energynetworks association

Energy Networks Annual Innovation Summary Report 2023

ENA Annual Innovation Summary Report

Executive Summary

The energy networks and underlying infrastructure are critical enablers in Great Britain's (GB) decarbonisation journey to delivering a successful and rapid net zero future. The fifteen network operators across GB (shown in Figure 1 below) have an important role to play in making sure that the energy system can meet the needs of consumers in a changing energy landscape.

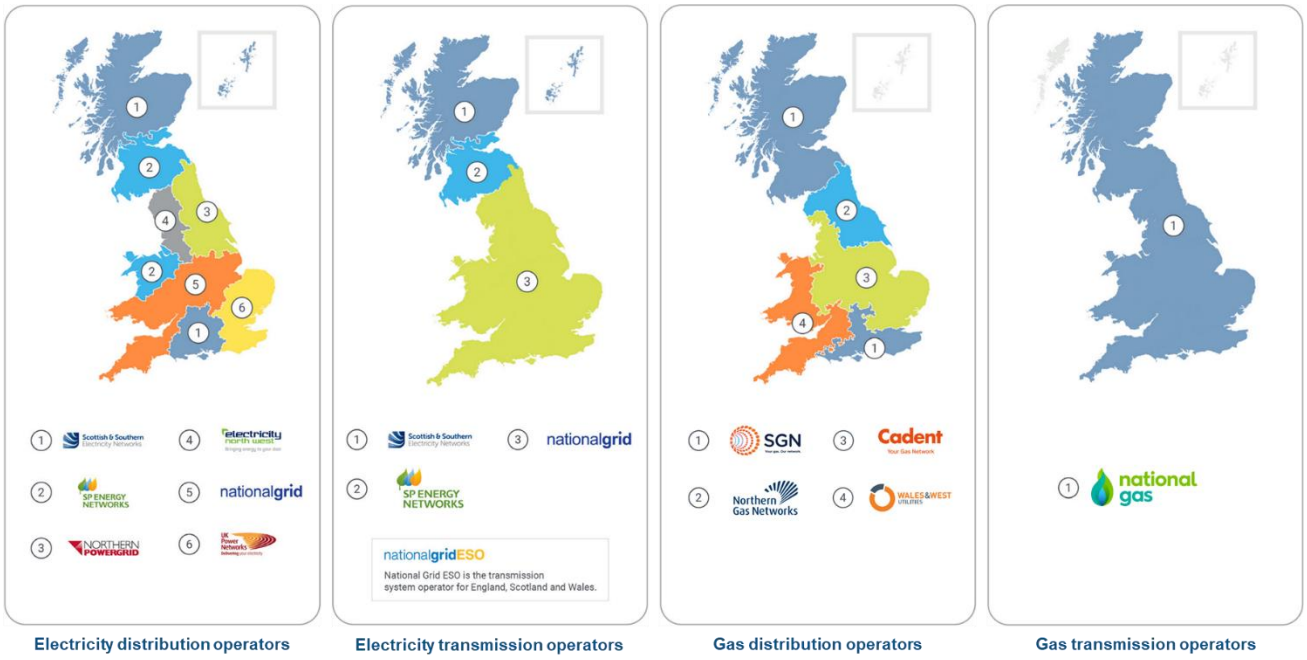


Figure 1. Network operators in Great Britain

In service of these decarbonisation goals, the networks invest millions of pounds each year into innovative projects to develop the energy system of the future. This report reflects on the progress networks have made in FY23 on innovation with a specific focus on RIIO-2 funded innovation. RIIO-2 is the second round of price controls set by Ofgem (the GB network regulator) under the RIIO (Revenue = Incentives + Innovation + Outputs) model which ensures that networks operate safely and responsibly while providing reliable service for their customers. For gas distribution and transmission networks the RIIO-2 period (RIIO-GD2 and RIIO-T2) runs from 2021-2026 and for electricity distribution networks (RIIO-ED2) the period runs from 2023-2028.

The aim of this work (and subsequent annual reports) is to highlight key trends, case studies, and progress against the shared strategic themes as networks move through the RIIO-2 price control period. Information on projects funded through the RIIO-2 price control is captured by each network in the Innovation Measurement Framework (IMF), which is used throughout the report to show network performance against key indicators and against the previous financial year.

This report is focused on FY23 and is aligned with the second year in Ofgem's RIIO-2 price control (i.e. the financial year of 2022-2023 within the overall 2021-2028 price control period). This means that the scope of the report encompasses the second year of RIIO-T2 (2021-2026) and RIIO-GD2 (2021-2026) but does not include RIIO-ED2 as FY23 was the final year of the RIIO-ED1 period (which ran from 2015-2023).

Given this scope, the statistics quoted throughout this report only account for projects funded through the RIIO-2 Network Innovation Allowance (NIA) and Strategic Innovation Fund (SIF) mechanisms in FY23. As the electricity distribution networks had not yet entered their ED2 period in FY23 (the ED2 price control launched on 1 April 2023) their projects and spending are not included. This allows for easy comparison with the figures from the 2022 Annual Innovation Report to show progress over the year. However, to align with the whole-system Energy Networks Innovation Strategy the electricity networks have been engaged in the creation of this report and their projects are referenced throughout the text. A full set of combined statistics (for all gas and electricity networks) will be available from next year onward.

High level Timeline and Progress to Date

Since the start of the RIIO-2 period in April 2021, significant progress has been made through the value delivered via network innovation funding. While there are many milestones that contributed towards this innovation journey, this high-level timeline showcases a selected set of pivotal events which were key in either shaping the progress made or are exemplary cases of innovation and collaboration.

RIIO-2 Innovation Timeline of Key Events to Date

APR 2021 — **Start of RIIO-2**: Ofgem sets out £30bn package of investment to be used within the RIIO-2 price control period for the energy networks to hit net zero targets.

AUG 2021 — **SIF Launched**: Ofgem announces £450M (to 2026), via the Strategic Innovation Fund (SIF) to support ambitious, innovative projects and accelerate the net zero transition, at lowest cost to consumers.

OCT 2021 — **Electricity system decarbonisation commitment**: **The** UK commits to decarbonise electricity system by 2035.

NOV 2021 — **COP 26**: UK government pledges to secure global net zero by mid-century and keep 1.5 degrees within reach, pushing the urgent need for agile innovation.

MAR 2022 — **Energy Networks Innovation Strategy**: ENA releases a unified gas and electricity strategy to ensure that network innovation takes a whole system approach and aligns to UK's overall low carbon innovation portfolio.

APR 2022 — **Energy Security Strategy**: post-COVID and amid volatility caused by Russia's war on Ukraine, the UK announces Energy Security Strategy to combat the energy crisis.

JUL 2022 — **Pathway to 2030 HND**: NG ESO publishes the 'Pathway to 2030' Holistic Network Design (HND) documents setting out the blueprint for the grid infrastructure required to deliver 2030 offshore wind targets.

SEP 2022 — **EIS**: Glasgow hosts 2022 Energy Innovation Summit (EIS), where networks share significant trends and learnings from the largest regulator-funded innovation projects – NIA, SIF, and NIC.

DEC 2022 — **ASTI framework**: Ofgem introduces new Accelerated Strategic Transmission Investment (ASTI) framework to accelerate the strategic delivery of electricity transmission investment.

FEB 2023 — **ENA Innovation Basecamp**: The ENA and Ofgem call on innovators to accelerate the transition to a 2035 net zero energy network through the Energy Innovation Basecamp.

APR 2023 — **RIIO-ED2 & DSO**: The 14 electricity DNOs enter RIIO-ED2 and UKPN launches the nation's first independent DSO.

APR 2023 — **Hydrogen vision**: ENA publishes hydrogen vision document on how the evolution of a UK-wide hydrogen network can unlock economic growth, provide consumer choice and bolster energy security.

APR 2023 — **Progress & collaboration**: 254 innovation projects registered (including 55 SIF projects) since start of RIIO-2, 108 of which were (or are) collaborative.

JUL 2023 — **FES 2023**: NG ESO publish the 2023 Future Energy Scenarios (FES). FES sets out a range of different, credible ways to decarbonise our energy system.

FY23

Progress in FY23

In FY23, networks have grown the number of projects registered and the number of partner organisations working on innovation projects. **439 ideas were generated** by the networks and third-party partners with a total **148 new projects registered** over the year. A further **73 projects closed this year** and of these 73, **47% (35 projects) have already been identified as leading to another project** to further develop or trial the innovation being tested. A further **five projects have already been implemented in business as usual (BAU)**. Throughout the regulatory period the networks expect these numbers to increase but many of the projects delivered in this regulatory period may only be integrated into BAU in the next regulatory period.

Innovation Process

In March 2022, the ENA developed the Energy Networks Innovation Strategy – a single combined gas and electricity network strategy – which ensures that network innovation takes a whole system approach and aligns with GB's overall low carbon innovation portfolio. At the core of the strategy are a set of Objectives, Themes, and Principles. Regardless of the funding source, innovation projects address at least one of the themes to ensure that efforts are targeted at the most significant challenges networks face. This report focuses on the joint network progress organised against these themes:

- **Data and digitalisation** – *developing new data services and applying data science methods to harness the power of digitalisation to solve both system operation and wider stakeholder challenges.*
- **Flexibility and market evolution** – *developing and testing market-based solutions to increase the flexibility and efficiency of the energy system, accelerating the adoption of low carbon solutions.*
- **Net zero and the energy system transition** – *facilitating and accelerating the UK's transition to net zero greenhouse gas emissions.*
- **Optimised assets and practices** – *developing and implementing industry-leading techniques for optimising assets and practices.*
- **Supporting consumers in vulnerable situations** – *exploring how best to support the needs of consumers who find themselves in vulnerable situations, today and in the future, to enable a just transition.*
- **Whole energy system** – *develop joined-up approaches across sectors and energy vectors.*

Value of network funding

The benefits from innovation projects are varied—adding value for networks, the wider energy industry, and consumers while supporting the progress towards government policies and targets. Broadly, the outputs of innovation improve network security, resilience, and provide data and insights that network operators need to make better decisions about how to operate and invest in their networks. The benefits of innovation are then passed to network users in the form of new or improved services and reduced bills as the energy system decarbonises.

The SIF and NIA funded projects in this report exemplify the impact of this funding and the value of innovation for the whole energy system. Led by Ofgem and Innovate UK, SIF funding provides significant capital funding to progress innovative ideas into real-word trials of new technologies. As the networks' core funding mechanism, NIA funding is administered directly by the networks to progress all aspects of innovation. At the time of writing, the ENA and its network members are working on a research project to better understand the value and benefit of this network-led innovation funding. Some of the key insights on the value of this funding are outlined below and explored further in the main report body:

- The **agile**, **robust**, and **flexible** self-governance process of the NIA allows networks to quickly address innovation challenges as they emerge and change in a rapidly evolving landscape; this value was particularly important during the COVID-19 pandemic.
- This funding **promotes collaboration between networks**, facilitating whole systems thinking through a non-competitive framework which emphasises knowledge sharing.
- The NIA **de-risks innovation** by enabling low-TRL projects with uncertain outcomes that networks would not otherwise be able to fund, allowing for industry-leading progress.
- The NIA **compliments other funding sources**, with SIF and NIC projects building off learnings from NIA research.
- The **open scope** of this funding permits innovation progress across a wide range of sectors.

Network progress in key outcome areas

Network progress on innovation is organised around a set of "outcome areas" which originate from the IMF for RIIO-2. They aim to show how networks (for this report, specifically transmission networks and gas distribution networks) are performing across the innovation process from idea selection and partnership building through to benefits delivery. Below is a brief summary of progress made in FY23 against each of the four outcome areas.

- **Outcome Area 1: *The focus of innovation*** – *spread of projects across innovation themes*
    1. Network operators agree that progressing innovation across a broad spectrum of topics is a key enabler to drive the other outcome areas.
    2. The IMF lists £52.9 M planned investment across the 148 innovation projects registered in FY23.
    3. Combined with the in-flight projects carried into FY23, 242 projects were active over the period.
- **Outcome Area 2: *Working with partners*** – *collaboration in innovation projects*
    1. Collaboration across the networks and with third parties / non-network innovators has become an increasingly important factor to drive progress forward.
    2. Out of the projects registered in FY23, 60 projects include more than one network operator (46% of all projects initiated).
- **Outcome Area 3: *The innovation funnel*** – *translating ideas into projects*
    1. Networks recorded 439 ideas generated and 146 projects taken forward from those ideas (33% of ideas generated) in the IMF this year.
    2. Separately, this year's ENA Innovation Basecamp has bolstered the idea generation stage to allow projects to be reviewed and allocated to NIA and SIF routes. This process included 53 problem statements generated by the networks and received 273 proposals from innovators.
- **Outcome Area 4: *Benefits for customers*** – *delivering positive outcomes for consumers*
    1. Translating innovation into meaningful change for consumers is the central motivator for network innovation.
    2. There are numerous benefits to customers including new markets and services, cost-reductions, and the de-risking of novel / developing technologies that have been identified in innovation projects from the past year.

Next Steps

In reflecting on previous periods of innovation, project work has shown a particularly strong focus on the themes of 'Net zero and the energy system transition' and 'Optimised assets and practices.' Despite the ongoing importance of these themes, future work will likely increase across the other

four innovation themes to further address the full array of challenges the networks will continue to face. The pipeline of projects for the next year suggests an exciting array of work across all strategy themes.

Work in the past year has also highlighted risks that networks face throughout the innovation process. Developing robust and structured communication and engagement strategies around innovation can be an important tool in mitigating these risks throughout a project.

Lastly, as RIIO-2 progresses, the networks expect to see a wider array of projects creating a strong evidence base to support decarbonisation goals and more learnings/solutions brought into BAU.

FY23 Year in Review

The end of FY23 marks the end of the RIIO-ED1 period, with the electricity distribution network operators (DNOs) now joining other networks in RIIO-2. As the DNOs were not a part of the RIIO-2 price control in FY23, data on their projects or benefits have not been tabulated with the other networks in the IMF or the Balanced Scorecard referenced throughout this report; as such, the majority of GB-level statistics presented in this report do not include DNO projects. However, all networks (including DNOs) are referenced in the case studies and links throughout the report. The networks have also contributed to the report writing process by providing their views on industry-wide progress in the past year.

