cadent Gas colleagues to receive real-time alerts about critical leaks, enable more accurate analysis and modelling of leakage data across the network to take quick and effective action.

With a vital role to transport gas over hundreds of miles of pipeline, reducing leakage remains a continual focus for Cadent Gas. The DPLA project will now deliver major advancements in the industry's ability to monitor and reduce leakage from gas networks. This will not only contribute to net zero goals by reducing leakage-related emissions but will also help to reduce costs for gas consumers.

PROJECT PARTNERS

Cadent Gas Ltd – *Lead*
Guidehouse Europe Ltd
National Gas Transmission Plc
Northern Gas Networks Ltd
Southern Gas Networks Plc
Wales & West Utilities Ltd

PROJECT THREE

Predictive Safety Interventions

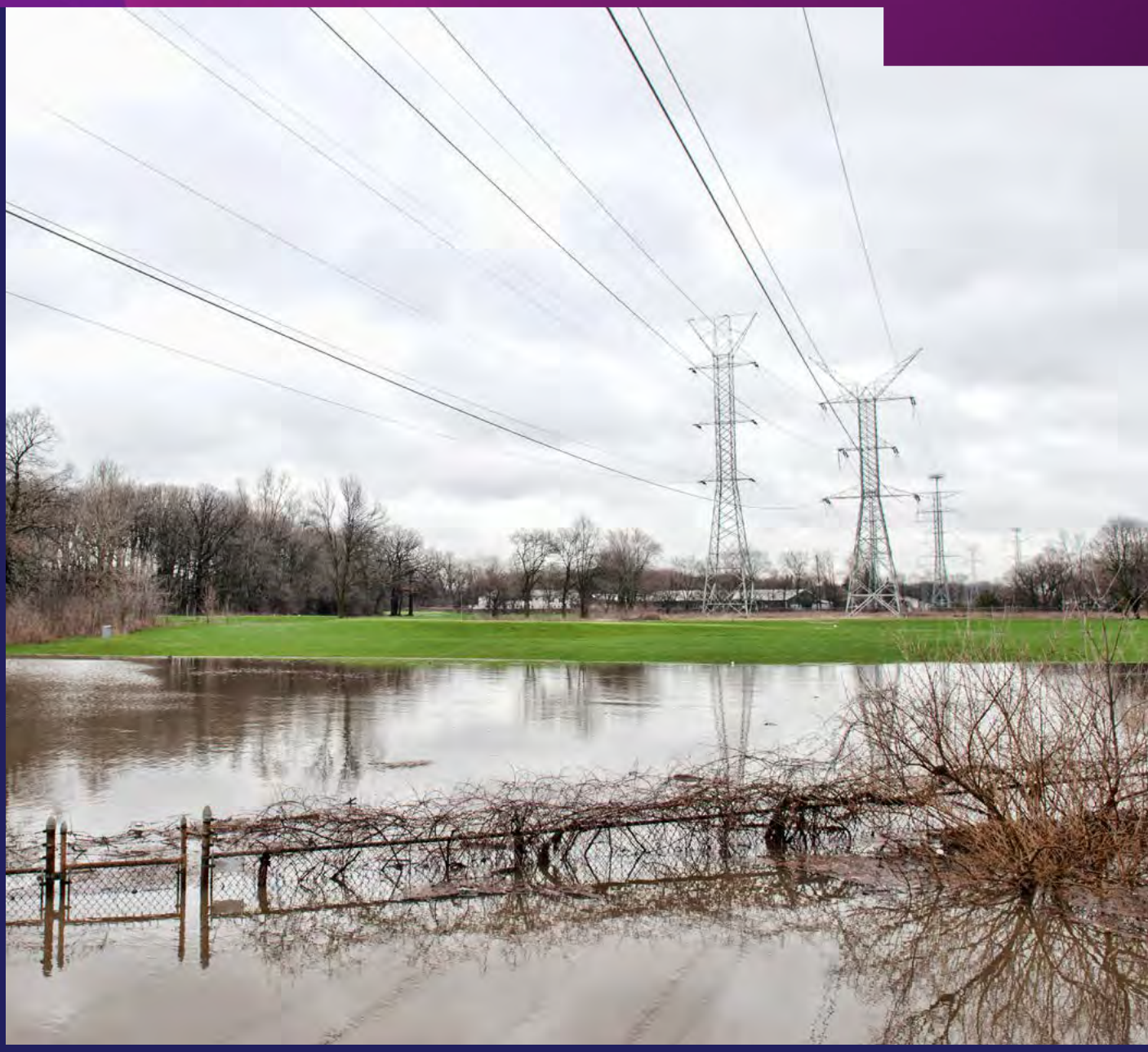
According to Health and Safety Executive annually released statistics, at least 10,000 working days were lost to injury in the wider utility sector in 2021-22, costing the sector more than £160m. The Predictive Safety Interventions project has a clear and direct target to prevent the occurrences of fatal and non-fatal injuries in operating the gas networks which will also reduce the costs borne by the energy consumer of operational management of the energy networks.

