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Energy Networks Annual Innovation Report 2024

DOCUMENT CONTROL

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1	26/08/2024	Innovation Group	First draft of the report to be reviewed by the wider ISG.
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3	27/09/2024	Innovation Group	Final draft of the report to be signed-off by the wider ISG.

Related documents

Reference 1	FY23 ENA Annual Innovation Summary Report
Reference 2	ENA Energy Networks Innovation Strategy 2024 & Energy Innovation Atlas
Reference 3	ENA Smarter Networks Portal

Change history

Version	Change reference	Description
1	1st draft	Draft content based on agreed (with ISG subgroup) sections, projects, and narrative.
2	2nd draft	Revised draft based on feedback from wider ISG via 1st draft review period.
3	Final draft	Final draft including edits based on feedback from wider ISG via 2nd draft review period.

Distribution

ENA Annual Innovation Summary Report

Report Highlights

The energy networks 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. These networks can be categorised in two main types: transmission networks and distribution networks.

Transmission networks are high-voltage electricity and high-pressure gas networks which transport energy over long distances from generation sources to regional distribution networks. They form the backbone of the national energy system. Distribution networks on the other hand are lower-voltage electricity and lower-pressure gas networks which distribute energy from the transmission networks to end consumers, including homes and businesses. These operate at a regional level. Both electricity and gas have separate transmission and distribution networks each playing a crucial role in the overall energy system.

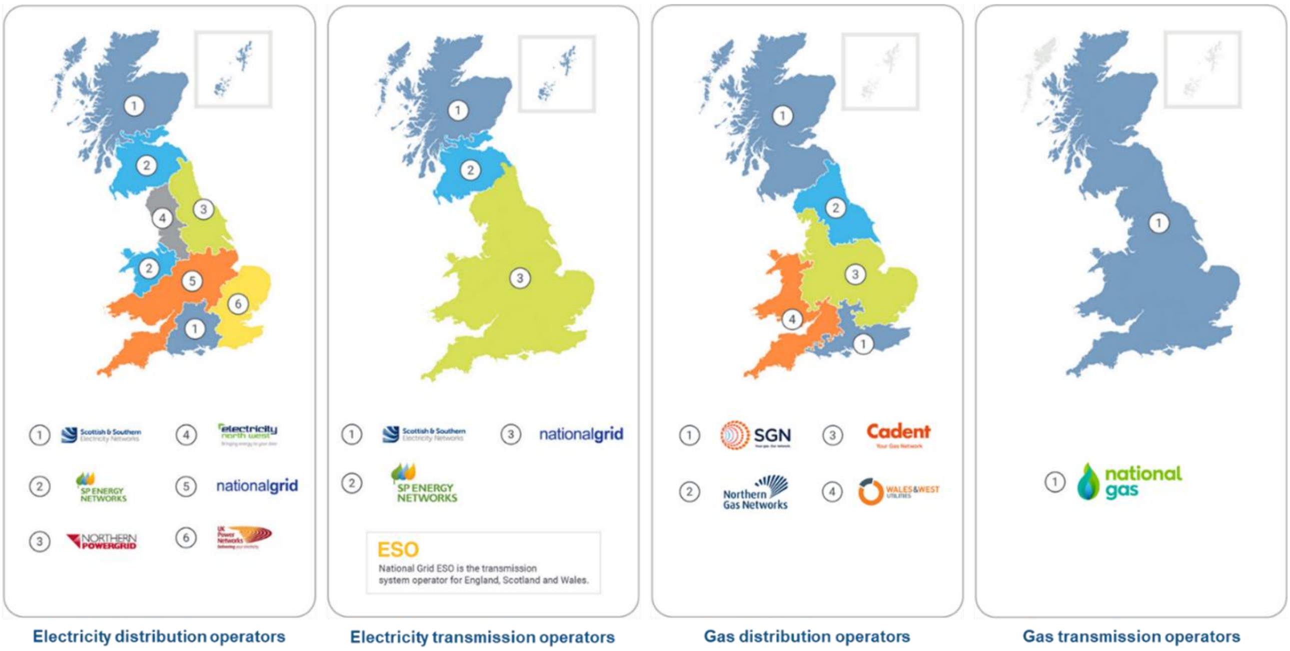


Figure 1. Network operators in Great Britain

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 FY24 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. This report is focused on the third year in Ofgem's RIIO-2 price control (i.e. the financial year of 2023-2024 within the overall 2021-2028 price control period).