Balanced scorecard

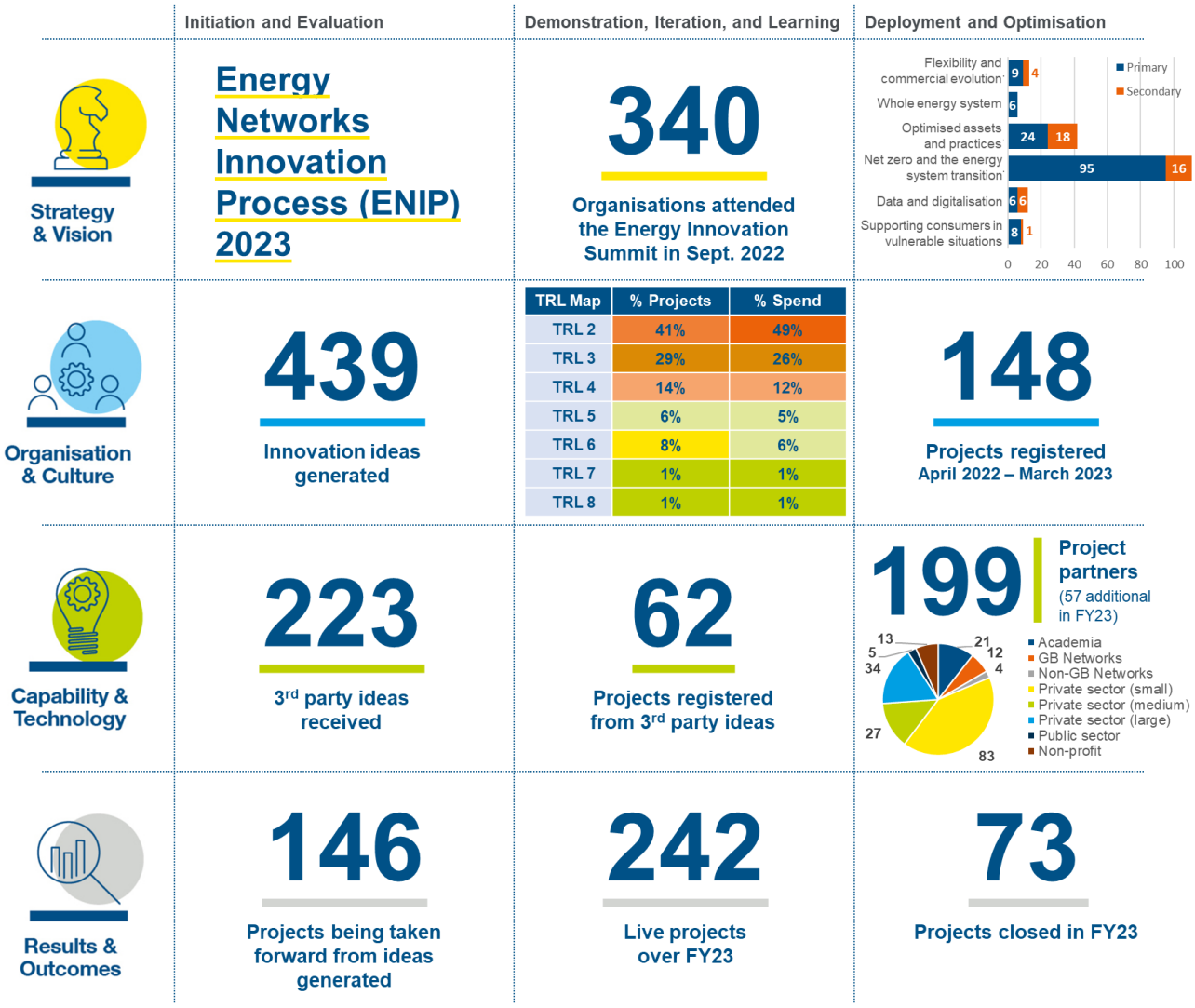


Figure 2. FY23 Balanced Scorecard

The Balanced Scorecard highlights four performance indicator groups identified by the networks as key enablers of innovation: Strategy & Vision, Organisation & Culture, Capabilities & Technology, and Results & Outcomes. The three columns map these performance indicators to the three stages of the innovation process (initiation and evaluation; demonstration, iteration, and learning; and deployment and optimisation) to show how networks are performing against each indicator throughout the innovation process. This year's scorecard shows a strong number of ideas generated/received and a growth in the number of projects registered from third party ideas. Further, it is important to note the additional value brought via the publication of challenge statements that the networks put out to the industry through the Basecamp and other initiatives to facilitate even more ideas.

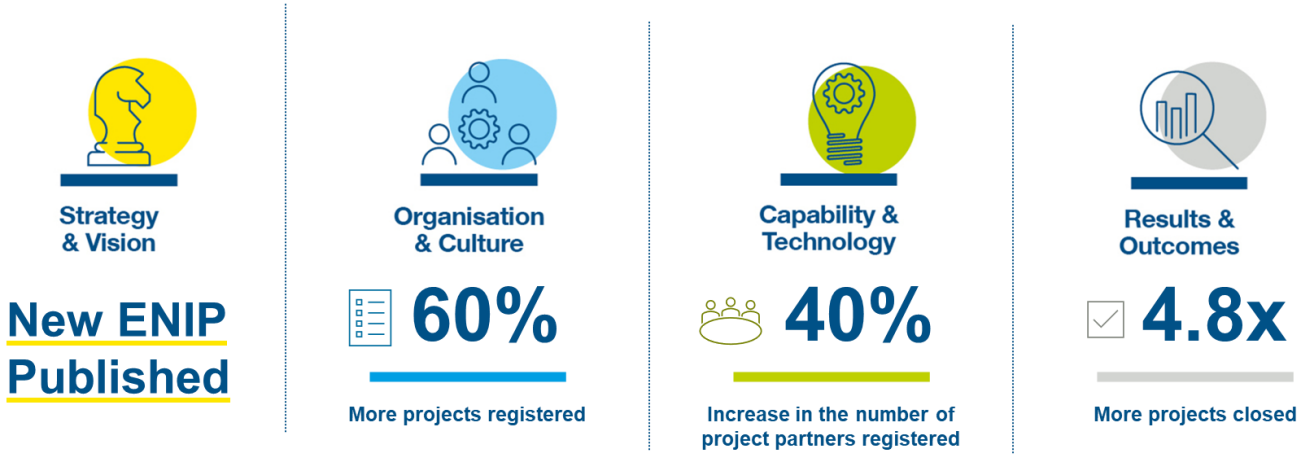


Figure 3. Progress versus FY22

The 2023 scorecard shows progress in the number of projects registered and spread of those projects across innovation themes with 1.5x as many projects registered over the financial year (148 in FY23 up from 93 in FY22). An increased focus on collaboration this year has also led to a twofold increase in projects developed from third party ideas (62 in FY23 and 29 in FY22). The number of project partners has also increased by 40% from 142 in FY22 to 199 partners in FY23. Nearly 5x more projects (73 up from 16 in FY22) have been closed this past year as the transmission and gas distribution networks move further into RIIO-2. A further five projects have been brought into BAU, which is a significant accomplishment and improvement over the last financial year where two projects were deployed. Project solutions can only be integrated into BAU if the innovations have been sufficiently trialled and there is a suitable regulatory and market environment available – the process behind integrating project learnings into BAU is further explored below and in the section on Outcome area 3: the innovation funnel.

The innovation process

Planning for Innovation: Themes, Objectives, Principals

The latest Energy Networks Innovation Strategy, released by the ENA in March 2022, set out the shared "objectives, themes, and principles" for network innovation projects. This strategy provides a common set of goals and metrics for innovation to ensure that projects are targeted at specific challenges.

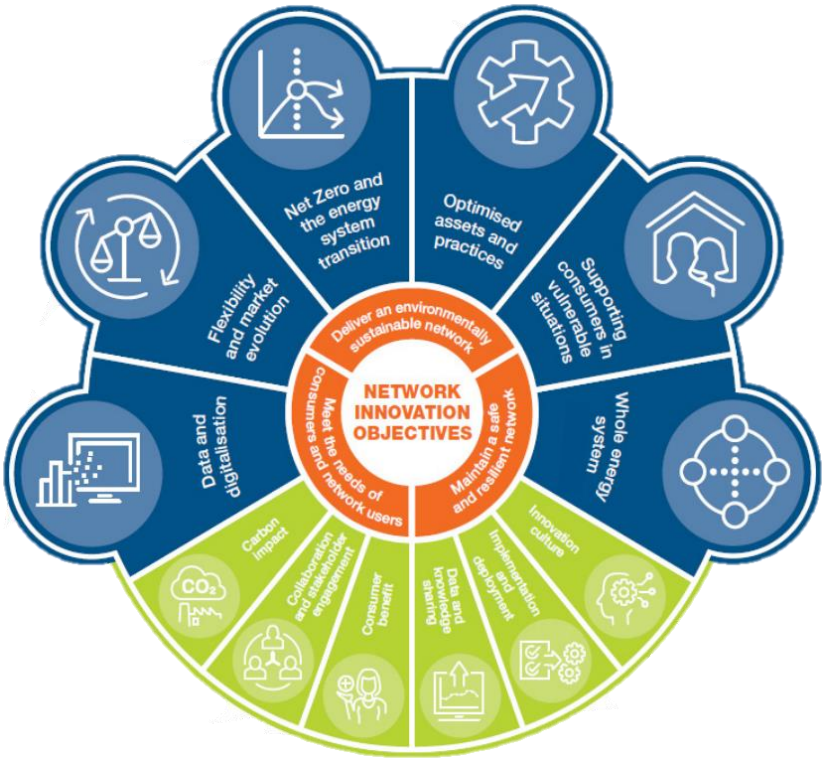


Figure 4. ENA Themes, Objectives, and Principals

The three consumer-facing outcome categories from Ofgem sit at the core of this strategy and are the key **objectives** for any innovation project. Their focus is to meet the needs of consumers (including those in vulnerable situations) in a safe and environmentally responsible way while maintaining a resilient network.

The six **principles** target the way that networks approach innovation, rather than the content/subject of a particular innovation project. They stress the importance of collaboration and openness throughout the innovation process, while ensuring that aspects such as carbon impact consumer benefit are considered.

The six **themes** are the priority innovation areas developed collaboratively by the networks. Each theme also has a set of focus areas which indicate the networks' priorities in that area. These themes and focus areas help to direct innovation so that it targets the biggest challenges for the future energy system.

Each theme has its own importance and role in shaping the focus of the innovation portfolio. The themes are also not funding specific and both NIA and SIF funded projects, while focused on specific challenges, will still fall under at least one of the agreed innovation themes. The general relationship between these themes is discussed below:

Data and digitalisation work is often an enabling tool for all projects and evidence-based decision-making by increasing the information available for networks to use in future projects as well as BAU operations and resilience planning.

Given the goal to decarbonise the power system by 2035, **net zero and the energy system transition** is a core focus for most innovation projects, which enables networks to meet their own objectives and support the decarbonisation of their customers across all sectors.

In a similar vein, the **whole energy system transition** theme places a comparable emphasis on decarbonisation but stresses the importance of broader thinking. Collaborating across network types, value chains, and with non-network stakeholders will help to deliver the net zero transition as efficiently as possible and at the lowest possible cost to consumers.

> "Working collaboratively between electricity and gas networks enables understanding of how we can come together as networks to look at combined solutions".
>
> *– Network Innovation Lead*

Optimised assets and practices projects look to deliver solutions efficiently but with a focus on reliability and security of supply – core network responsibilities which will continue to be important given the increasing variety and flexibility of new network demands.

The theme of **flexibility and market evolution** also focuses on new network demands. Work in this theme is important for accelerating the uptake of Low Carbon Technologies (LCTs) and increasing consumer participation in the energy transition. This is particularly important given new network responsibilities focused on system operation with the launch of the Distribution System Operator (DSO) and Future System Operator (FSO) functions.

The final theme, **supporting consumers in vulnerable situations** is considered in all innovation projects as RIIO-2-funded projects use a vulnerability assessment tool to determine how the project might impact vulnerable consumers allowing networks to identify and mitigate against potential negative impacts. This theme is increasingly important in the changing political and economic situation but can sometimes be difficult to address given the limited access networks have to interface directly with consumers.

Innovation Cycle

Regardless of theme or subject matter network innovation projects all undergo the same process from idea generation through to benefits realisation. In the first stage of this process (as shown below in Figure 5), ideas from networks and innovators are refined and revised to align with the themes presented above. Once an idea reaches the second stage the focus is turned to delivery and dissemination of project learnings and findings. After this stage project outputs are evaluated to determine if additional work is needed to increase the viability of an idea or technology. If further trials or tests are needed or if the learnings inspire further work, the new ideas are funnelled back into stage one of this process. Otherwise, the final stage is focused on implementation and introducing project findings into BAU operations. This integration step can often be more difficult than anticipated as new technologies or processes may require additional regulatory approval. Networks continue to work with regulators, policymakers, and supply chain partners to make sure that the benefits of innovation spending can be safely and reliably delivered to consumers.

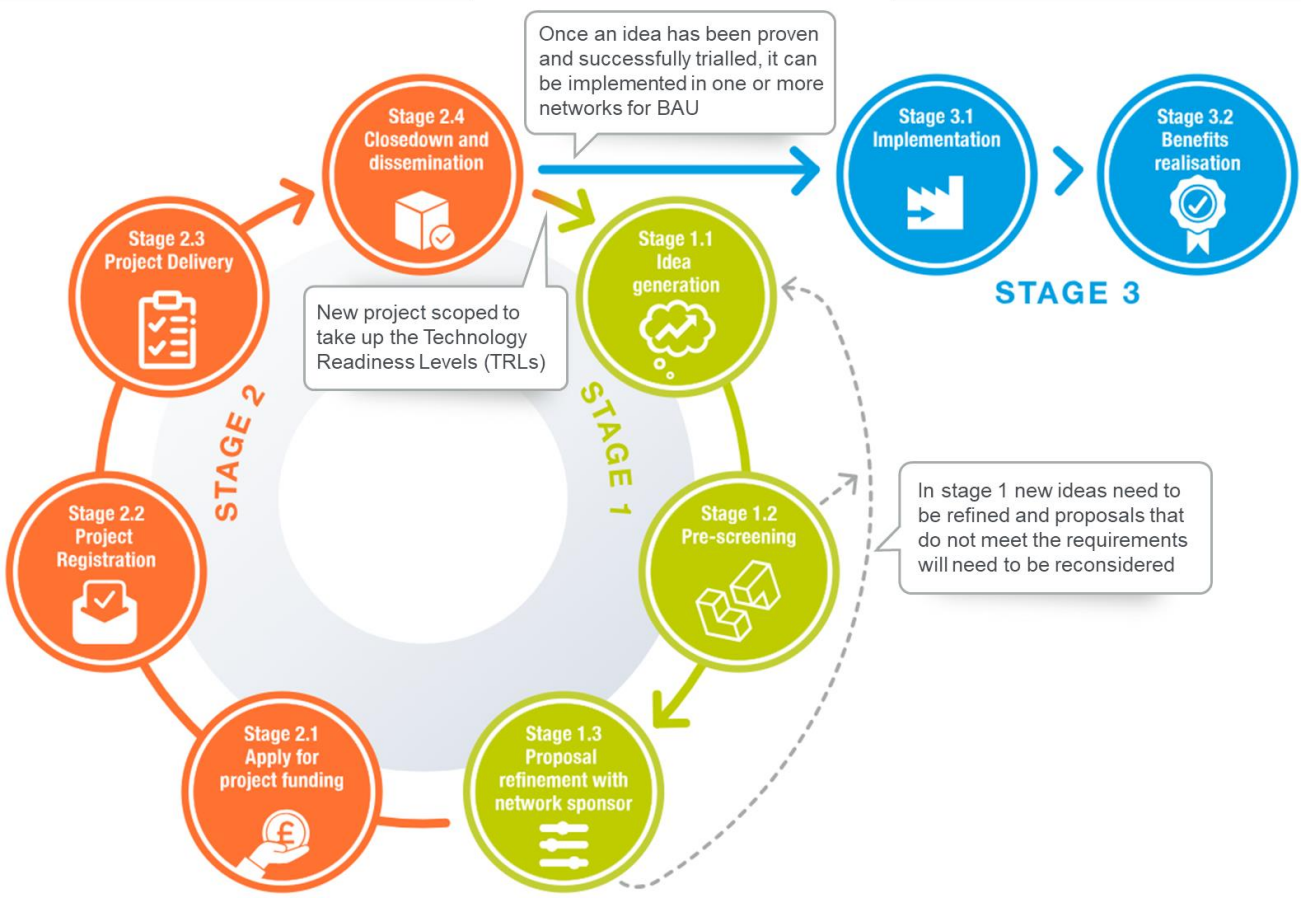


Figure 5. The innovation process

Value of network funding

This report focuses on two of the largest innovation funding sources, the SIF and the NIA, which deliver significant value to networks and customers through this innovation cycle.

The SIF programme was launched at the start of RIIO-2 as a competitive funding pool focused on areas of strategic importance to the energy system. Funding for these projects is organised into distinct rounds which focus on developing solutions from ideas into large-scale demonstrations. This funding stream provides significant levels of capital funding to enable real world trials of new technologies and services, de-risking first-of-a-kind projects for networks and consumers. More information on the progress made across SIF projects can be found in the SIF Annual Report published by Ofgem and Innovate UK.

The NIA is the largest network-led funding source for innovation reviewed in this report, representing 88% of the projects and 82% of the funding registered in the FY23 IMF. This section specifically focuses on the value of NIA funding which is the subject of a separate ongoing research initiative led by the ENA. The project will conclude later this year but Table 1 below shows a summary of the initial insights regarding the value of NIA funding in progressing innovation. Flexibility and agility are the most unique and significant benefits of NIA funding, allowing for innovation to progress to support networks reach government decarbonisation targets and improve

system performance and resilience. Without NIA funding, innovation would likely be slower, less collaborative, and constrained, with less overall progress.