In the previous SIF phases, FYLD Ltd and Southern Gas Networks (SGN) partnered to produce an artificial intelligence model to accurately forecast the likelihood of an injury occurring to a fieldworker. In the Beta phase the project team are developing this model further, increasing data inputs into the model to include human behaviour factors and live network data, such as traffic and roadworks.

The project will build the capability to deliver an AI powered personalised intervention pushed directly into the hands of field teams and their remote managers at the point of starting work, and dynamically doing so as the workday progresses. Successful delivery of this project will see a market-leading AI model to predict on site incidents before they happen and power an intervention to prevent them occurring.

PROJECT PARTNERS

Southern Gas Networks Plc – *Lead*
Cadent Gas Ltd
FYLD Ltd
National Gas Transmission Plc
Northern Gas Networks Ltd



PROJECT FOUR

Predict 4 Resilience (P4R)

Severe and extreme weather events can have a major impact on the electricity network, resulting in widespread, extended network outages. These cause significant inconvenience to individuals and businesses who are increasingly dependable on their power supply.

Today, network operators have developed extensive response plans to react to faults caused by severe weather events, using their experience to restore power to consumers as quickly as possible. However, with more severe events, network operators now need a step change in how they prepare and respond to those events. So, while the weather cannot be controlled, it can be predicted more accurately, with greater visibility and anticipation of its impact on the network.

Led by SP Transmission, the Predict 4 Resilience (P4R) project is aiming to provide accurate fault insights and forecasts for its users during adverse weather events. It utilises probabilistic fault prediction and related decision-support for the first time in a GB network innovation project, transforming human-centric decision-making and leading to an improved response to faults on the electricity network.

PROJECT PARTNERS

Scottish Power Transmission Plc – *Lead*
SIA Partners UK Plc
SP Distribution Plc
SSEN Distribution Plc
University of Glasgow

Heat

PROJECT ONE

Velocity Design with Hydrogen

The energy transition presents network designers with the complex task of distributing low and zero carbon gases, undertaking this at operational scale will be completely novel, and therefore industry needs to better understand and develop specifications for how to do this safely, reliably, and without interrupting gas supplies to energy consumers.

Low and zero carbon gases have different chemical properties to natural gas that is currently distributed by pipeline. As gases move through pipes they can pick up and move around small debris that exists within the pipes. Because of this, and also to maintain optimal pressures, low carbon gases may need to be transported at different velocities. The impact of doing so in a live pipeline environment has not yet been fully investigated and understood.

Work on this subject to date has been theoretical, using digital hydraulic models. The Velocity Design with Hydrogen project is undertaking 'full-scale' testing to set suitable velocity limits in conditions that could exist where the natural gas network might be converted to hydrogen.

The project is making maximum use of DNV's Spadeadam test facilities in Cumbria, utilising equipment already available to test pipe components and materials used in UK gas infrastructure, under operational conditions.