The aim of this report is to highlight key trends, case studies, and progress against the shared strategic themes as networks move through the RIIO-2 price control period. Separately, information on projects funded through the RIIO-2 price control is captured and supplied 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 (note that this information can usually be sourced back to the Smarter Networks Portal as the central repository for regulation-funded innovation projects).

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 FY24. While the report does also reference Network Innovation Competition (NIC) projects which are live in FY24 (in addition to NIA and SIF projects), the presented statistics and corresponding project log only considers RIIO-2 projects. Importantly, this year's metrics includes data from all networks, including the electricity distribution networks which entered their ED2 price control period in FY23.

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 notable milestones, this high-level timeline highlights a selected set of pivotal events which were key in either shaping the progress made or are exemplary cases of innovation and collaboration.

Innovation Key Event Timeline - FY24 -

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 Unified Gas and Electricity Innovation Strategy**: ENA releases a joint energy network innovation strategy to ensure a whole system approach aligning to the UK's overall low carbon innovation portfolio.

FY24

MAY 2023 — **Utility Week Live** & **Innovation Zero**: Birmingham and London host large collaborative events bringing 10,000 professionals together to discuss solutions to drive innovation and net zero progress.

AUG 2023 — **Winser Report**: DESNZ publishes independent recommendations from the Electricity Networks Commissioner, Nick Winser, on how to accelerate the deployment of electricity transmission infrastructure.

OCT 2023 — **Energy Act 2023**: act passes, legislating the creation of a Future System Operator (FSO); in Jan 2024, the ESO announces the name for this new organisation as the National Energy System Operator (NESO).

OCT 2023 — **EIS**: Liverpool hosts the Energy Innovation Summit (EIS), where networks share significant trends and learnings from the largest regulator-funded innovation projects – NIA, SIF, and NIC.

DEC 2023 — **Decision on Hydrogen Blending**: DESNZ make a strategic policy decision to support blending of up to 20% hydrogen by volume into the GB gas distribution networks, if enabled.

MAR 2024 — **ENA Innovation Basecamp**: ENA and Ofgem launch the 2024 Problem Statements and call on innovators to accelerate the transition to a 2035 net zero energy network.

APR 2024 — **2024 Innovation Strategy and Innovation Atlas**: ENA publishes an updated strategy and 2050 roadmap charting an innovation path to support the net zero transition and challenges to the UK's energy security.

JUL 2024 — **FES 2024**: ESO publish updated framework with a narrower set of credible Net Zero 'pathways' (rather than 'scenarios') to decarbonise the energy system by 2050.

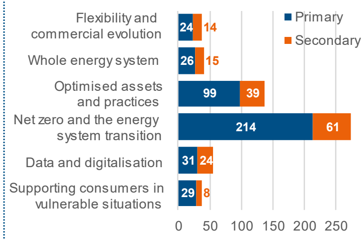
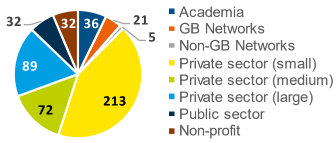
JUL 2024 — **RIIO-3 SSMD Decision**: Ofgem publish document to set out decisions on bespoke policy areas for gas and electricity sectors as well as cross-cutting policies.

2026 — **Decision on hydrogen for domestic heat**: Based on the hydrogen technical and safety case, it is anticipated that DESNZ will make a Policy decision on hydrogen's use for domestic heat in 2026.