Table 1. Benefits of NIA funding

Benefit	Key Themes	Description
Governance	Agile methodology; flexible approach; robust process	NIA funding is an agile, self-governed process with limited restrictions on timing; this allows for networks to solve relevant problems flexibly through a robust and established process.
Trial and error	Higher risk / reward; progress on lower TRL solutions	The NIA is key for funding projects with uncertain outcomes (i.e. potentially higher risk, higher reward ideas), which are usually those developing/progressing low-TRL solutions.
Collaboration	Facilitated collaboration; increased stakeholder engagement	NIA projects promote collaboration between networks and requires engagement with third parties. Predictability of funding also key to gaining stakeholder support for projects.
Breadth of scope	Wide project variety; knowledge sharing; network improvements; hydrogen learnings	The NIA allows for a range of innovation progress as projects can vary widely (e.g. funding low TRL projects to support vulnerable customers, network infrastructure improvements, and transport decarbonisation).

Another one of the clearest benefits highlighted by the networks was the agility of the NIA, supported by the robust self-governance process. This value was particularly evident at the height of the COVID-19 outbreak when networks were able to quickly start up projects to address the new service problems brought on by the pandemic. Projects in this timeframe mainly concerned finding solutions to maintain security of supply to consumers, especially those vulnerable, during a time when site visits were difficult.

The NIA also helps to fund higher-risk projects on lower technology readiness level (TRL) solutions. This was the case with the Shift 2.0 project which used NIA funding to trial a world-first procurement of LV flexibility services and allowed the first UK DNO to procure flexibility from an EV service provider.

The non-competitive nature of this funding also allows for collaboration between networks, the Consumer Building Blocks and Street Score 2 projects are two of many examples of this collaborative spirit where multiple networks have come together to address an industry-wide issue. The value of this collaboration is further explored in Outcome area 2: working with partners.

The NIA is also an important innovation funding source due to its breadth of scope – the collaboration and flexibility of the programme allow networks to support the decarbonisation of a wide range of sectors, ultimately supporting an array of government decarbonisation targets. In the past year alone, the FutureGrid Phase 1 – 5% Hydrogen Blend Test and Switching vulnerable consumers to hydrogen projects have explored hydrogen's potential use in the gas grid to support the government target of enabling up to 10GW low-carbon hydrogen production capacity by 2030. The Neighbourhood Green and Re-Heat: Enabling Renewable Heat projects have also used NIA funding to support the target of Installing 600,000 heat pumps per year by 2028. The flexible nature

of this funding stream allows networks to progress towards decarbonisation goals across a broad range of other sectors and industries.

Additionally, the benefits of NIA funding are not limited to projects solely funded through the NIA, as NIA work is often used as the foundation for future work funded through other mechanisms. One strong example of this relationship is the FutureGrid facility, a full-scale NTS hydrogen test facility, which has been built off learnings exclusively from NIA projects, with current development split across NIA, SIF, and NIC. The Crowdflex SIF project (discussed more in Outcome area 3: the innovation funnel) was also built off the findings of an initial NIA project. This funding provides an important opportunity for flexibility which compliments other available funding mechanisms.

The networks have also highlighted several potential improvements to NIA funding that could further bolster the agile and collaborative nature of this type of funding resource. One suggestion was to re-think the funding timeline as NIA projects are tied to a price control period. This restriction limits the projects that networks can launch towards the end of the price control and creates a source of significant uncertainty as future price controls may also include changes to project eligibility criteria. A further suggestion was to incorporate review practices into the funding process to assure that goals are achieved through progress meetings and QA/QC checks. Even with these suggested improvements, the networks have highlighted the importance and value of this funding stream to meeting both industry-specific and wider government decarbonisation targets.

Outcome areas

Reporting on innovation progress is measured against four outcome areas identified in the network-wide IMF for RIIO-2[1]. The four areas reflect on (1) the focus of innovation (the spread of projects across innovation themes), (2) working with partners (collaboration in project work), (3) the innovation funnel (the success of turning ideas into practices), and (4) benefits for consumers (projected benefits). Together, these outcome areas show network progress on innovation with a focus on delivering open innovation as effectively as possible.

Outcome area 1: The focus of innovation

Outcome area one is focused on the spread of projects across the shared network innovation themes as defined in the innovation strategy. Project alignment with the themes gives an indication of how networks are prioritising work to support their joint ambitions. The focus of projects within these themes is likely to shift throughout the price control period as work continues to build off successful projects and electricity distribution networks enter the price control.

Just under two thirds of the projects launched this year registered “net zero and the energy system transition” as their primary strategy theme (95 out of 148 total projects launched). This focus on net zero is in-line with the trends in projects launched in FY22 and with the overarching importance and urgency of work in this area. Further, many projects registered against the net zero theme are aligned to at least one other theme. This focus does not undermine the importance of the other themes in making sure that the energy transition is a just transition which does not leave behind consumers in vulnerable situations. RIIO-2 funded projects have an additional requirement to consider the potential impact of the innovation on vulnerable consumers in the Project Eligibility Assessment (PEA), so while not all projects explicitly focus on improving outcomes for consumers in vulnerable situations all projects do consider their impact in this area.

Key progress on each theme is outlined below and a full list of projects and their associated themes can be found in Appendix III. FY23 Project List & Status.

Data and digitalisation

Developing new data services and applying data science methods to harness the power of digitalisation to solve both system operation and wider stakeholder challenges.

Projects in this area are largely focused on building tools to support more efficient operations and planning; this includes using advanced modelling techniques to explore decarbonisation pathways so that networks are prepared for shifting future demands. These projects often fit into multiple themes, for example the alpha phase of the Digital Platform for Leakage Analytics SIF project used data to reduce methane leakage, supporting both system efficiency (through reduced shrinkage) and improved progress against net zero targets through reduced fugitive emissions. This project closed in February of 2023 but has just received SIF Beta funding.

Other interesting projects with a strong digital focus progressed this year include the Collaborative Local Energy Optimisation (CLEO) project which is creating a self-service energy planning portal for

[1] As electricity distribution networks were not a part of the RIIO-2 price control in FY23 they have not been included in the IMF figures quoted throughout the report. These DNOs are however referenced in case studies and links to projects in the report.

local authorities and the Intelligent Gas Grid's alpha phase which is using data-driven artificial intelligence (AI) and machine learning (ML) techniques to detect anomalies and leaks.

Flexibility and Market Evolution

Developing and testing market-based solutions to increase the flexibility and efficiency of the energy system; accelerating the adoption of low carbon solutions.

Progress this year against this theme has been focused on novel flexibility options both through active load flexing and through the uptake of smart-enabled LCTs. The increasing potential of domestic flexibility was an important theme this year with the Crowdflex project progressing investigation into this area; at the time of writing, the project has just wrapped up its Alpha phase and is moving into the Beta phase. The Flexible Tower Block project, which also closed this year, explored domestic flexibility through a novel tariff for storage heaters, showing the appetite for such a tariff and potential financial benefits for both customers and networks.

In the area of non-domestic flexibility, notable successes in FY23 include the completion of Optimise Prime, the world's largest trial of commercial EVs which looks to understand and minimise the impact the electrification of commercial vehicles will have on distribution networks. The Flexible Operation of Water Networks Enabling Response Services (FLOWERS) project has also explored the potential value of flexibility from water networks (one of the largest consumers of electrical power) for distribution networks.

The ESO's Demand Flexibility Service over this past winter has also underscored the potential value of domestic flexibility in times of network stress. This groundbreaking trial allowed over 1.6 million households and businesses the opportunity to participate in a national flexibility service and be rewarded for the first time. An innovation project (Demand Flexibility Service Evaluation) launching in FY24 is analysing the results from participants. This work was also supported by the learnings from Crowdflex's Alpha Phase establishing domestic flexibility as novel reliable flexibility resource.

The importance of this theme is further underscored by the DSO and FSO transitions which are underway and the progress made this year by electricity networks in procuring record levels of flexibility (see ENA Open Networks flexibility figures).

Net zero and the energy system transition

Facilitating and accelerating the UK's transition to net zero greenhouse gas emissions.

As in previous years, this theme continues to be central to the networks as they approach both their own net zero targets and the sector wide decarbonisation target in 2035 (set by the government in 2021). Decarbonisation in homes has been a significant focus for projects in this theme this past year. The Net Zero Service Termination Project, among others, explored how networks can best interface with and support customers as they decarbonise. In a similar vein, the Lessons from the Past project is exploring what lessons the gas networks can take forwards from earlier energy transitions (namely the transition from town gas to natural gas in the 60s and 70s).

The future of heating was another important topic for projects in this theme in the past year with the H100 Fife Phase 2 Village Pre-FEED project closing and the FutureGrid Phase 1 – 5% Hydrogen Blend Test project launching. The former was submitted to DESNZ, and it was decided that it would not proceed to the next phase. Plans were however progressed for the NGN Hydrogen Village Trial to take place in Redcar and are currently awaiting government decision to progress to the stage 3: Build and Prepare. The latter is a part of a broader testing plan to rigorously explore any upgrades needed to the GB gas transmission network (known as the "National Transmission System" or

"NTS") to support hydrogen blending. The Collaborative Visual Data Twin – Phase 1 project (discussed in more detail below) has also used some of these insights to begin building a digital twin of the NTS to model the behaviour of a hydrogen-enabled NTS.

The Novel methods for sealing SF6 leaks project is trialling innovative methods to reduce leakage of an insulating gas (SF6, a potent greenhouse gas) used in high voltage electricity equipment to prevent short-circuiting, these improvements reduce outages for customers and lower network emissions.

Collaborative Visual Data Twin – Phase 1

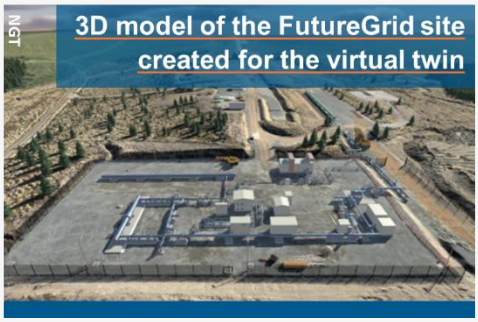
Project ID: NIA_NGGT0178
Budget: £861,762
Networks: NGT

Duration: Jan 2022– Jan 2023
Status: Complete

Overview: As gas networks continue to explore the potential role of hydrogen in the future energy system and in their networks, it has become clear that innovation is required to tackle the unique set of technical challenges that the introduction of this energy source poses. This project investigates the additional complexity of transporting hydrogen through the creation of a digital reproduction of the NTS. This digital reproduction, or "digital twin" will help NGT to better understand how their assets are affected by the introduction of hydrogen.

Progress: This project is split into two phases with the first phase undertaking data collection and planning the implementation of the tool. The second phase will then focus on building the system scoped by the first phase. This first phase closed in FY23 and delivered on its ambition to collate the data and scope the tool. A key output from this phase is that the project team has combined/compiled the existing 2D drawings/schematics of a hydrogen-enabled NTS (created for the FutureGrid project) and developed them into "building information models" (a modelling methodology developed by the Building Information Modelling innovation project). These models and schematics are the "virtual" and "data" twins which will be connected in phase two to create the full digital twin.

Benefits: The key benefits expected from this phase of work centre around the ability of this tool (and assembled data) to support an improved understanding of the NTS. This will support advanced analytics capability, the ability to monitor sites remotely, and the ability to create predictive models to future-proof the system. The financial savings estimated from testing and avoiding the deployment of unsuitable solutions is upwards of £10M.



Significant Learning: This project highlighted a number of technical learnings including the added value of engaging multiple suppliers to build the digital twin system, encouraging competition in approach and cost. Developing a common API framework allows for interactions between these separate systems. Further, this work has highlighted the importance of a secure access method for sensitive data on critical national infrastructure (such as the NTS) so that the data may be harnessed for relevant use cases without compromising the assets.

Next Steps: Phase 2 of this project launched in May of 2023 and will be continuing this work by linking the data from phase 1 together to create the digital twin. This project is also expected to interface with the Virtual Energy System project led by the ESO which is creating a framework for a system of connected digital twins for the GB energy system. The final developed digital twin will help to build an evidence base for transporting Hydrogen on the NTS.

Optimised Assets and Practices

Developing and implementing industry-leading techniques for optimising assets and practices.

The optimisation of network assets is a core part of network operations and will therefore always be an important focus of network innovation. Aligned to the longstanding commitment to resilience and optimisation, networks continue to leverage innovation funding to deploy and test new and advanced modelling techniques to deliver improved operations.

One example which has closed this year is the LV Predict project which has developed a modelling framework for the low voltage (LV) network (defined as 1kV and below) to determine the probability of failure of LV assets. A second phase of this work is currently being scoped to refine and extend the framework by improving the skill and reliability of the model, expand the model to other network assets, and apply the model in decision making. Improving visibility at this network level is an increasingly important aspect of understanding and optimising network operations as the demands on energy networks diversify.

The Storm AI project is also using advanced modelling techniques (AI and machine learning) to provide more accurate re-connection estimates for customers impacted during a storm. This is especially important given the rise in extreme weather events expected as a result of global warming and climate change. This project looks to address the core network resilience issue while also tackling an important aspect of consumer vulnerability (getting customers reconnected quickly) and harnessing new digital tools throughout the process.

In a similar vein, the Visual Inspection and Condition Assessment Platform for OHL Steelwork (VICAP) project trialled the use of drone imaging and machine learning techniques to support steelwork corrosion assessments on overhead lines.

Supporting consumers in vulnerable situations

Exploring how best to support the needs of consumers who find themselves in vulnerable situations, today and in the future, to enable a just transition.

As all networks move into RIIO-2, this past year has seen progress against this theme both inside of project work and in wider strategy setting. Outside of projects, many networks have updated and expanded their definitions of vulnerability to account for the changing stresses placed on consumers. The introduction of the Vulnerability Assessment Tool last year has also helped to standardise the approach used by networks when dealing with projects likely to impact vulnerable consumers. The tool now forms part of the PEA registration process for each new NIA innovation project in RIIO-2. A consistent methodology for reviewing any potential impacts has helped the networks to evaluate the distributional impacts of innovation on consumers in vulnerable situations.

The projects registered to this theme in the past year both look to identify or understand vulnerable consumers (supporting both BAU work and future innovation) and test solutions support these customers. In the former category, the Vulnerability Visualisation Tool (Version 2) has combined the

vulnerability metrics available to create a single model to understand likely vulnerability in an area, directing networks to offer additional support where it is needed most. Project Vulnerability and Energy Networks, Identification and Consumption Evaluation (VENICE) has explored the impacts of the pandemic and cost of living crisis on consumption, using these insights to evaluate how best to engage fuel poor customers in the energy transition and ensure that they are not left behind.

In trialling and testing support schemes, the Resilient Homes project has explored the use of re-purposed electric vehicle batteries in homes of customers to protect those who are vulnerable (especially those with medical equipment) from the negative impacts of a supply interruption.

It is important to note that as the consumer relationship is normally in the remit and reach of the energy supplier rather than the energy network, networks cannot often directly engage with consumers. Despite this, innovation projects (like those outlined above) can present the opportunity for networks to support consumers in a variety of ways (e.g. reducing costs and improving network resilience).

Whole energy system

Develop joined-up approaches across sectors and energy vectors.

As GB continues along its decarbonisation journey interactions across the energy system become increasingly important. Shifting future demands will require the networks to work together and with a broader range of partners in exploring decarbonisation pathways. This need for collaboration is consistent with the shift towards system operation roles for distribution networks as they take on a broader range of system operation responsibilities at the regional level.

Projects in the past year which have focused on this theme have looked to efficiently manage new network demands and users while making sure that energy networks continue to work well together into the future. The Network-DC Circuit Breakers project supported improved coordination between onshore and offshore networks which will become increasingly important with the expansion of offshore wind in GB. The Project Synthesis – Effective Regional Inertia Monitoring and Automatic Control with a Whole System Approach (T2) project is exploring frequency response in the context of the whole energy system to support the growing share or renewables on GB networks.

The Gas and electricity transmission infrastructure outlook project which closed this year has also focused on future interactions between networks and explored the potential role for collaboration between gas and electricity transmission networks in a decarbonising energy system. Projects, like the Customer Energy Village, have also focused on the whole systems role for energy efficiency in heat decarbonisation.