The project's outcome will establish proven design standard velocity limits for the distribution of low and zero carbon gases and embed these as the new industry-approved standard practice. These industry-wide standards will optimise the use of existing gas network assets and components, and equip network designers with dependable velocity limits to minimise the impact and costs of network re-purposing, providing secure and robust delivery of gas at the lowest cost possible to consumers throughout the energy transition.

PROJECT PARTNERS

Southern Gas Networks Plc – *Lead*
Cadent Gas Ltd
DNV Services UK Ltd
Institute of Gas Engineers and Managers
National Gas Transmission Plc
Northern Gas Networks Ltd
Wales & West Utilities Ltd

Zero emission transport

PROJECT ONE

HyNTS Deblending

The HyNTS Deblending project, led by National Gas, will demonstrate how gas separation and purification techniques can be used to deliver high purity hydrogen for use in transportation.

The project will demonstrate and measure the effectiveness of a skid-mounted gas 'deblending' technology from the national gas transmission system at the FutureGrid test facility site. This design will enable mobile deployment of the deblending technology to demand sites, with primary use cases including refueling sites for Heavy Goods Vehicles (HGVs), maritime, and aviation.

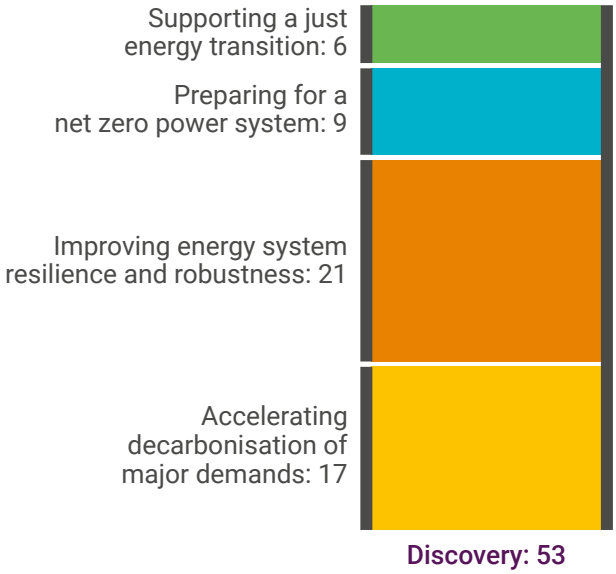
Successful demonstration of this will enable cheaper transportation of hydrogen from large scale production sites, and enable gas transmission connection sites to be commissioned whilst the transmission system is still being utilised to transport natural gas.

PROJECT PARTNERS

National Gas Transmission Plc – *Lead*
Cadent Gas Ltd
DNV Service UK Ltd
Element 2 Ltd
Element Energy Ltd
HyET Hydrogen B.V.
Northern Gas Networks Ltd
Southern Gas Networks Plc
Wales & West Utilities Ltd

Find out more about the Round 1 SIF Beta Projects on Ofgem Strategic Innovation Fund YouTube Channel

SIF Round 2: Moving forward



Discovery: 53

In April 2023, Ofgem announced £6.1m of funding for Round 2 Discovery Phase projects to explore new ideas with the potential to help consumers and transform the energy system in the coming years.

This was the first opportunity for Electricity Distribution Network Operators to apply to the SIF and as a result we received significantly more applications, leading to more projects being funded.

The 53 funded projects looked at tackling some of the greatest challenges facing the energy system and society, including:

- using electric vehicles to rapidly restore power to the vulnerable such as those reliant on dialysis machines during power cuts
- looking at how an entire terraced street could be decarbonised using an affordable smart local energy system
- looking at how wind farms, instead of fossil fuel generators, could be used to restore the grid following a blackout. This is something not currently possible
- whether hydrogen production costs could be cut by using wastewater rather than pure water

These projects concluded in June with a high proportion applying to continue into the Alpha phase. Announcements of which projects are successful will be made later this year.

https://www.ukri.org/publications/strategic-innovation-fund-list-of-funded-round-two-alpha-projects/

To find out more about out Round 2 Discovery projects watch their 60 second videos and recordings of their Show & Tell webinars on the Ofgem Strategic Innovation Fund YouTube Channel

SIF Round 3

For Round 3 the SIF will further focus on specified areas that are key to achieving key energy sector targets over the next decade, such as delivering a net zero power system by 2035.