FY24 Year in Review

FY24 marks the first year of RIIO-2 for electricity distribution network operators (DNOs). As all networks are now operating in the RIIO-2 price control (as of the start of FY24), data on all network projects and benefits have been tabulated and collated in the FY24 IMF data (and the Balanced Scorecard – see Figure 2) referenced throughout this report; as such, the statistics presented in this report are not able to be directly compared to the FY23 report where DNOs data were not available and so not included in the presented statistics). However, it is important to note that, like last year, all networks have continued to collaborate on the report writing process by providing their views on industry-wide progress in the past year.

Balanced scorecard

	Initiation and Evaluation	Demonstration, Iteration, and Learning	Deployment and Optimisation
Strategy & Vision	[Energy Networks Innovation Strategy 2024]	**335** Attendees at the Basecamp Launch event	
Organisation & Culture	**927** Innovation ideas generated	(see TRL Map below)	**235** Projects registered in the FY24 period
Capability & Technology	**629** 3rd party ideas received	**92** Projects registered from 3rd party ideas	**500** Project partners in RIIO-2 
Results & Outcomes	**246** Projects being taken forward from ideas generated	**423** Live projects over FY24	**208** Projects closed in FY24

TRL Map	% Projects	% Spend
TRL 2	34%	12%
TRL 3	20%	13%
TRL 4	11%	24%
TRL 5	7%	4%
TRL 6	5%	31%
TRL 7	8%	5%
TRL 8	2%	1%

Figure 2. FY24 Balanced Scorecard

The Balanced Scorecard[1] highlights four performance indicator groups identified by the networks as key enablers of innovation: Strategy & Vision, Organisation & Culture, Capabilities & Technology, and Results &

[1] The Balanced Scorecard showcases data from the IMF entries submitted by each network with a focus on projects launched in RIIO-2. The project logs released alongside this report is a subset of this full dataset which includes a log of RIIO-2 projects and ideas/future projects for FY25.

Outcomes. The three columns map these performance indicators to the three stages of the innovation process (1 - Initiation and Evaluation; 2 - Demonstration, Iteration, and Learning; and 3 - Deployment and Optimisation) to show how networks are performing against each indicator throughout the innovation process. This year's scorecard shows continued strength in the number of ideas generated/received and in the number of projects registered from third party ideas. Further, there have been several notable conferences held this year (e.g. Utility Week Live, Innovation Zero, Oxford Energy Innovation Forum (EIF), Energy Innovation Summit (EIS), SIF Community Forum, and Basecamp) that have brought additional value via collaboration to support the development of new initiatives to facilitate even more ideas.

The 2024 Balanced Scorecard demonstrates significant progress in the number of projects registered and their distribution across innovation themes. FY24 has seen a robust total of 235 projects registered, demonstrating the networks' commitment to innovation and improvement. Collaboration remains a key focus throughout RIIO-2, as evidenced by the substantial number of projects developed from third party ideas. In FY24, 92 projects originated from external collaborations, highlighting the value of diverse partnerships in driving innovation. The expansion of the collaborative network is also evidenced by the increase in project partners. RIIO-2 has seen a total of 500 partners engaged in various projects, indicating a growing ecosystem of innovation. A notable development this year is the closure of 208 projects, a significantly high number, partly driven by the inclusion of the electricity distribution networks into RIIO-2. The closure of these projects represents the culmination of significant research and development efforts across the energy sector. A further 20 projects have been brought into Business As Usual (BAU) during FY24 leading to a combined total of 34 since the start of RIIO-2, which is a significant accomplishment and improvement over the last financial year[2]. 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

In April 2024, Energy Networks Association (ENA) updated 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 goals. At the core of the strategy are a set of Objectives, Principles, and Themes. 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 combined 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 and beyond to an inclusive, fully sustainable energy system.*
- **Optimised assets and practices** – *developing and implementing industry-leading techniques for optimising existing core business and adopting new technologies.*
- **Supporting consumers in vulnerable situations** – *exploring how best to support the needs of consumers in vulnerable situations, where it lies within our power, to enable a just transition.*
- **Whole energy system** – *optimising system efficiency and reliability by integrating and coordinating the operation of electricity, gas, and heat networks with other sectors and utilities.*