Outcome area 2: working with partners

Outcome area two is focused on collaboration and the extent to which networks work with stakeholders and build partnerships through their innovation work. This past year has shown considerable progress on collaboration through both project work and industry wide initiatives – the launch of the Basecamp programme and the return of the in-person Energy Innovation Summit allowed networks and stakeholders to come together in ways that they have not been able to in the past two years. The result of these efforts was an expanded portfolio of project partners for this year and an exciting pipeline of innovation projects to be rolled out in the next financial year.

Who participates in innovation?

Networks collaborate with a wide range of experts and stakeholders across their project portfolios, which helps to ensure that projects can draw on deep expertise and incorporate a diverse set of perspectives. In the RIIO-2 period to date, networks have worked with 199 project partners on innovation projects from a wide range of organisations as shown in Figure 6 below. This includes 57 new project partners registered in FY23 which represents a widening of 40% to the total number of partners and supporters registered in FY22. The 15 energy networks have worked with 83 small businesses, 27 medium businesses, and 34 large businesses. The list of project partners also includes a further five networks outside of GB, 21 universities, and four public-sector organisations.

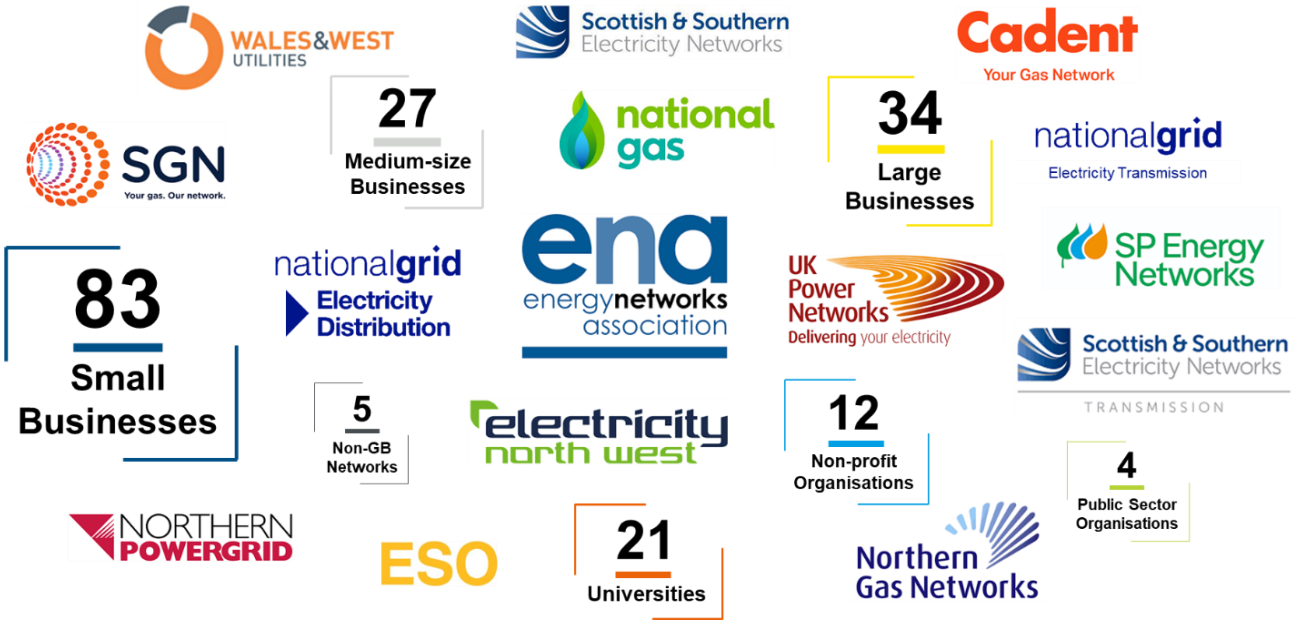


Figure 6. GB energy networks and their innovation partners in FY23

Collaboration between networks and across network types is also critical in making sure innovation considers impacts to the whole energy system. This past year the networks have launched 73 collaborative projects (with more than one network operator providing funding). The Gas and electricity infrastructure outlook project brought gas and transmission networks together to explore the future of a decarbonised transmission system and pinpoint the key interactions between the gas and electricity networks. The Virtual Energy System project is another example of networks working together to explore system interactions by developing a common framework for digital twins so that as networks develop individual models of their assets they can be combined to explore interactions across networks and give a view of the whole energy system.

The Street Score 2 project (as explored in more detail below) also highlights the value of collaboration in innovating on common business areas/challenges. Building from the learnings from Street Score 1, this project explores street works – a common business challenge between networks – and how networks can reduce the associated impact on vulnerable consumers.

Street Score 2

Project ID: NIA_NGN_338
Budget: £328,119
Networks: NGN, Cadent, NPg, SGN, SSEN-D, WWU
Duration: Feb. 2022 – Jan. 2023
Status: Complete

Overview: Customers in vulnerable situations and the wider public often find journeys through and around street works a challenge. There is some level of inconvenience inherent in the nature of street works, but networks can minimise the impact of these works by adjusting their practices based off of customer feedback. The first portion of this work focused on understanding the ways in which street works might put members of the public into vulnerable situations. For example, being re-directed into the road may involve navigating kerbs and/or unstable ramps which present tripping hazards. The second part of the project has taken this feedback and developed a set of suggestions for improving the accessibility of street works.
As street works are an important part of operations for both gas and electricity distribution networks, collaboration throughout this project has helped to ensure that the learnings developed are relevant for all networks and can be widely shared/adopted. This type of collaboration also ensures that work is not duplicated between networks.

Progress: This project builds off the engagement completed for the Street Score 1 project which showed that vulnerable individuals, carers, and advocates are unhappy with the current way street works are designed. This phase of work further analyses this feedback and advances the concepts/principals raised into the prototyping and design development stage. The Street Score 2 project closed in January 2023 and has delivered a methodology that can be used to "score" street works so that network operatives can better understand the accessibility of the works and make improvements as needed. A further 20 options for improving street works were identified by the project team and shared with the networks.

Benefits: The primary aim of this work is to improve customer experience in navigating street works with additional potential benefits including: (1) possibility of reduced fines for street works due to improved management practices; (2) improved customer experience with street works due to adoption of better practices; (3) improved engagement between network operators and community groups as facilitated through the stakeholder engagement portion of this work.

Significant Learning: This work has helped networks to understand the ways in which street works present challenges for vulnerable consumers and the public. This includes the methodology used to score and improve the accessibility of street works and a number of concrete options for improving signage and communications which can be trailed in future work. The networks are currently reviewing how to take these findings further in terms of business commitment, early improvements, a new design code, and longer-term development scopes.

Next Steps: Following project completion, the networks are sharing project learnings and outcomes with stakeholders. The project team will be engaging with networks and other industry stakeholders at the 2023 ENA Innovation Summit to share the findings with a wider audience. Additionally, NGN has scoped six potential future projects each further addressing a challenge identified during the Street Score project.

Collaborative initiatives in FY23

Beyond project work, networks have also continued to develop industry-wide programmes to support collaboration throughout the innovation process. The rollout of the Basecamp programme this year has been a significant step in opening up the innovation process to third parties. The programme generated 273 new ideas targeted at 53 innovation areas identified by networks and 118 of those ideas were invited to pitch to networks in London in July of this year. As this is a recent programme the ideas generated through this process were not captured in the IMF or included in the Balanced Scorecard. The projects selected through this process will start to filter through in FY24.

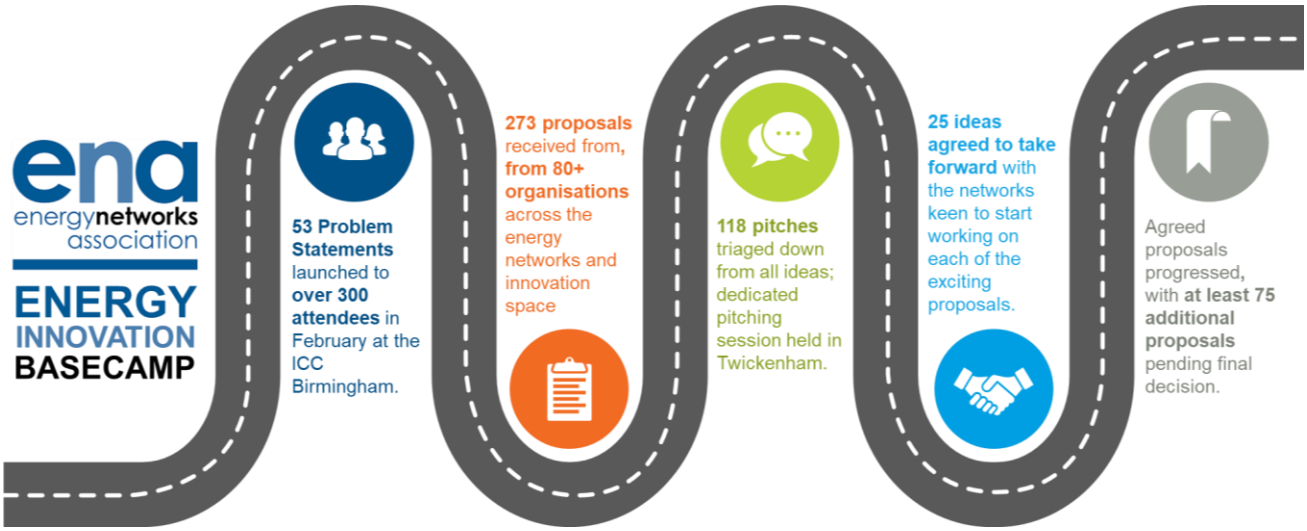


Figure 7. ENA Basecamp 2023 roadmap

The Strategic Innovation Fund (SIF) process has remained another important point of collaboration in FY23. The open application and pitching process is aimed at enabling a broad range of third-party innovators to bring their ideas to the networks. Proposals generated for Basecamp have been fed into this competition, while in parallel the open UKRI application and pitching process generated a further pool of project ideas. The three phases of funding (Discovery, Alpha, and Beta) are designed to allow innovators and networks to explore truly novel ideas and build upon learnings at each round of funding. In RIIO-2 to date, the networks (all distribution and transmission networks) have made 214 SIF applications (across Rounds 1 and 2 for Discovery, Alpha, and Beta), of which 157 have been funded.

FY23 also saw the return of the in-person Energy Innovation Summit which was expanded from the Energy Networks Innovation Conference to open the event up to wider industry through a partnership with the Department for Energy Security and Net Zero, Innovate UK, Ofgem and Regen. The event brought together 1,137 network and industry representatives from 340 organisations to discuss lessons learned from over 60 innovation projects and reflect on progress made against innovation targets.

Outcome area 3: the innovation funnel

As part of the IMF, this outcome area is focused on how ideas are funnelled through the innovation process from ideas generated, to projects developed, and finally integrated into BAU. This past year, the IMF showed that networks reviewed 439 ideas with 223 of those ideas coming from external partners, the progress of those ideas is shown in Figure 8 below.

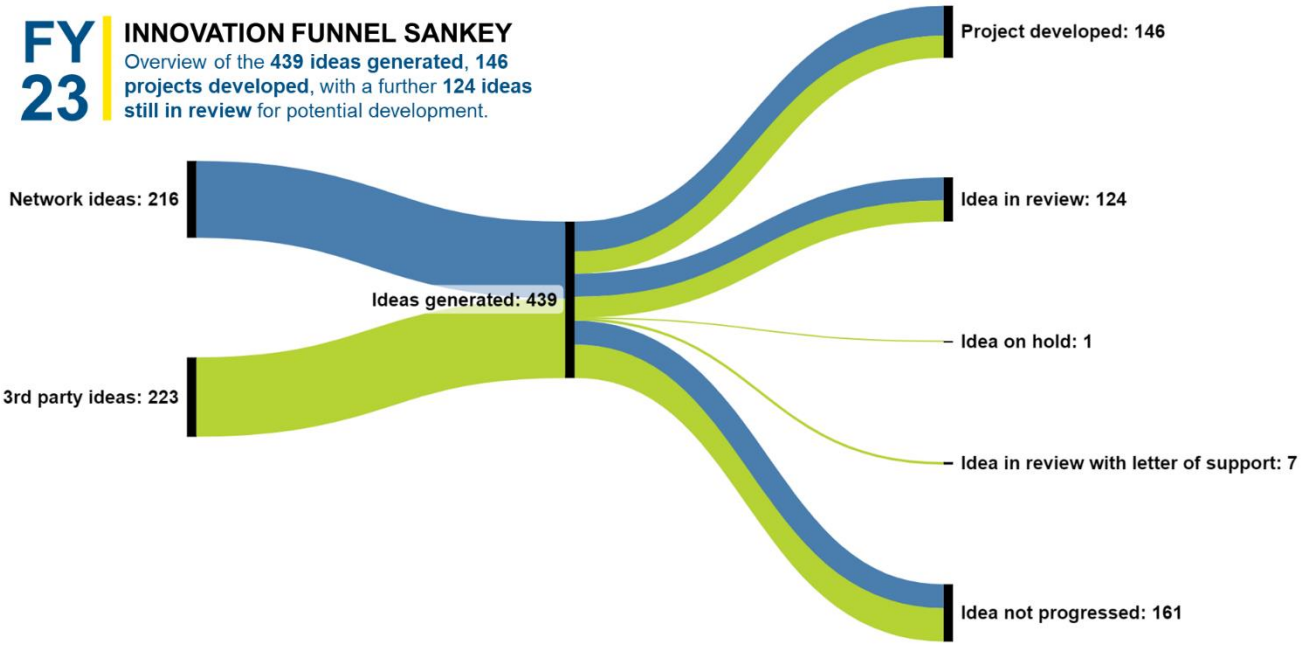


Figure 8. The innovation funnel for ideas received in FY23

Approximately a third of the ideas generated in FY23 were developed into projects; roughly another third were not progressed further by networks for not having sufficiently aligned with innovation aims or for not providing a strong business/investment case. The robust governance process used to evaluate these ideas ensures that those that progress are good value for money and are aligned to the shared set of network goals. Out of the 146 ideas developed into projects, 62 of those ideas came from third parties.[2]

Previous projects and learnings were also important drivers of network innovation in FY23 as projects are often developed off the back of prior projects to develop a technology or programme further. The learnings from closed projects are always important for networks when considering any new ideas or proposals. Building on past learnings is core to much of the innovation in the past year but is well exemplified by the Crowdflex project (explored in detail below) which has grown through multiple rounds of funding and whose learnings have supported separate trials and projects, including the Demand Flexibility Service launched this winter.

[2] Further guidance on the how ideas are selected for projects and the pitching process can be found in the ENIP.

CrowdFlex Alpha

Project ID: 10037410
Budget: £606,196
Networks: ESO, SSEN, NGED

Duration: Aug 2022 – Feb 2023
Status: Complete

Overview: The Crowdflex programme explores how domestic flexibility can be harnessed as a reliable energy and grid management resource. To establish the value of this resource the programme is developing a trial of domestic flexibility and models to help integrate the resource into the network's planning. The overarching aims across the phases of this work were to (1) understand network (ESO and DSO) requirements for domestic flexibility and the commercial arrangements needed to support its usage; (2) identify the technical and consumer behaviour limitations which impact the flexibility resource; and (3) understand how the variable nature of domestic flexibility can be developed into a reliable grid resource.

Progress: The CrowdFlex project showcases how innovation can build off earlier projects to further the TRL of a technology or novel programme. The SIF-funded work on the project builds on the earlier innovation work in the CrowdFlex NIA and Domestic Reserve Scarcity Trial. The subsequent Discovery phase of the project explored the stochastic nature of domestic flexibility to inform the feasibility study for the widespread use of domestic flexibility. The Alpha phase, which closed in FY23, delivered both a specification for designing consumer demand and flexibility models and a plan for a series of flexibility trials to further build the evidence base for use in the modelling.

Benefits: The Discovery phase of this project showed the scale of the potential value of domestic flexibility. With 60% of EV households in GB participating in domestic flexibility, the value of this flexibility could be worth £1.25Bn/yr to the end consumer. The use of domestic flexibility to reduce peak demand is also anticipated to save 4.6MtCO2eq/year (assuming that this demand would otherwise be met with OCGTs). When these savings are passed to consumers, domestic flexibility is expected to reduce the average household's bill by 11% and reduce the emissions from their electricity use by 17%.