We received over 270 proposals for Round 3 projects through Innovate UK's Call for Ideas process. The energy networks are now prioritising and working with partners to bring the best of these forward for applications in November 2023.

Whole system network planning and utilisation to facilitate faster and cheaper network transformation and asset rollout

As per The Climate Change Committee's (CCC) sixth carbon budget and the UK Government's Energy Security Strategy, the capacities of low carbon generation such as onshore wind, offshore wind and solar need to increase 2, 4 and 5 times the current levels respectively, by 2035.

This increase in intermittent low carbon generation also requires tens of GWs of flexibility assets such as storage, electrolysers and gas Carbon Capture and Storage plants up and running by 2035 to support the system. Meeting these targets requires a significant ramp up of plan, build and connection rates for these assets in the mid-2020s and early 2030s.

While there are other bottlenecks (supply chain, regulation, markets etc), the planning process, network constraints and securing timely connection to the grid have been raised as constituting key delivery risks to achieving the government's 2035 targets.

To address these challenges and enable the timely build out of the energy network infrastructure needed, there is a greater need for strategic and holistic energy network planning and connections queue management; this is the key focus area of this challenge. In addition, there are significant opportunities to use the move to a smarter, digitalised and more flexible energy system to accelerate connections to the grid.

Novel technical, process and market approaches to deliver an equitable and secure net zero power system

This Innovation Challenge builds upon the Round 2 SIF Challenge of 'Preparing for a Net Zero Power System'. The Round 3 Challenge has an increased focus upon developing ground-breaking digital technologies, novel hardware for power network operation, and flexibility provision from long duration storage; all technologies that are expected to be needed to deliver a net zero power system.

A key policy commitment within the UK Government's net zero strategy is to fully decarbonise the power system by 2035, subject to security of supply considerations. Over the last two decades Great Britain has delivered the fastest-decarbonising power system of all major economies globally. As of 2020, around 40% of installed capacity and 30% of generation output came from fossil fuels; these may need to be replaced by renewables, nuclear and other low carbon sources prior to 2030.

With the objective to deliver a fully Net Zero Power System by 2035, increasing attention has been given to resolving how to provide clean electricity during the most challenging periods when demand might be high and renewable generation is low.

Operating a power system safely and securely with high levels of renewables will bring novel challenges and require new approaches. Unlocking these opportunities will require innovation across technology (including control systems), processes, markets and standards and must take place in the wider context of local energy systems, cyber security, Distribution System Operator (DSO) transition27, and new challenges to energy security.

Unlocking energy system flexibility to accelerate electrification of heat

Heating buildings contributes to almost a quarter of all UK carbon emissions. The UK Government has set targets to deploy at least 600,000 heat pump systems per annum by 2026 (potentially

scaling to 1.7m per annum by mid-2030s) and ensure that all heating systems are net-zero compatible by 2035.

It is suggested that heat pumps alone could add up to 14 Terra watt hours of electricity demand to the power system in 2030, this is expected to increase peak demand by 50% by 2035, doubling again by 2050.

Flexibility will be needed to support shifting or reducing heat demand at times of system stress or high carbon intensity. Technology solutions like thermal energy storage (TES) and long-duration storage can help to decouple electricity demand and supply, to minimise system costs and maximise renewable consumption. However, these technologies are relatively unused and further analysis is needed to understand the value to the energy system.

To support these challenges, and enable timely heat decarbonisation, better coordination and visibility are needed for local heat requirements against network constraints. This will better inform network planning activities alongside increasing accessibility of flexibility solutions and markets to support peak demand, whilst meeting the needs of all consumers, especially the fuel-poor and vulnerable.