Value and benefits of network funding

The benefits from innovation projects are varied – adding value for consumers, the wider energy industry, and networks while supporting the progress towards government policies and targets. Broadly, the outputs of

[2] The figure of 20 projects brought into BAU during FY24 represents best available data and is not comparable to the FY23 report due to i) lack of electricity DNO data at the time and ii) missing project data points. Note that not all-BAU funded projects run by networks have been added to the IMF.

innovation improve network security, resilience, and provide data and insights the network operators need to make better decisions about how to operate and invest in their networks as the energy system decarbonises. Importantly, these innovations contribute to the broader transformation of networks to support the net zero transition, providing holistic solutions rather than just point-to-point fixes. The benefits of innovation are then passed to network users in the form of new or improved services and reduced bills.

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 provides significant capital funding to progress innovative ideas into real-word trials of new technologies. As the networks' core innovation funding mechanism, NIA funding is administered directly by the networks to progress all aspects of innovation. Some of the key insights on the value of this funding are outlined below:

- 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.
- Innovation funding **promotes collaboration between networks**, facilitating whole systems thinking through a non-competitive framework which emphasises knowledge sharing.
- The funding **de-risks innovation** by enabling low technology readiness level (TRL) projects with uncertain outcomes that networks would not otherwise be able to fund, allowing for industry-leading progress.
- The **funding types complement each other** and **allow for iterative learning**, with SIF and Network Innovation Competition (NIC) projects building off learnings from NIA research. Additionally, NIA funding can be used to match fund with other funding sources, and the portfolios can be complemented by external non-Ofgem funding in an innovation ecosystem.
- The **open scope** of this funding permits innovation progress across a wide range of sectors.

Capabilities enabled by RIIO structure

Several foundational capabilities have been developed over the course of the RIIO-1 and RIIO-2 price control periods through leveraging network funding and progressing the innovation space.

The GB electricity sector has seen significant recent advances, driven in large part by the RIIO regulatory framework. RIIO incentivises electricity networks to develop advanced data techniques and software capabilities, leading to significant advances in energy forecasting, which have in turn led to improved network capacity prediction and efficient resource allocation. The evolving approach to flexibility, with RIIO encouraging the integration of demand-side response mechanisms and diverse energy storage mechanism, helps the management of the electricity grid; example flexibility-focused projects include Demand Flexibility Service Evaluation, HOMEflex, and Equitable Novel Flexible Exchange (EQUINOX). Additionally, the shift towards active network management, supported by the performance-based incentives in RIIO, empowers network operators to optimise grid performance in real time, enhancing resilience and minimising disruptions; a sample of projects which support active grid management include Intelligent Gas Grid and TOTEM (Transmission Owner Tools for EMT Modelling) Extension. The commitment to open network data, another RIIO focus, has enhanced data sharing and collaboration while data-first initiatives like the digitisation of Local Area Energy Plans (LAEPs) are providing a more granular understanding of local energy needs.

The RIIO structure is also driving innovation and progress in the GB gas sector's energy transition. As GB moves towards net-zero targets, natural gas continues to be a critical fuel. A key innovation area has been the development of hydrogen safety and technical cases, which are fundamental for supporting the future integration of hydrogen into the gas transmission and distribution networks. Innovation funding has supported the development of detailed feasibility and design studies and development of the safety case and physical testing of hydrogen in the gas network through demonstration projects to create the evidence base for policy and future decision making. The work enabled by RIIO is essential for improving public understanding and gaining trust in the use of hydrogen as a critical future energy source, especially in hard-to-electrify parts of the GB energy system. Recently government strategic policy decisions have indicated support for blending up to 20% hydrogen (by volume) into the GB gas distribution network based on evidence from the HyDeploy trials. Additionally, RIIO has supported projects exploring hydrogen blending in both transmission and distribution networks through projects including: Blending Infrastructure for the NTS, Hydrogen Blending in LPG Feasibility Study, Hydrogen Blending: National Safety Evidence Review, HyNTS FutureGrid Deblending and HyNTS FutureGrid Compression. These initiatives, along with increasing levels of biomethane in the gas networks are contributing to decarbonisation efforts in the gas sector.