Significant Learning: The CrowdFlex project has identified the suitability of domestic flexibility for Constraint Management and further potential market value of this resource for both flexibility service providers (FSPs) and consumers. These findings have helped to shape the model specification, setting out a plan to use a series of interconnected models that also demonstrate the principles of the Virtual Energy System. Each FSP would manage an independent model of their own domestic flexibility resource and these models will be interoperable with ESO (and potentially other networks), using common API Schemas to enable the forecasting of the cumulative potential of domestic flexibility, enabling the maximum value to be realised.

Next Steps: The project has just received SIF Beta Phase funding to start the delivery and testing of both the trial and the model. This phase will place an emphasis on building interconnected models of consumer demand and flexibility. These models will utilise the data gathered from the trials, which examine both availability and utilisation payments (two commercial arrangements for producing flexibility) to assess the volume of consumer response under different situations. This modelling will help the ESO's control room to better understand the reliability of domestic flexibility so that it may be integrated into the network flexibility portfolio. The model is also expected to help DSOs and flexibility service providers to build services which are likely to add value for both networks and consumers. The model insights will also support the ESO's Virtual Energy System programme and insights from the discovery phase have already fed into the HOMEflex project and

the ESO's Demand Flexibility Service. The full roadmap of projects linked to the CrowdFlex programme is shown below in Figure 9.

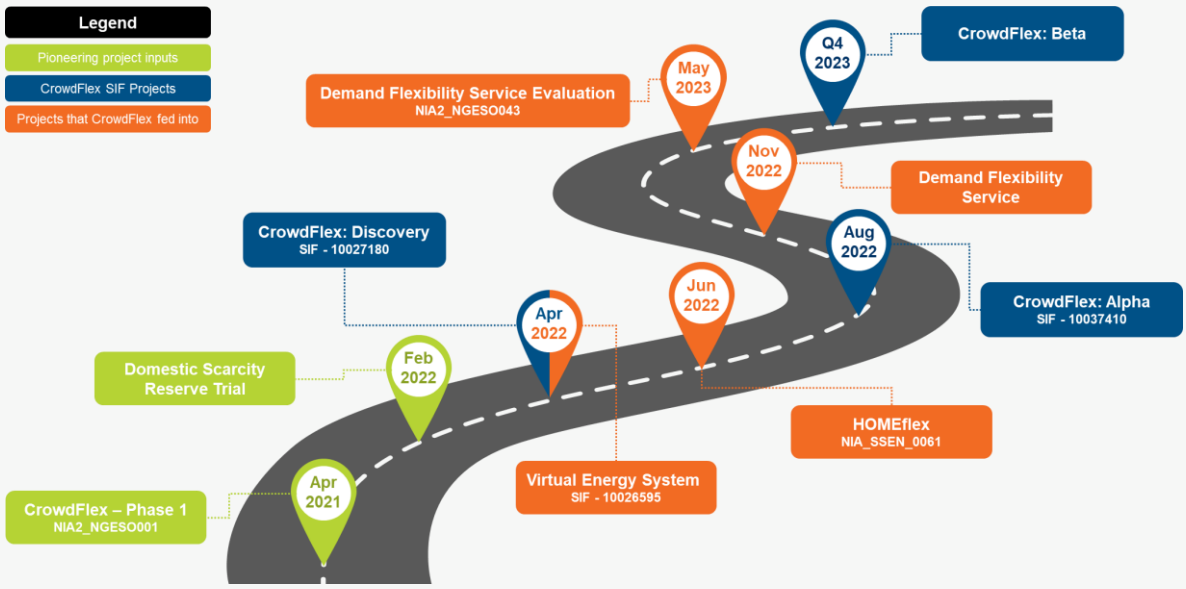


Figure 9. CrowdFlex innovation roadmap

Building from new ideas, previous projects, and ideas from FY22, the networks launched 148 innovation projects in FY23. With the 94 projects launched before FY23 which were still active, this totals 242 active innovation projects managed by networks throughout FY23.

In FY23, the networks have brought 73 projects to a close. After project close, networks take the learnings from that work into future innovation projects and into their BAU operations. However, it is important to note that not every project is suitable for immediate integration into BAU. Several projects explored by the networks focus on innovative decarbonisation solutions (e.g. hydrogen blending) or market arrangements that have not been sufficiently trialled for a network-wide rollout. Instead, these projects directly contribute to a growing evidence base about the decarbonisation options available across the country to support policymakers and regulators in their decision-making.

A further tranche of projects will feed back into the innovation cycle and new projects will further their learnings. Out of the 73 projects which closed this year, 47% (35 projects) will lead to another project. This follow-on work will build the TRL of the solution being trialled or test the solution further to ensure there are no adverse impacts for consumers.

If a solution is fully developed (i.e., no further innovation is needed to increase TRL) and is suited to the current regulatory environment, it can be embedded into BAU. Considering this, it is a great achievement that another five projects (adding to a total of seven so far within these first two years of RIIO-2) have moved to the BAU stage. As networks are still in the early stages of RIIO-2, not many projects have been fully deployed. However, it is important to note that the rollout of a project in to BAU is not only dependent on networks (the challenges networks face in this process are discussed in more detail in the Next Steps section).

Later in the regulatory period the networks expect the number of BAU-integrated projects to increase but, due to the nature of the innovation being trialled, many of the projects delivered in this regulatory period will only be integrated into BAU in the next regulatory period or following future policy guidance (e.g., many hydrogen projects can only be integrated into BAU after the government decision on hydrogen for heating). This wide spread of ideas and projects underscores the importance of innovation funding in allowing networks to collaborate with a wide range of partners on variety of (possibly higher risk) projects that simply would not be possible otherwise.

Outcome area 4: benefits for customers

Delivering benefits to both networks and consumers is core to innovation. Where possible, projects aim to quantify benefits which are then are collated and reported in the IMF. The qualitative or non-financial benefits are by their nature more difficult to calculate but are also essential to innovation progress; the benefits are widespread, coming in the form of progress towards government decarbonisation targets, technological advancement, and improvements to system performance and resilience. As underscored by the breadth of the ENA themes, innovation is expected to support a wide range of progress, much of which cannot be standardised in any one format or reduced into a single financial figure that can be directly compared across networks.

This summary report draws on both quantitative and qualitative assessments to demonstrate the true breadth of project benefits. An assessment of the expected benefits (with accompanying explanations) for each project, including reassessments during project delivery through to close can be found in the documentation uploaded to the Smarter Networks Portal.

A single project likely has multiple beneficiaries as networks pass on cost reductions from operational improvements and/or provide learnings to support policy decisions. The below shows a non-exhaustive list of benefit categories for networks and non-network actors organised on two axes to show the type of benefit and the primary beneficiary. As already highlighted, of the non-monetary benefits listed in the bottom two quadrants are critical to efficient and fair network decarbonisation but cannot be easily compiled or reported in aggregate.

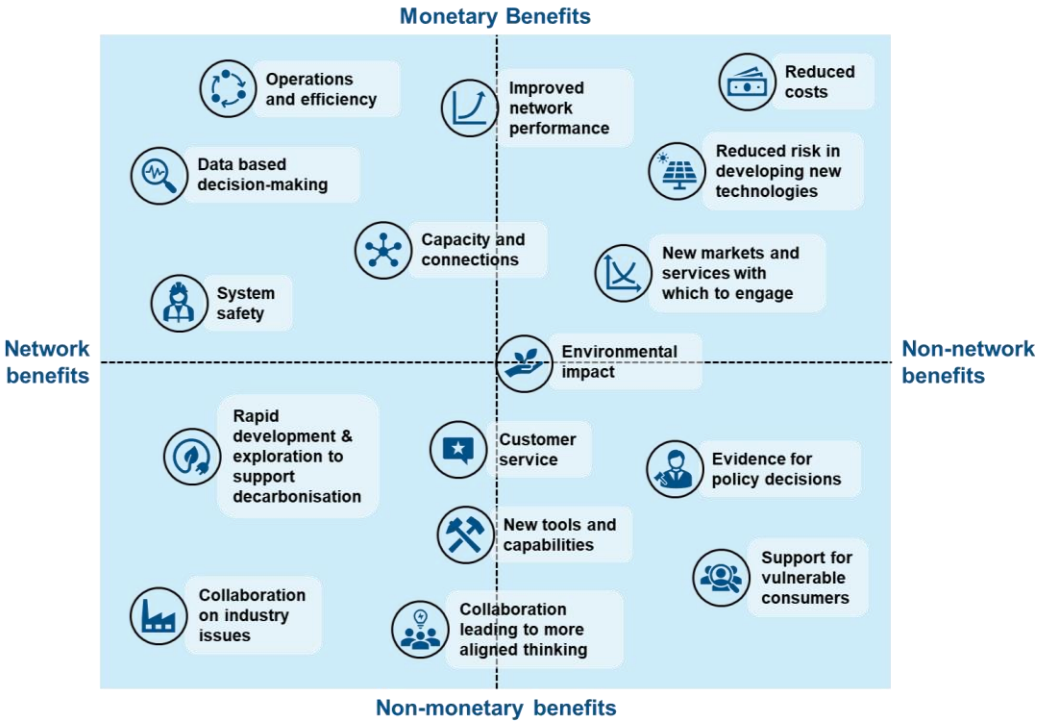


Figure 10. FY23 innovation benefits by type and beneficiary

The networks are in the process of reviewing these benefits to produce a view of the value of innovation funding across the industry. In parallel, the networks (led by the ENA) are developing a framework to measure the social value of initiatives led by the energy networks. As part of this process, the ENA will look to understand how the IMF could be updated to align with any methodology produced through this initiative to better capture the range of benefits created by network innovation.

Autonomous Aerial, Thermal Inspections of Substations (AATIS)

Project ID: NIA2_NGET0018
Budget: £572,000
Networks: NGET
Duration: May 2022 – Dec 2023
Status: Live

Overview: The AATIS project is investigating the potential to use drones and artificial intelligence (AI) to monitor substation assets. This solution has potential to replace the current manual condition monitoring survey process with improvements in both efficiency and the quality of the survey. The system, which is being trialled at the Deeside Centre for Innovation (DCI), will seek to demonstrate that a drone is able to fly autonomously/ beyond visual line of sight (BVLOS) and carry out the inspections needed with minimal intervention. The images and data captured by the drone will then be fed into an AI model for processing to generate near real-time asset condition reports.

Progress: To date, the project team has installed the system at the DCI and is working on an initial "visual line of sight" trial of the drone operation. This stage is seeking to capture enough evidence to build up the Operating Safety Case (OSC) that would be required for BVLOS operations. The drone

has also shown that it is able to avoid obstacles intelligently even within the complex substation environment. All evidence captured, along with mitigation plans will be collated to form the BVLOS OSC submission to the Civil Aviation Authority (CAA) in order to acquire permission for BVLOS operation at DCI.

Benefits: If testing continues to be successful, this project would prove the feasibility of replacing manual asset condition monitoring survey with autonomous drone inspections. The efficiency and data improvements from this upgrade are expected to result in a net present value benefit of £800,000 over the next 15 years. This improved efficiency and resulting savings will help to reduce network expenditure, allowing savings to be passed on to consumers. Further, the additional data and granularity available through automation may help NGET and other networks to adopt condition-based asset management (as opposed to the current time-based approach), which may extend asset lives and reduce outages. These improvements would both improve the network-user experience and deliver further cost savings.

Next Steps: Once the supervised trial is completed and permission from the CAA to carry out BVLOS missions is granted, a further trial will test its ability to operate in various BVLOS missions (i.e., at distances outside the normal visible range of the pilot). This testing will continue to capture data that can be used to train and test the AI model's capabilities. Any follow-on work will be determined based on the outcome of the trial and discussions with NGET's internal stakeholders.

Significant Learning: The first year of this project has underscored the complexity of the substation environment and the challenges of working in this setting. Despite the improvements in drone technology and the marketing of these tools as "plug & play", additional care must be taken into account when working in the substation environment. This translates to careful planning and configuration along with stakeholder coordination to ensure that the system can be operated safely. In a similar vein, the project found that it was more difficult than anticipated for the AI to identify the foreground target assets from the background assets that are not of interest. This is because electrical assets in a substation are interconnected and are of similar colours. To help with this, the team has carried out supervised testing in a real substation environment to provide the AI with further training data and has therefore achieved a major improvement.

Next Steps

Opportunities

In reflecting on the progress in previous periods, including the past year, innovation has shown progress across strategy themes with a particularly strong focus on the themes of 'Net zero and the energy system transition' and 'Optimised assets and practices.' Of the 148 projects launched this year 80% (119 projects) are registered with one of these as their primary theme and represent 80% of funding registered over the financial year. Beyond the registered themes, the expanded PEA requirements for RIIO-2 (including ensuring projects assess their potential impacts on vulnerable consumers) and new system operation goals/roles for networks have meant that even projects within these two themes have approached innovation through a whole-systems lens. The first combined (electricity and gas) network strategy released last year also ensures that network innovation takes a fully whole system approach and aligns with the UK's overall low carbon innovation portfolio.

The individual network strategies for the next year indicate that the net zero and optimisation themes will continue to be prioritised, but that networks are also developing projects across the other strategy themes. A varied pool of innovation projects throughout RIIO-2 will help to ensure that networks are addressing the full range of challenges facing the future energy system.

Led by the ENA, the networks have recently started the process of developing the next iteration of the combined innovation strategy, to be released in March 2024. The strategy will aim to establish a timeline of the key milestones out to 2035 and 2050, focusing on the challenges they will present, the potential scenarios expected, and the policy drivers and key decisions to be taken along the way.

The projects already registered in the first months of FY24 promise an exciting pipeline of innovation projects for the next year. The Local Energy Oxfordshire Neighbourhoods (LEO-N) SIF project will build off the "Prospering from the Energy Revolution" (PFER) funded work for Project LEO which established the importance of local energy planning and the value of flexibility for a local zero carbon energy system. The Data-Driven Online Monitoring and Early Warning for GB System Stability (DOME) project will explore a method for early fault identification on the power grid for faults driven by the increased prevalence of non-synchronous generation sources (such as wind and PV).

Registered against the "supporting vulnerable consumers" theme the Spotlight, PSR Resilience System, and VIVID - Vulnerability Identification Via Informative Data projects will be looking at novel data sources and methods to identify Priority Services Register (PSR) customers so that these households can be adequately supported. The three different methods being explored across the projects use a variety of data sources (from smart meter data to telecommunications data) to identify these customers and better understand their needs. The Low Power Heat and project will also support PSR customers with safer heating options in the event of a gas outage.

As the networks move further into FY24 and RIIO-2, innovation funding will continue to progress the decarbonisation and optimisation of GB networks. This allows them to take advantage of the latest advances in data availability and ongoing digitalisation, flexibility opportunities, collaboration on whole system approaches, and methodologies to support vulnerable customers.

Lessons Learned

Even with the successful launch of 148 projects and the completion of a further 73 projects this year, networks have continued to come up against challenges and risks throughout the innovation process. A summary of these challenges is presented below in Figure 11. A number of these risks can be mitigated through clear communication and early/consistent engagement across the business, with stakeholders, and across the networks. This emphasis on communication and dissemination is also underscored in the ENA innovation strategy and principles with the focus on "innovation culture; data and knowledge sharing; and implementation and deployment".