Enabling power-to-gas (P2G) to provide system flexibility and energy network optimisation

The UK has set an ambitious target of 10GW of low-carbon hydrogen production by 2030. Flexibility services are currently provided by gas turbines and batteries, but electrolysers can also be added to this portfolio in the future, given their ability to ramp up quickly in response to control signals. It has been shown that electrolysers can technically fulfil the necessary conditions for grid service by ramping up and down in seconds, with potential to shift load from 10% to 100%. This is important as the UK energy system transitions and integrates more intermittent renewable in line with Net Zero targets.

Another key and unique aspect of electrolyser flexibility is its ability to "vector shift", which is using low cost, constrained or other curtailed electricity to produce green hydrogen. This green hydrogen can then be stored over time and be used as a fuel to generate electricity back via turbines or for other end-use demands such as industry.

The critical enabler for vector shifting and flexible demand operation of the electrolysers is the ability to store the hydrogen effectively, both technically (efficiency, performance, safety etc.) and commercially (cost, viable business models etc.). Hydrogen can be stored underground in caverns over long durations and above ground in pressurised tanks or in solid-state for shorter durations.

There are several dependencies to unlocking these system value streams, including resolving uncertainty in hydrogen production use cases (off-grid, co-located etc), optimisation of electrolysers and storage locations, effective hydrogen transport, and need for coordination across the hydrogen value chain with energy networks and system operation. Addressing these issues to unlock the system value of green hydrogen production and storage is the key focus area for this challenge.

Watch the Round 3 launch and challenges webinars on the Ofgem Strategic Innovation Fund YouTube Channel

Commercialisation and SIF

The demand for SIF funding has been impressive and exceeded our most optimistic forecasts in terms of funds channeled to high-quality projects. Nevertheless, our data also tells us that we have areas for improvement.

Across Round 1, early-stage small and medium-sized enterprises (SMEs)1 accounted for 13% of unique project participants, receiving 5% of SIF funding awarded. And early data from Round 2 shows a drop in the involvement and funds received by early-stage SMEs to 10% and 4% respectively.

While data only tells part of the story, it is clear we need to increase the flow and quality of innovators who engage and are successful in partnering with our energy networks. It highlights an opportunity for us to do more at the early stages of engagement with innovators, even pre-Discovery. This complements our Giant Leap Together operating model by recognising the critical role innovators play in our ideation activities, while recognising that more can be done to help innovators be 'SIF ready' to get involved in the ideation process.

This also highlights the role we can play in the accessibility of innovation funding for nascent companies. In recognising these challenges and opportunities, we have not been idle. Working in collaboration with the Network Operators, other key stakeholders, and the wider ecosystem, we have embarked on a series of transformation initiatives that have the potential to drive positive improvements in how all of us deliver innovation in collaboration.

Several Networks have come together, working intensively on how to identify and assess the Culture of Innovation within their organisations. Alongside the energy regulator, Ofgem, this initiative is looking at how systemic and operational challenges impact on the ability to deliver impactful innovation at pace and scale. Work on this project is ongoing and we plan to publish an exemplar, co-developed with the Networks, to bring some of the opportunities from embracing a 'Culture of Innovation' to life.

We have also initiated the development of an 'Innovation Playbook'. The primary objective of this is to acquire comprehensive insights into the factors contributing to the success and failures of prior energy innovation projects. Laying the groundwork to guide and support projects throughout their life cycle and encourage key learnings from historical best practice. We will generate empirical evidence to pinpoint knowledge and practice gaps, enhancing our ability to support SMEs, Networks, and the future of the energy ecosystem. The Playbook will serve as an open collaborative resource for innovators, programmes, funding mechanisms, regulators, and relevant entities, offering substantial evidence for evaluating distinct paths to commercial deployment that require tailored support or guidance.