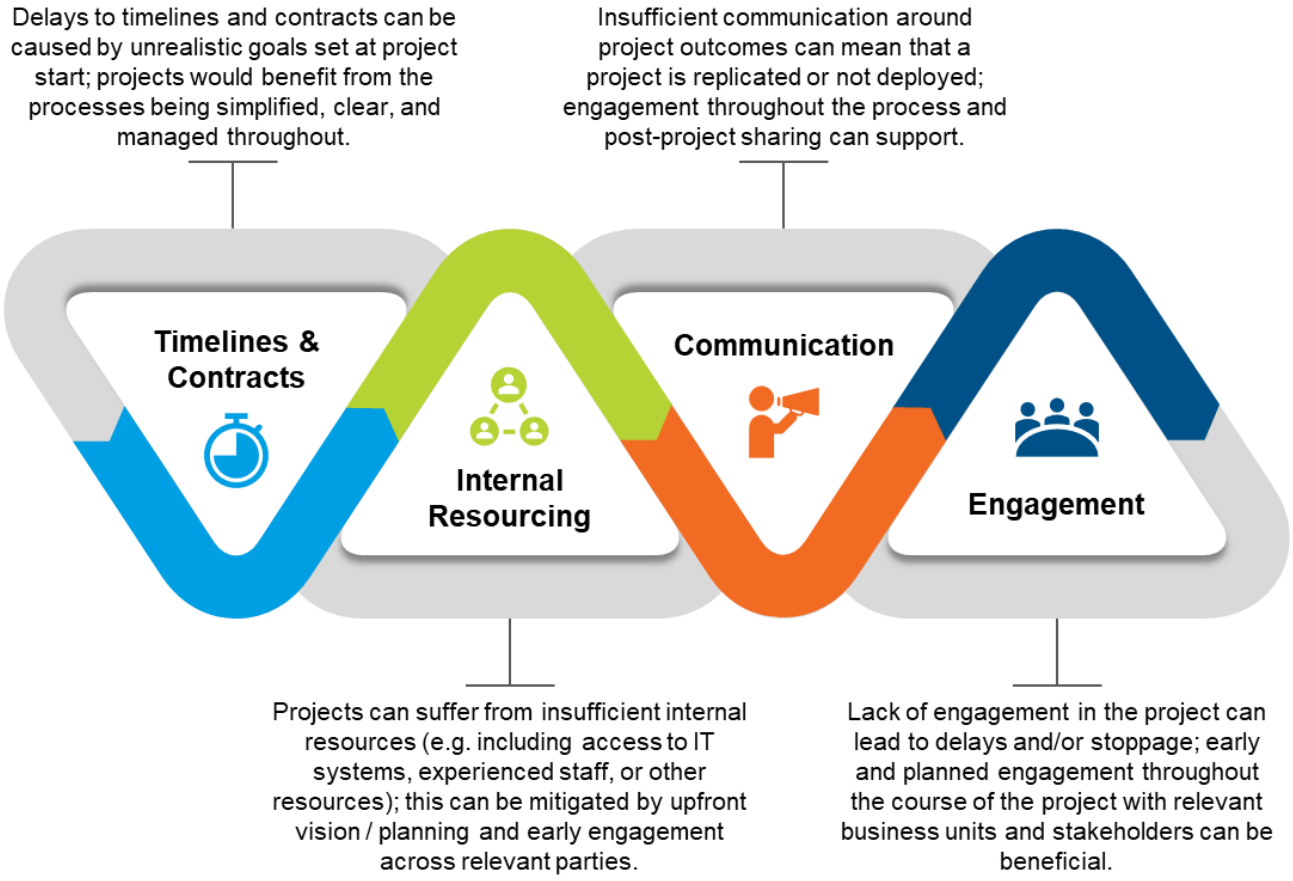


Figure 11. Risks to innovation

Once a project has closed, networks look to take the learnings into BAU which can bring its own set of challenges. In FY23 networks have integrated five additional projects into BAU, bringing the total over the regulatory period so far to seven. As networks are still in the early stages of RIIO-2 these numbers are aligned with the focus on idea generation and project rollout, with a focus on BAU deployment anticipated later in the period.

Reflecting on these challenges, networks noted (1) a resistance to change both within the business and in policy/regulatory space, (2) operational constraints delaying deployment (e.g. security process or needing to tender), and (3) limited (financial / operational / personnel) resources. Similar to the above challenges throughout the process, there is a need to communicate the value of innovation clearly throughout the project and across the business.

Suggestions for the future

In line with the above risks and challenges, networks have reflected on the key enablers and support needed for integrating the outcomes from innovation into BAU. Enablers centre around the value of communication and planning throughout a project. These include communication and engagement across their businesses, to make sure that all staff are invested in successful deployment. Making this communication effective requires a well-articulated analysis of benefits to show other parts of the business the value of proposed changes. This value can be further articulated through a "plan for deployment" which can be referred to throughout the project and alignment of innovation team strategy with the wider business strategy.

The networks have also identified support from industry stakeholders which would help in this process. Following on the focus on communication and internal buy-in, networks identified a need for a consistent methodology to account for non-financial project benefits. It is often difficult for networks to articulate the environmental and knowledge benefits of their innovation work and justify the ROI for these projects to both senior leadership and the wider energy industry. Led by the ENA, the networks have recently started a piece of work to develop a robust framework/model for measuring the social value created by GB energy networks. The ENA will also be looking to ensure future updates and improvements to the IMF feed in to and align with this piece of work.

Networks also felt that additional funding earmarked for deploying innovative work into BAU would help overcome the resourcing/policy/organisational practice hurdles to integrating the work into everyday operations. The specifics of deployment are often outside of the scope of innovation projects and networks struggle to quickly assemble the necessary resources. Additional policy support through relaxed licence obligations or the ability to use a more simplified/agile policy process also emerged as an important avenue to boost BAU deployment. The Regulatory Sandbox programme introduced by Ofgem is expected to help in this regard by enabling trials which traditional regulation may not have otherwise allowed.

Moving into the next financial year, networks look to continue the focus on collaboration that was evident in the programmes and projects this year. As the gas and transmission networks progress in RIIO-2 (and are joined by the electricity distribution network operators) the networks also expect to see an increase in projects which target the whole systems, data and digitalisation, vulnerability, and flexibility/market evolution themes. The past two years of RIIO-2 have built a strong foundation for continued innovation to support building the networks of the future.

Appendix I. Network overview

Energy Networks

As this report is focused on RIIO-2 funded innovation over FY23 (April 2022 to April 2023), its primarily focused on innovation projects led by the gas and transmission networks (in the second year of the RIIO-2 period). The electricity distribution networks are also featured in the case studies and projects linked throughout the report, but their projects will not be reflected in key reporting metrics (such as the balanced scorecard) until the FY24 report.

Each network has prepared an individual innovation summary for FY23 (linked in the table below) and the insights from these individual reports have been used to create this overarching summary report. The networks have also contributed to this report through engagement in workshops to scope the narrative and discuss challenges across network types.

Network Type	ENA Network Member
Electricity Distribution	NGED
	SPEN
	SSEN
	UKPN
	ENWL
	NPg
Electricity Transmission	NGESO
	NGET
	SPEN-T
	SSEN-T (SHET)
Gas Distribution	WWU
	NGN
	Cadent Gas
	SGN
Gas Transmission	NGT

About the ENA

The Energy Networks Association (ENA) represents the owners and operators of licenses for the transmission and/or distribution of energy in the UK and Ireland. ENA's overriding goals are to promote UK and Ireland energy networks ensuring the networks are the safest, most reliable, most efficient, and sustainable in the world. As the voice of the energy networks sector, the ENA acts as a strategic focus and channel of communication for the industry.

About ERM

This report was written by Environmental Resources Management (ERM) in partnership with the ENA and the energy networks. ERM is a leading sustainability consultancy focused on helping clients identify, manage, and exploit the innovation challenges and opportunities presented by the energy transition.

Appendix II. The innovation cycle

Every innovation project begins with an idea which is then advanced through the innovation cycle. In the first part of this cycle, a broad range of ideas are generated by networks and third parties and refined to make sure that they align with the network innovation themes and principles. At this stage, programmes like Basecamp are particularly valuable for advancing collaboration and making sure that a wide range of ideas reach the networks.

Any selected ideas are then developed in to funding proposals in collaboration with the networks to ensure that they align with the network-wide innovation goals as defined in the innovation strategy. Successful proposals will be funded, launched, and registered on the Smarter Networks Portal. This database tracks SIF, NIA, and NIC projects to ensure that any learnings from funded projects are made widely available to support other innovation.

Throughout project delivery, networks report intermediate outcomes to stakeholders and review that projects are still projected to deliver positive net benefits. At this stage, if projects are found to have greater-than-anticipated costs funding may be freed up ensure that innovation funding is used effectively to deliver the greatest possible benefit to consumers.

For projects which are delivered in full, the project close provides a valuable opportunity for knowledge sharing with both project stakeholders and the wider innovation community.

Depending on the project outcomes and the ultimate project goals the project findings can either be implemented (integrated in to BAU/everyday network function), or if additional work is needed to boost the technology readiness a new project can be scoped from the learnings.

Once a project or innovation is successfully integrated into BAU it delivers the full range of benefits projected in the funding proposal. However, this integration step can often be more difficult than anticipated as new technologies or processes may require additional regulatory approval. Networks continue to work with their regulatory partners to make sure that the benefits of innovation spending can be safely and reliably delivered to consumers.

Every other year this process is reviewed and updated by the ENA in the Energy Networks Innovation Process (ENIP) document which sets out a detailed overview of the innovation process for stakeholders looking to engage with networks on projects. This document provides further context and guidance on how ideas are transformed into projects.

Appendix III. FY23 Project List & Status

The following projects were active over FY23 as identified in the IMF and are organised according to their "primary strategy theme". An excel log of projects over the RIIO-2 period is available alongside this report.

	Year started	Network	Status	Reference number	Project name	Type	Project cost
Data and digitalisation	2022/23	NGESO	Complete	NIA2_NGESO019	Peak Demand Forecasting	NIA	£250,000
	2022/23	NGESO	Live	NIA2_NGESO0021	AI Centre of Excellence	NIA	£266,000
	2022/23	NGESO	Live	NIA2_NGESO022	BC Forecasting	NIA	£350,000
	2022/23	NGESO	Live	NIA2_NGESO028	Virtual Energy System – Common Framework Demonstrator	NIA	£534,904
	2022/23	NGESO	Live	NIA2_NGESO032	Course-correction Dispatch Instructor	NIA	£1,700,000
	2022/23	NGESO	Live	NIA2_NGESO046	STARTZ (Stability Requirements Calculation Toward Net-Zero)	NIA	£400,000
Flexibility and market evolution	2021/22	NGESO	Live	NIA2_NGESO005	Stability Market Design	NIA	£300,000
	2021/22	NGESO	Complete	10027180	Crowdflex: Discovery	SIF	£206,829
	2022/23	NGESO	Live	NIA2_NGESO015	FIC (Future of Interconnectors)	NIA	£400,000
	2022/23	NGESO	Live	NIA2_NGESO024	REVEAL	NIA	£400,000
	2022/23	NGESO	Live	NIA2_NGESO025	3MD (Market Monitoring Model Development)	NIA	£250,000
	2022/23	NGESO	Live	NIA2_NGESO029	DER Visibility	NIA	£100,000
	2022/23	NGESO	Live	NIA2_NGESO030	Enduring Cross-Border Balancing	NIA	£200,000
	2022/23	NGESO	Live	NIA2_NGESO031	Service Provider Capability Mapping	NIA	£250,000
	2022/23	NGESO	Live	NIA2_NGESO039	Future of the Transmission Network Charging Methodology	NIA	£500,000
	2022/23	SPEN-T	Live	NIA_SPEN_0071	A Holistic Intelligent Control System for flexible technologies (T2)	NIA	£1,200,000
	2021/22	SSEN-T	Live	10024879	Incentive - Discovery R1	SIF	£136,002
	2022/23	SSEN-T	Live	10037143	Incentive - Alpha R1	SIF	£495,408
Net Zero	2021/22	Cadent	Complete	NIA_CAD0073	Common future end states and transition pathways	NIA	£195,000
	2021/22	Cadent	Complete	NIA_CAD0075	HyNet – Management of Additional Sources of Hydrogen Supply	NIA	£50,000
	2021/22	Cadent	Complete	NIA_CAD0072	HyNET Homes - Understand phase (Technical)	NIA	£916,830

	Year started	Network	Status	Reference number	Project name	Type	Project cost
Net zero and the energy system transition	2021/22	Cadent	Complete	CAD_SIF001	Digital Platform for Leakage Analytics – Discovery Phase	SIF	£125,328
	2022/23	Cadent	Complete	CAD_SIF0002	Digital Platform for Leakage Analytics – Alpha Round 1	SIF	£495,134
	2022/23	Cadent	Live	NIA_CAD0079	Functional Specification: Hydrogen Blending Infrastructure	NIA	£160,366
	2022/23	Cadent	Complete	NIA_CAD0076	Hydrogen Blending: Functional Spec for Commercial Frameworks (Phase A)	NIA	£211,808
	2022/23	Cadent	Live	NIA_CAD0078	Exit Strategy Mechanism	NIA	£150,000
	2022/23	Cadent	Live	NIA_CAD0083	End User Behaviour – Impact on Safety	NIA	£285,303
	2022/23	Cadent	Live	NIA_CAD0081	Hydrogen Conversion Strategy - Pipework	NIA	£337,719
	2022/23	Cadent	Live	NIA_CAD0082	Use of Automatic Isolation Valve (AIV) Systems with Hydrogen – AIVs in LP and MP Services	NIA	£375,000
	2022/23	Cadent	Live	NIA_CAD0084	Implications of Hydrogen Purity	NIA	£475,000
	2022/23	Cadent	Complete	NIA_CAD0080	Hydrogen Village Safety Framework	NIA	£26,330
	2022/23	Cadent	Live	NIA_CAD0086	Hydrogen Village - Property Market Evaluation	NIA	£150,000
	2022/23	Cadent	Live	NIA_CAD0087	HyLights: Hydrogen Gas Lamp Feasibility	NIA	£20,000
	2021/22	NGESO	Live	NIA2_NGESO002	Solar PV Nowcasting	NIA	£500,000
	2021/22	NGESO	Live	NIA2_NGESO003	Probabilistic Machine Learning Solution for Dynamic Reserve Setting	NIA	£400,000
	2021/22	NGESO	Complete	NIA2_NGESO006	Resilient Electric Vehicle charging (REV)	NIA	£350,000
	2021/22	NGESO	Complete	NIA2_NGESO0014	A Common Framework for the Virtual Energy System	NIA	£350,000
	2021/22	NGESO	Live	NIA2_NGESO017	Probabilistic planning for stability constraints	NIA	£382,000
	2022/23	NGESO	Live	NIA2_NGESO027	Carbon Intensity Modelling	NIA	£205,000
	2022/23	NGESO	Live	NIA2_NGESO036	Hydrogen Production for Thermal Electricity Constraints Management	NIA	£520,000
	2022/23	NGESO	Live	NIA2_NGESO047	Distributed ReStart – Redhouse Live Trial	NIA	£500,000
	2022/23	NGESO	Complete	10037410	Crowdflex: Alpha	SIF	£606,196
	2021/22	NGET	Complete	10027585	SIF Discovery 2021 - NGET - Eye in the Sky	SIF	£119,105
	2021/22	NGET	Live	NIA2_NGET0003	Retrofitting Oil Source Heat Recovery to Transformers	NIA	£220,000