Finally, we are looking at how we can support more peer-to-peer engagement. Innovators can learn best from other innovators who are more progressed in the business development cycle or might have successfully launched energy network innovations previously. We have an ambition to see a community built around our innovators, giving them a collective voice, and helping us learn more about their journey.

We want to grow our pipeline of innovators and innovations. Not just to satisfy upcoming challenge areas, but to ensure we can support the development of creative ideas and encourage more robust propositions for our networks to consider. With a focus on Innovator support, we have been interrogating how early-stage companies respond to our annual funding approach. We believe a need exists to engage with these companies earlier, with deeper engagement and over longer periods, and that this will lead to more fruitful future partnerships.

As a starting point for this, we have encouraged all our innovators to engage with Innovate UK's Edge service where they can access business advice and support to grow and scale their companies. 29 SIF funded companies have already taken up this engagement. We have also ramped up our investor relations to ensure

we stay abreast of what the investor markets are looking for and to help our best companies access these investors. It is our plan to further develop how we can help and support innovators through our Commercial function, reaping rewards for People, Planet & Business.

The commercial success and impact of SIF during the last year will only be truly known by how it shapes the energy landscape of tomorrow. By focusing on that end-to-end value chain, recognising the powerful role our innovators play, and harnessing the wider ecosystem to support, nurture and propel innovators, we can reshape the energy system innovation pathways.

"We are delighted to have won funding for our Intelligent Gas Grid project from the Beta phase of the Strategic Innovation Fund. Having a Commercial function embedded within a funding programme is hugely helpful. It has allowed us to tap into wider business support from Innovate UK, progress our business development activities and identify new avenues for commercial funding. On a project level, the team's input has helped us successfully navigate some fundamental IP challenges."

Adam Kingdon, CEO, Utonomy Ltd

Read our blogs to find out more about the support that Innovate UK provide to businesses

Measuring the impact of SIF

The SIF is designed to deliver net benefits to gas or electricity consumers. Innovate UK is committed to an active approach to measuring and evaluating the impact of SIF. Through the projects funded by SIF we will be monitoring projects progress towards the realisation of financial, environmental and network users benefits. All though the impacts from the outputs of SIF projects will be seen in many ways, both directly and indirectly, we will be focusing most of our attention on the achievement of the following target benefits:

- Cost savings on energy bills for consumers
- Cost reductions in operating the network and wider energy system
- Cost savings for users of network services
- Direct and indirect emission reductions
- Improved access to revenues for users of network services, or the creation of new revenue streams
- New to market products, processes, and services

Benefits management helps to foster a performance culture that places impact at the heart of the design, delivery, and evaluation of all SIF activities and funded projects. United understanding of the impact that SIF and designing projects from the outset to deliver these desired outcomes is key to the success of the SIF.

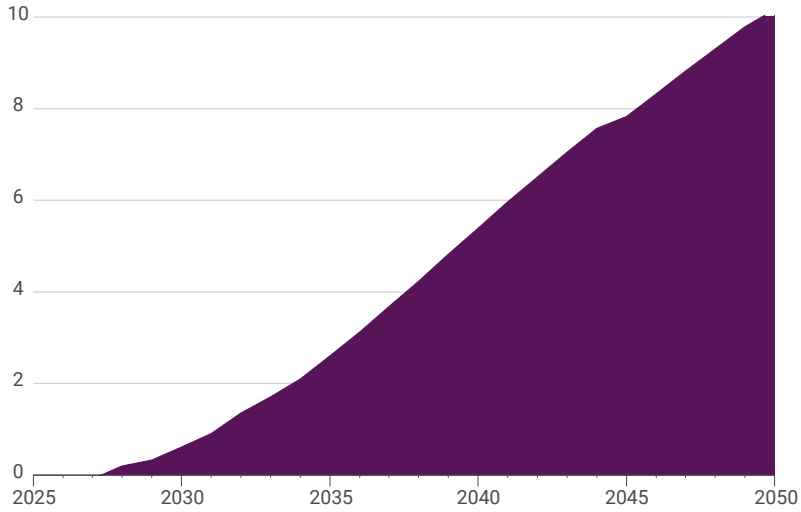
Planning for impact

As projects progress through the Discovery-Alpha-Beta process, the project partners improve their understanding and confidence of how they will deliver benefit and what that benefit might look like. Each of the Round 1 Beta projects has articulated expected impact through a Benefits Map, provide a visual representation of the links between project activities and the delivery of benefits. As such, they can be used to foster a benefits-focused approach to project delivery.