	Year started	Network	Status	Reference number	Project name	Type	Project cost
Net zero and the energy system transition	2021/22	NGET	Live	NIA2_NGET0006	Non-invasive In-situ Monitoring and Interpretation of SF6 Alternatives in GIS Equipment	NIA	£1,900,000
	2021/22	NGET	Live	NIA2_NGET0007	EPRI Research Collaboration on Electric & Magnetic Fields Health & Safety (P60) 2021-25	NIA	£1,886,480
	2021/22	NGET	Live	NIA2_NGET0011	Alternative Approaches to Tower Painting Preparation	NIA	£238,880
	2021/22	NGET	Live	NIA2_NGET0012	EPRI Research Collaboration on Underground Transmission (P36) 2021-2025	NIA	£2,063,000
	2022/23	NGET	Complete	NGET/Eye_in_the_Sky/SIFDataDigitalisation/Rd1_Alpha	SIF Alpha 2021 - NGET Eye in the Sky	SIF	£440,000
	2022/23	NGET	Live	NIA2_NGET0001	Impedance Scan Methods	NIA	£359,000
	2022/23	NGET	Live	NIA2_NGET0004	Centralised PAC	NIA	£1,325,796
	2022/23	NGET	Live	NIA2_NGET0009	Visual Inspection and Condition Assessment Platform for OHL Steelwork (VICAP)	NIA	£430,000
	2022/23	NGET	Live	NIA2_NGET0013	Overhead Line Sagging Monitoring Using 5G Signals	NIA	£350,000
	2022/23	NGET	Live	NIA2_NGET0014	Secure Edge Platform	NIA	£295,000
	2022/23	NGET	Live	NIA2_NGET0010	Non-intrusive Tower Foundation Inspections using UGW (NITFI)	NIA	£257,000
	2022/23	NGET	Live	NIA2_NGET0015	Fibre Health Monitoring	NIA	£712,000
	2022/23	NGET	Live	NIA2_NGET0016	Novel methods for sealing SF6 leaks	NIA	£1,100,000
	2022/23	NGET	Live	NIA2_NGET0017	System value from V2G peak reduction in future scenarios based on strategic transport and energy demand modelling	NIA	£881,503
	2022/23	NGET	Live	NIA2_NGET0020	Co-Simulation	NIA	£300,000
	2022/23	NGET	Live	NIA2_NGET0022	Switch Oil Markers	NIA	£95,000
	2022/23	NGET	Live	NIA2_NGET0024	Insulating Dielectrics: Esters & Alternative Liquids	NIA	£700,000
	2022/23	NGET	Live	NIA2_NGET0026	Energy water nexus	NIA	£667,543
	2022/23	NGET	Live	NIA2_NGET0028	Identification and quantification of C4F7N gas arcing by-products and their implication for GIS operation	NIA	£1,770,000

	Year started	Network	Status	Reference number	Project name	Type	Project cost
Net zero and the energy system transition	2022/23	NGET	Live	NIA2_NGET0032	Swarfless Cut Isolation System for SF6 Outages and Repairs (SCISSORs)	NIA	£280,000
	2022/23	NGET	Live	NIA2_NGET027	Enhance Power Flow Control Capability of GB Network	NIA	£590,000
	2021/22	NGN	Complete	NIA_NGN_302	H21 - Wider Impacts of Hydrogen	NIA	£161,136
	2021/22	NGN	Live	NIA_NGN_301	H21 - Failure modes and permeation testing of PE	NIA	£287,556
	2021/22	NGN	Live	10027276	SIF Discovery 2021 - NGN - Thermal Imagery Analysis	SIF	£78,182
	2022/23	NGN	Complete	NIA_NGN_414	HVT Legislative and Regulatory Analysis	NIA	£496,000
	2022/23	NGN	Live	NGNG_NIA_346	H21 ATEX Equipment and SR/25 Impact Assessment	NIA	£380,000
	2022/23	NGN	Live	NGN_NIA_344	H21 Ignition Consequence Research	NIA	£356,030
	2021/22	NGT	Live	NIA_NGGT0172	Risk Assessment Methodologies for Pipelines & AGIs 2021-2026	NIA	£383,692
	2021/22	NGT	Complete	NIA_NGGT0176	Hydrogen Fuel Gas for NTS Compressors	NIA	£711,631
	2021/22	NGT	Complete	NIA_NGGT0156	Hydrogen Deblending Feasibility Phase 2	NIA	£618,209
	2021/22	NGT	Complete	NIA_NGGT0178	Collaborative Visual Data Twin - Phase 1	NIA	£750,445
	2021/22	NGT	Live	NIA_NGGT0180	NTS Materials Testing to Enable Hydrogen Injection in High Pressure Pipelines	NIA	£1,026,641
	2021/22	NGT	Live	NIA_NGGT0182	Multifunctional Graphene Coatings for Pipeline Protection	NIA	£820,000
	2021/22	NGT	Live	NIA_NGGT0183	Inhibition of Hydrogen Embrittlement Effects in Pipeline Steels	NIA	£664,873
	2021/22	NGT	Complete	NIA_NGGT0184	Gas and Electricity Transmission Infrastructure Outlook	NIA	£312,500
	2021/22	NGT	Complete	NIA_NGGT0188	Variable hydrogen blend compression	NIA	£131,250
	2021/22	NGT	Complete	10020605	SIF Discovery R1 - HyNTS Deblending	SIF	£146,545
	2021/22	NGT	Complete	10020609	SIF Discovery R1 - CH4RGE - Emissions Capture	SIF	£144,782
	2021/22	NGT	Complete	10020620	SIF Discovery R1 - Gas Network Interoperable Digital Twin	SIF	£78,779
	2021/22	NGT	Complete	10020622	SIF Discovery R1 - HyNTS Pipeline DataSet	SIF	£95,571

	Year started	Network	Status	Reference number	Project name	Type	Project cost
Net zero and the energy system transition	2021/22	NGT	Complete	10021808	SIF Discovery R1 - Gas Analyser Systems for Hydrogen Blends	SIF	£113,415
	2021/22	NGT	Complete	10022352	SIF Discovery R1 - NGM Hydrogen Metering	SIF	£86,378
	2021/22	NGT	Complete	10022648	SIF Discovery R1 - Hydrogen Barrier Coatings for Gas Network Assets	SIF	£74,706
	2021/22	NGT	Complete	10023216	SIF Discovery R1 - Green Hydrogen Injection into the NTS	SIF	£114,651
	2021/22	NGT	Complete	10023632	SIF Discovery R1 - HyNTS Compression	SIF	£155,333
	2021/22	NGT	Complete	10024392	SIF Discovery R1 - Nuclear Net Zero Opportunities (N-NZO)	SIF	£107,495
	2022/23	NGT	Live	NIA_NGGT0185	NSIB Hydrogen Skills & Competencies	NIA	£410,168
	2022/23	NGT	Complete	NIA_NGGT0192	New Pipeline AI Route Planning	NIA	£66,875
	2022/23	NGT	Complete	NIA_NGGT0194	Impact of Hydrogen on Polymer Materials	NIA	£58,000
	2022/23	NGT	Complete	10036949	SIF Alpha R1 - HyNTS Compression	SIF	£559,035
	2022/23	NGT	Complete	10036950	SIF Alpha R1 - HyNTS Deblending for Transport Applications	SIF	£389,298
	2022/23	NGT	Complete	10036952	SIF Alpha R1 - HyNTS Pipeline Data Set	SIF	£632,759
	2022/23	NGT	Complete	10036954	SIF Alpha R1 - HyNTS Protection	SIF	£531,041
	2022/23	NGT	Live	NIA_NGGT0191	Hydrogen Impact on NTS CP & External Coatings Performance	NIA	£73,133
	2022/23	NGT	Live	NIA_NGGT0189	HyNTS Defect Fatigue Behaviour	NIA	£70,000
	2022/23	NGT	Live	NIA_NGGT0197	Hydrogen Production Technology for Use on the NTS	NIA	£256,000
	2022/23	NGT	Live	NIA_NGGT0186	Assessment of Legacy Gas Pipeline Steels to Hydrogen Embrittlement Effect	NIA	£114,511
	2022/23	NGT	Live	NIA_NGGT0196	Fire & Gas Detection and Suppression - Hydrogen	NIA	£88,449
	2022/23	NGT	Live	NIA_NGGT0187	Precision Thermography	NIA	£207,725
	2022/23	NGT	Live	NIA_NGGT0202	Technical and commercial impact of high pressure carbon transportation	NIA	£393,333
	2022/23	NGT	Live	NIA_NGGT0198	Dynamic Risk Based Patrolling	NIA	£172,504
	2022/23	NGT	Live	NIA_NGGT0200	Identification of NTS Opportunities in the Transport Sector	NIA	£260,760
	2022/23	NGT	Live	NIA_NGGT0206	5% Hydrogen FutureGrid Testing	NIA	£344,469

	Year started	Network	Status	Reference number	Project name	Type	Project cost
Net zero and the energy system transition	2022/23	NGT	Live	NIA_NGGT0203	Impact of Hydrogen and Hydrogen Blends on Linepack	NIA	£195,280
	2022/23	NGT	Live	NIA_NGGT0205	Safe Venting & Recompression of Hydrogen	NIA	£518,653
	2022/23	NGT	Live	NIA_NGGT0201	HyNTS Variable Gas Blend Measurement System Development - Phase 1	NIA	£90,035
	2022/23	NGT	Live	NIA_NGGT0195	Multiple Gas Detection	NIA	£378,738
	2022/23	NGT	Live	NIA_NGGT0208	Common Planning Pathways	NIA	£308,661
	2021/22	SGN	Live	NIA2_SGN0005	Data Sharing Protocols	NIA	£20,000
	2021/22	SGN	Live	NIA2_SGN0002	Energy Storage Strategy	NIA	£119,997
	2021/22	SGN	Live	NIA2_SGN0016	Glenmavis Masterplan Options Appraisal	NIA	£49,000
	2021/22	SGN	Live	NIA2_SGN0001	Grangemouth to Granton LTS Futures	NIA	£533,200
	2021/22	SGN	Live	NIA2_SGN0018	Hydrogen Entry Unit Design	NIA	£350,000
	2021/22	SGN	Live	NIA2_SGN0008	HyPurge	NIA	£310,926
	2021/22	SGN	Live	NIA2_SGN0006	Industrial & Commercial Plant Hydrogen Sensitivity Assessment	NIA	£86,665
	2021/22	SGN	Live	NIA2_SGN0011	Levenmouth Wastewater Treatment Works	NIA	£230,000
	2021/22	SGN	Live	NIA2_SGN0013	Long Term, Large Scale Hydrogen Storage Database	NIA	£168,000
	2021/22	SGN	Live	NIA2_SGN0007	North East Scotland Pre-FEED	NIA	£1,018,810
	2021/22	SGN	Live	NIA2_SGN0004	Phoenix IIoT Demonstrator	NIA	£423,978
	2021/22	SGN	Live	NIA2_SGN0012	Recommissioning Grangemouth to Granton	NIA	£226,334
	2021/22	SGN	Live	10025731	Digital Twins: Exploring the commercial, societal and operational benefits on green hydrogen projects	SIF	£124,265
	2021/22	SGN	Live	10027059	Digital Twin - Exploring the societal, operational, and cross industry whole system benefits on the Gas Distribution Network	SIF	£119,127
	2021/22	SGN	Live	10027183	Intelligent Gas Grid	SIF	£116,401
	2021/22	SGN	Live	10027191	Predictive Safety Interventions	SIF	£58,729
	2021/22	SGN	Live	NIA2_SGN0014	Technical assessment and feasibility study into water requirements for hydrogen production	NIA	£124,410

	Year started	Network	Status	Reference number	Project name	Type	Project cost
Net zero and the energy system transition	2021/22	SGN	Live	NIA2_SGN0015	Servitudes and Easements	NIA	£80,000
	2021/22	SGN	Live	10027185	Velocity Design with Hydrogen	SIF	£55,543
	2022/23	SGN	Live	NIA2_SGN0017	Bio CNG – SIU Feasibility Study	NIA	£36,750
	2022/23	SGN	Live	NIA2_SGN0003	H100 'town' Expansion-Storage Solution: Balgonie Feasibility Study	NIA	£333,333
	2022/23	SGN	Complete	NIA2_SGN0009	H100 Fife Phase 2 Village Pre-FEED	NIA	£750,000
	2022/23	SGN	Live	NIA2_SGN0022	H100 Specific Fire & Risks	NIA	£231,825
	2022/23	SGN	Live	NIA2_SGN0023	Hydrogen MOBS Data Analysis Phase 1	NIA	£35,400
	2022/23	SGN	Live	NIA2_SGN0021	Hydrogen Navigator	NIA	£350,000
	2022/23	SGN	Complete	NIA2_SGN0010	HyScale Academic Review	NIA	£258,152
	2022/23	SGN	Live	NIA2_SGN0024	HyScale LOHC Phase 2 Project	NIA	£633,584
	2022/23	SGN	Live	NIA2_SGN0020	Leakage Management in the Energy System Transition	NIA	£99,317
	2022/23	SGN	Live	NIA2_SGN0019	Retrofit Excess Flow Valves (EFVs)	NIA	£226,660
	2022/23	SGN	Live	10036957	Gas System of the Future Digital Twin	SIF	£847,123
	2022/23	SGN	Live	10037416	Intelligent Gas Grid - Alpha	SIF	£601,426
	2022/23	SGN	Live	10037420	Predictive Safety Interventions - Alpha	SIF	£498,618
	2022/23	SGN	Live	10037659	Velocity Design with Hydrogen – Alpha	SIF	£513,689
	2022/23	SGN	Live	NIA2_SGN0025	Interventions for Hydrogen by Asset Group	NIA	£276,547
	2022/23	SGN	Live	NIA2_SGN0026	Hydrogen Village Trial Hydrogen Appliance Supply Chain	NIA	£263,993
	2022/23	SGN	Live	NIA2_SGN0029	SR25 Calculator update	NIA	£47,600
	2022/23	SGN	Live	NIA2_SGN0028	Hypurge Safe Tooling	NIA	£62,260
	2022/23	SGN	Live	NIA2_SGN0027	Ignition Probability in Small Services	NIA	£93,700
	2022/23	SGN	Live	NIA2_SGN0030	HyCompact Laboratory Testing	NIA	£133,333
	2022/23	SGN	Live	SGN_EFFU0038	H2London Feasibility Study	NIA	£393,000
	2022/23	SGN	Live	NIA2_SGN0033	Hydrogen MOBS Asset Information Review Phase 2	NIA	£202,213
	2022/23	SGN	Live	NIA2_SGN0034	High Volume Gas Escapes Tool – update for hydrogen	NIA	£14,930
	2022/23	SGN	Live	NIA2_SGN0036	BISEP - H2 Testing with LTS Futures (Phase 1)	NIA	£176,773

	Year started	Network	Status	Reference number	Project name	Type	Project cost
Net zero and the energy system transition	2021/22	SPEN-T	Live	NIA_SPEN_0062	Dynaload	NIA	£200,000
	2021/22	SPEN-T	Complete	10025738	A Holistic Hydrogen Approach to Heavy Duty Transport (H2H)	SIF	£139,341
	2021/22	SPEN-T	Complete	10025479	Resilient and Flexible Railway Multi-Energy	SIF	£151,938
	2021/22	SPEN-T	Complete	10025661	Flexible Heat	SIF	£153,175
	2021/22	SPEN-T	Complete	10025662	Heat Balance	SIF	£139,662
	2021/22	SPEN-T	Complete	10025653	Asset Reuse and Recovery Collaboration (ARRC)	SIF	£99,279
	2021/22	SPEN-T	Complete	10025660	Fast Flex	SIF	£129,908
	2021/22	SPEN-T	Live	NIA_SPEN_0077	Truly Sustainable D&T Substations	NIA	£130,000
	2022/23	SPEN-T	Complete	10037453	A Holistic Hydrogen Approach to Heavy Duty Transport (H2H) - Alpha	SIF	£449,783
	2022/23	SPEN-T	Complete	10037467	Heat Balance - Alpha	SIF	£543,462
	2021/22	SSEN-T	Live	NIA_SHET_0033	NIA_SHET_0033 Protection Solutions to Perform for Lower Levels of Fault Current on AC Networks (PSL-FC)	NIA	£671,000
	2021/22	SSEN-T	Live	NIA_SHET_0034	NIA_SHET_0034 Low Profile 132kV Steel Poles	NIA	£1,650,000
	2021/22	SSEN-T	Live	NIA_SHET_0037	NIA_SHET_0037 Probabilistic Modelling for Connection Studies	NIA	£400,000
	2022/23	SSEN-T	Live	NIA_SHET_0035	NIA_SHET_0035 TOTEM (Transmission Owner Tools for EMT Modelling) Extension	NIA	£400,000
	2022/23	SSEN-T	Live	NIA_SHET_0036	NIA_SHET_0036 Condition Assessment of SF6 Alternatives	NIA	£700,000
	2021/22	WWU	Complete	NIA_WWU_2_02	Regional decarbonisation pathways	NIA	£424,891
	2021/22	WWU	Complete	NIA_WWU_2_01	SWIC Hydrogen Supply Pipeline Infrastructure	NIA	£150,000
	2021/22	WWU	Complete	NIA_WWU_2_03	SWIC Market-Accelerating Hydrogen Distribution and Storage	NIA	£70,000
	2021/22	WWU	Complete	NIA_WWU_2_07	SWIC: Assessment of potential hydrogen demand in 2030 - 2050	NIA	£50,000
	2021/22	WWU	Live	NIA_WWU_2_04	Tools of Engagement Phase 2	NIA	£44,805
	2022/23	WWU	Complete	NIA_WWU_2_08	GD2-1 SWIC - Hydrogen Peaking Plant Feasibility Study	NIA	£50,000
	2022/23	WWU	Complete	NIA_WWU_2_09	GD2-17 Industrial Fuel Switching Phase One	NIA	£46,480