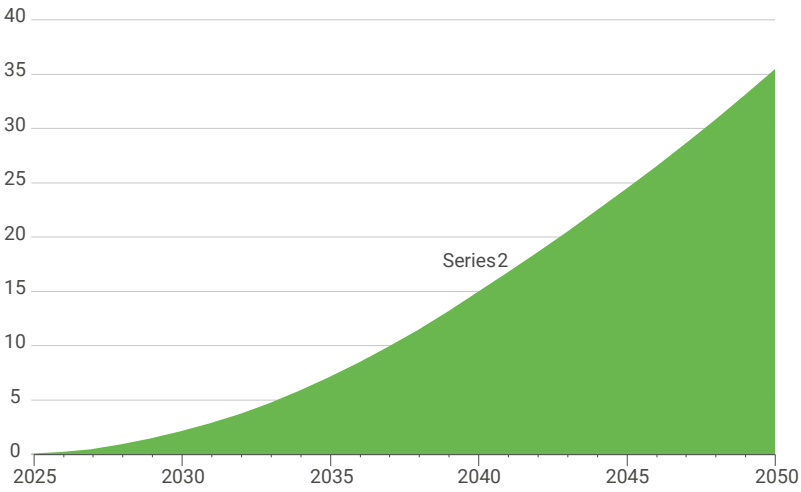
Quantification of the impact of innovation is always trickier and to date Ofgem have utilised a cost-benefit analysis (CBA) approach to support the case for SIF investments. However, with such a wide portfolio of projects spanning all aspects of the energy system it has been acknowledged that a more dynamic approach needs to be taken. Innovate UK, Ofgem, Energy Networks Association and the Energy Innovation Centre are collaborating with the Network Operators to modify current impact measurement methodologies and produce one approach that is relevant for all network innovation funding mechanisms.

Early indicators

We have reason to feel optimistic about the impact of SIF. Early benefit assessments are indicating that the SIF Round 1 Beta project outputs have the potential to deliver £2.6 billion financial savings and 7.1 $mtCO_2e$ by 2035.



Round 1 Beta projects total estimated financial benefits (£bn)



SIF Round 1 Beta projects total estimated carbon savings ($MtCO_2e$)

Wider benefits

In addition to the SIF target benefits, we want to understand the impact that SIF and Innovate UK's delivery of the fund is having on the innovative companies that we work with. In 2023/24 we will start to gather data from all SMEs that partner on a SIF project. When aggregated the date will help build a complete picture of the impact the businesses, organisations, and individuals we support are making to the wider UK economy, wider society and the environment.

This evidence will also assist Innovate UK and Ofgem to design compelling programmes and make the case for future network innovation investment.

Innovate UK are also looking at how to improve Equality, Diversity, and Inclusion (EDI) in the SIF and across the wider energy sector. We are proud to be part of the Tackling Inclusion and Diversity in Energy (TIDE) group, a cross industry group spearheaded by the ENA, Energy Institute, Energy UK and Ofgem. TIDE members are collaborating to collate cross-sector EDI insights and evidence to inform robust outcomes, building on experience and expertise to share best practice and deliver industry-wide changes.

Subscribe to our podcast to hear more stories from the SIF

Comments on the SIF? Both Ofgem and Innovate UK welcome feedback.

- To comment on the SIF programme overall: networks.innovation@ofgem.gov.uk
- To comment on Innovate UK's work in delivering the SIF: sif_ofgem@iuk.ukri.org

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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