	Year started	Network	Status	Reference number	Project name	Type	Project cost
Net zero and the energy system transition	2022/23	WWU	Complete	NIA_WWU_2_10	Potential for Salt cavern storage of hydrogen in and near South Wales GD2-33	NIA	£190,000
	2022/23	WWU	Complete	NIA_WWU_2_16	Hydrogen for Industrial Estate Heating GD2-68	NIA	£47,706
	2022/23	WWU	Live	NIA_WWU_2_12	EUSE - Ventilation Within Buildings GD2-20	NIA	£160,000
	2022/23	WWU	Complete	NIA_WWU_2_13	EUSE – Hazardous Areas Within Buildings GD2-21	NIA	£24,000
	2022/23	WWU	Live	NIA_WWU_02_14	Hydrogen for Aviation across the Western Gateway GD2-34	NIA	£120,913
	2022/23	WWU	Live	NIA_WWU_2_17	Lessons from the Past: What can we learn from past energy transitions in the Gas Industry GD2-59	NIA	£59,000
	2022/23	WWU	Live	NIA_WWU_02_15	Hydrogen Village Regulation Project - GD2-58	NIA	£197,120
	2022/23	WWU	Live	NIA_WWU_2_19	Integrated Hydrogen Hubs- GD2-09	NIA	£50,000
Optimised assets and practices	2021/22	NGESO	Live	NIA2_NGESO009	D3 - Data-Driven Power System Model Development for Control Interaction Studies	NIA	£300,000
	2021/22	NGESO	Complete	NIA2_NGESO0013	Advanced Dispatch Optimisation	NIA	£750,000
	2021/22	NGESO	Complete	10026595	Virtual Energy System	SIF	£149,929
	2022/23	NGESO	Live	NIA2_NGESO012	COMMANDER – Coordinated Operational Methodology for Managing and Accessing Network Distributed Energy Resources	NIA	£475,000
	2022/23	NGESO	Live	NIA2_NGESO018	Automated Identification of Sub-Synchronous Oscillations (SSO) Events	NIA	£450,000
	2022/23	NGESO	Live	NIA2_NGESO020	Strength to Connect	NIA	£350,000
	2022/23	NGESO	Live	NIA2_NGESO023	Inertia Measurement Method Optimisation	NIA	£371,000
	2022/23	NGESO	Live	NIA2_NGESO033	Co-optimisation of Energy and Frequency-containment Services	NIA	£469,000
	2022/23	NGESO	Live	NIA2_NGESO040	DETECTS II	NIA	£150,000
	2022/23	NGESO	Live	NIA2_NGES042	Revamp Interconnector Ramping Arrangements (RIRA)	NIA	£300,000
	2021/22	NGET	Live	NIA2_NGET0008	EPRI Substations (P37) and Analytics (P34) 2021-2025	NIA	£2,470,000
	2021/22	NGET	Complete	10027503	SIF Discovery 2021 - NGET - SEGIL	SIF	£133,814
	2022/23	NGET	Live	NIA2_NGET0005	Environmental Risk and Assurance (ERA)	NIA	£455,314

	Year started	Network	Status	Reference number	Project name	Type	Project cost
Optimised assets and practices	2022/23	NGET	Live	NIA2_NGET0018	Autonomous Aerial, Thermal Inspections of Substations	NIA	£572,000
	2022/23	NGET	Live	NIA2_NGET0019	Aerial E-field Inspection System for Live Overhead Transmission Assets	NIA	£1,181,000
	2022/23	NGET	Live	NIA2_NGET0021	New online tools for Assessment of Bushing Condition	NIA	£400,000
	2022/23	NGET	Live	NIA2_NGET0023	Cable Alternative Cooling Technologies for Underground Systems (CACTUS)	NIA	£517,000
	2022/23	NGET	Live	NIA2_NGET0025	Wide Area Control Framework	NIA	£225,000
	2022/23	NGN	Complete	10037368	Thermal Imagery Analysis (Rd1 Alpha)	SIF	£525,075
	2022/23	NGN	Complete	NIA_NGN_407	Asset Data Intelligence (Data Quality AI)	NIA	£205,906
	2021/22	SPEN-T	Complete	10025639	Digi-GIFT	SIF	£141,657
	2021/22	SPEN-T	Complete	10025651	EN-TWIN-e	SIF	£161,043
	2021/22	SPEN-T	Complete	10025656	Predict4Resilience	SIF	£133,368
	2022/23	SPEN-T	Live	NIA_SPEN_0073	Transmission OHL Crossing Protection Stage 1 (T2)	NIA	£80,000
	2022/23	SPEN-T	Live	NIA_SPEN_0074	Project Conan (T2)	NIA	£365,000
	2022/23	SPEN-T	Live	NIA_SPEN_0075	Landslide Protection Asset (T2)	NIA	£210,000
	2022/23	SPEN-T	Live	NIA_SPEN_0064	CyberSAFEN	NIA	£487,000
	2022/23	SPEN-T	Complete	10037451	Predict4Resilience (P4R) - Alpha	SIF	£617,235
	2022/23	SPEN-T	Live	NIA_SPEN_0081	Innovative Monitoring of GIS Cable Terminations	NIA	£400,000
	2021/22	SSEN-T	Live	10020514	NIMBUS - Discovery R1	SIF	£148,435
	2022/23	SSEN-T	Live	NIA_SHET_0038	NIA_SHET_0038 Ice Mapping (RIME)	NIA	£360,000
	2022/23	SSEN-T	Live	NIA_SHET_0039	NIA_SHET_0039 OHL Foundation Uplift	NIA	£176,000
	2022/23	SSEN-T	Live	NIA_SHET_0040	NIA_SHET_0040 Corrosion Mapping	NIA	£300,000
Supporting consumers in vulnerable situations	2022/23	Cadent	Live	NIA_CAD0085	Easy Assist Remote Actuation	NIA	£578,082
	2022/23	Cadent	Live	NIA_CAD0077	Low Power Hot Water	NIA	£180,000
	2022/23	Cadent	Live	NIA_CAD0088	Digital Exclusion	NIA	£92,887
	2021/22	NGN	Live	NIA_NGN_357	Community Resilience	NIA	£66,493
	2021/22	NGN	Complete	NIA_NGN_338	Street Score 2	NIA	£235,100

	Year started	Network	Status	Reference number	Project name	Type	Project cost
Supporting consumers in vulnerable situations	2021/22	NGN	Complete	NIA_NGN_300	Customer Vulnerability Mapping Tool	SIF	£104,666
	2022/23	NGN	Complete	NIA_NGN_415	Supporting Vulnerable Customers in Power Cuts	NIA	£48,500
	2022/23	NGN	Complete	NIA_NGN_334	Improving Carbon Monoxide Awareness	NIA	£130,649
	2022/23	NGN	Live	NIA_NGN_359	Project Helix	NIA	£100,100
	2022/23	SGN	Live	NIA2_SGN0031	TapSOS – Digitalisation of the emergency number – Phase 1	NIA	£96,000
	2022/23	SGN	Live	NIA2_SGN0035	Orbital Eye	NIA	£197,645
	2021/22	WWU	Complete	NIA_WWU_2_05	Safely switching vulnerable consumers to hydrogen	NIA	£104,700
Whole energy system	2022/23	NGESO	Live	NIA2_NGESO026	Consumer Building Blocks	NIA	£300,000
	2022/23	NGESO	Live	NIA2_NGESO038	Whole Energy System Network Planning Review	NIA	£100,000
	2021/22	NGET	Complete	10027601	SCADENT - Super Conductor Applications for Dense Energy Transmission	SIF	£148,437
	2022/23	NGET	Live	NIA2_NGET0002	Role and value of electrolysers in low-carbon GB energy system	NIA	£323,739
	2022/23	NGET	Complete	NGET/SCADENT/SIFWholeSystem/Rd1_Alpha	SCADENT - Super Conductor Applications for Dense Energy Transmission	SIF	£499,097
	2021/22	NGN	Live	NIA_NGN_345	Customer Energy Village: Energy Efficiency	NIA	£2,637,866
	2021/22	NGN	Live	NIA_NGN_303	IoT Pressure Sensor Pilot	NIA	£779,350
	2021/22	SGN	Live	10027575	NAVIGATION	SIF	£149,725
	2022/23	SPEN-T	Live	NIA_SPEN_0072	Project Synthesis – Effective Regional Inertia Monitoring and Automatic Control with a Whole System Approach (T2)	NIA	£350,000
	2021/22	SSEN-T	Live	10020383	Network DC - Discovery R1	SIF	£142,288
	2022/23	SSEN-T	Live	10036946	Network DC - Alpha R1	SIF	£491,905
	2021/22	WWU	Complete	SIF_WWU_2_01	HyPark	SIF	£150,000

Appendix IV. Future Project Log

The following ideas from the IMF "Idea log" have been reviewed by the networks over FY23 with some launching in FY23 and others set to launch in the coming years. The entries come from the IMF "Idea log" which tracks innovative ideas reviewed by the networks. These are the ideas logged in FY23 which have been marked as "project developed". A name matching has been used to remove ideas which have already been logged as projects in the above project log.

Network	Idea name	Idea origin	Funding
Cadent	EasyKey	External	NIA
Cadent	Low Power Heat	External	NIA
Cadent	Homeshield	External	NIA
Cadent	Hydrogen Village Safety Framework	Internal	NIA
Cadent	HVT Appliance Development Business Case	Internal	NIA
Cadent	Hydrogen Technical and Safety Case for Domestic heating	Internal	NIA
NGET	Grid Forming Converter Modelling and Stability	External	NIA
NGET	Voltage Interaction and Thermal Dynamics of Tertiary Connection (VITDTC)	External	NIA
NGET	Impact of nuclear co-generation on the electricity system	Internal	NIA
NGET	DELIVER - Digital-Twin Enabled Innovation for Energy Network Restoration	Internal	NIA
NGET	Characterisation of batteries and DC supplies in substation low voltage systems	External	NIA
NGET	Network Intelligence through Probabilistic Risk Assessment Methodology (NIPRAM)to improve electricity system restoration	Internal	NIA
NGET	Surge Arrestors Health Assessment by monitoring partial discharge (SAHARA)	Internal	NIA
NGET	CrystalClear	Internal	NIA
NGET	TRC5	External	NIA
NGET	Transition to Sustainable Automated foundation Construction	External	NIA
NGN	GIS Mapping for Hydrogen	External	NIA
NGN	Excess Gas Turbine	External	NIA
NGN	Supporting Vulnerable Customer in Power Cuts	External	NIA
NGN	Domestic Hydrogen Detection	External	NIA
NGN	Nuron Network Diversification & Resilience	External	NIA
NGN	CEV- Valliant Terraces	External	NIA
NGN	Thermal Imagery Analysis (Rd1 Beta)	Internal	SIF
NGN	Energy System of the Future Digital Twin (Rd1 Beta)	External	SIF
NGN	Intelligent Gas Grid (Rd 1 Beta)	External	SIF
NGN	Predictive Safety Interventions-FLYD (Rd1 Beta)	External	SIF
NGN	Digital Platform for Leakage Analytics (Rd1 Beta)	External	SIF
NGN	Velocity Design with Hydrogen (Rd1 Beta)	External	SIF
NGN	HyNTS Deblending for Transport (Rd1 Beta)	External	SIF
NGN	HyNTS Compression (Rd1 Beta)	External	SIF
NGT	Asset database management	Internal	NIA
NGT	Future Energy Scenarios updates with hydrogen	Internal	NIA
NGT	Hydrogen Fuel Gas for GTs emissions impact	External	NIA
NGT	PMC Hydrogen Stopple Trial at Spadeadam	Internal	NIA
NGT	Probabilistic Forecasting	Internal	NIA
NGT	SIF_2022_Hydrogen Storage in Pipelines	External	SIF
NGT	SIF_2022_Preparing for a net zero power system	Internal	SIF
NGT	Worst case impact for 100% hydrogen	Internal	NIA
SPEN-T	BLADE - Discovery Stage	External	SIF
SPEN-T	Blackhill Cable Termination Monitoring	Internal	NIA
SPEN-T	Truly Sustainable Distribution and Transmission Substation - Infinite Zero Substation	Internal	NIA
SSEN-T	SIF R1 A Network Direct Current	Internal	SIF
SSEN-T	SIF R1 A ARRC - Asset Reuse & Recovery Collaboration in partnership with lead TO	Internal	SIF

Network	Idea name	Idea origin	Funding
SSEN-T	SIF R1 A Innovative Control and Energy Storage for Ancillary Services in Offshore Wind - INCENTIVE	Internal	SIF
SSEN-T	SIF R1 A Green Hydrogen Injection into the NTS - in partnership with lead TO	Internal	SIF
SSEN-T	Nimbus	Internal	SIF
SSEN-T	Pollution On Insulators Caused by proximity to Rubbish Disposal Sites	Internal	NIA
WWU	Industrial Fuel Switching (IFS2)	Internal	NIA
WWU	Hydrogen Village Regulation (South Cornelly)	Internal	NIA
WWU	Lessons from the Past: What can we learn from past energy transitions in the Gas Industry	External	NIA
WWU	Hydrogen for Industrial Estate Heating (HIROC)	External	NIA
WWU	NextGen Electrolysis Discovery	External	SIF
WWU	Integrated Hydrogen Transport Hubs Discovery	External	SIF
WWU	European Hydrogen Distribution Insights	External	NIA
WWU	ATEX Equipment and SR/25 Impact Assessment	External	NIA
WWU	NSIB Skills & Competencies	External	NIA
WWU	Legislative and Regulatory Analysis	External	NIA
WWU	Domestic Hydrogen Sensor Research	External	NIA
NGESO	Alternative baselining	Internal	NIA
NGESO	SIF - Scenario for Extreme Events	Internal	SIF
NGESO	MinGFM	External	NIA
NGESO	Real-time Modelling of IBRs	External	NIA
NGESO	Exploring the economic benefits of co-optimising procurement of energy, response and reserve	Internal	NIA
NGESO	XMU Data	Internal	NIA
NGESO	Enhanced RMS (e-RMS) models for stability assurance	External	NIA
NGESO	Real-time predictions	Internal	NIA
NGESO	SIF - Powering Wales Renewably	External	SIF
NGESO	Electrification of the residential heat sector: Spatial and temporal analysis of electricity consumption and flexibility	External	SIF
NGESO	Quantifying the need for Within-Day Flexibility	Internal	NIA
NGESO	Hydrogen-based multi-time scale frequency support and constraint management in low inertia systems (HY-LOW)	External	NIA
NGESO	GB Inertia Forecasting	Internal	NIA
NGESO	Demand Inertia	Internal	NIA
NGESO	Reactive Demand Trends	Internal	NIA
NGESO	Transient Stability Assessment of GB Power System based on Real-Time Phasor-EMT Simulations	External	NIA
NGESO	LOCATER (Real time marginal emissions for the VirtualES)	External	NIA
NGESO	Demand Flexibility Service Analysis	Internal	NIA
NGESO	Forecasting the Risk of Constraints	External	NIA
NGESO	Data-Driven Online Monitoring and Early Warning For GB System Stability (DOME)	External	NIA
NGESO	Practical Transition into wider EMT GB Modelling	External	NIA
NGESO	Network Topology Optimisation	Internal	NIA
NGESO	Paperless office	Internal	NIA
NGESO	Virtual ES: Common framework demonstrator	Internal	NIA
NGESO	System Restoration Exploration and Adaptation of the existing Modelling platform (STREAM)	Internal	NIA
NGESO	Service Capability Mapping	Internal	NIA
NGESO	Model-driven Strategy for Balancing Optimisation (MSBO)	External	NIA
NGESO	Course correction Dispatch Instructor	External	NIA
SGN	Specific Fire & Risks	Internal	NIA

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