Innovation in the electricity and gas sectors have been driven by a strong focus on iterative improvements and collaborative knowledge-sharing within the GB energy system, supported by the RIIO framework. Through continuous refinement of technology and processes, supported by RIIO's performance-based rewards mechanisms, the electricity and gas sectors have consistently progressed and evolved. The RIIO framework not only encourages the development of novel projects but also provides a pathway for scaling successful demonstrations into BAU. Doing so ensures that promising technologies and practices are not only tested in laboratory settings or trials, but can be deployed at scale leading to real impact. By facilitating transition from early innovation to late-stage implementation and adoption as BAU, the RIIO framework plays a critical role in ensuring that innovation delivers consumer value while accelerating the transition to net zero.

Network progress in key outcome areas

Network progress on innovation is organised around a set of "outcome areas" which are reported in the IMF for RIIO-2. They aim to show how networks are performing across the innovation process from idea selection and partnership building through to benefits delivery. Below is a summary of progress made in FY24 against each of the four outcome areas, with data sourced from the IMF.

- **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. As was the case in FY23, most projects were registered against the "Net Zero and the Energy System" and "Optimised Assets and Practices" themes. These two themes represented 80% of projects launched in FY23 and 73% of projects in FY24.
    3. £207.4M planned investment across the 235 innovation projects registered in FY24.
    4. Combined with the in-flight projects carried into FY24, 423 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. This is highlighted by the 479 non-network project partners logged in the IMF for RIIO-2 including 301 new partners logged over FY24.
    2. Out of the projects registered in FY24, 84 collaborative projects include more than one network operator (37% of all projects initiated).
- **Outcome Area 3: *The innovation funnel*** – *translating ideas into projects*
    1. Networks recorded 927 ideas generated and 246 projects taken forward from those ideas.
    2. 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 27 problem statements generated by the networks, received 183 proposals from innovators, had 77 go to pitching, and finally 24 proposals agreed (with 8 others pending final decisions).
- **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 last year's report, it was noted that project work showed a particularly strong focus on the themes of 'Net zero and the energy system transition' and 'Optimised assets and practices.' This has continued to be true in FY24. Further to these themes, as expected, networks have focused on a wide range of topics including 'Data and digitalisation' (theme), 'Maintaining a safe and resilient network' (objective), 'Consumer benefit' (Principle) 'Supporting consumers in vulnerable situations' (theme) and 'Collaboration and stakeholder engagement'

(Principle), amongst others. The pipeline of projects for the next year suggests an exciting array of work across all strategy themes.

Apart from the thematic focus, as RIIO-2 progresses, the networks are increasingly focusing on developing a wider array of projects to create a strong evidence base to support decarbonisation goals, leveraging learnings from previous projects in an iterative nature to make the best use of funding, and bringing relevant projects to the implementation and/or BAU stages.

In the **Recommended Actions** section, further details are provided on addressing critical issues, including the need to enhance communication and collaboration, the development of a consistent methodology for quantifying non-financial project benefits, and the need to secure additional funding for deploying innovative solutions into BAU. This section also highlights the need for policy support through relaxations in licence obligations and simplification of the process to facilitate BAU deployment.

The innovation process

Planning for Innovation: Themes, Objectives, Principles

The latest [Energy Networks Innovation Strategy](), released by ENA in April 2024, sets out the shared objectives, themes, and principles for network innovation projects. This updated strategy provides a common set of goals and metrics for innovation to ensure that projects are targeted at specific challenges.

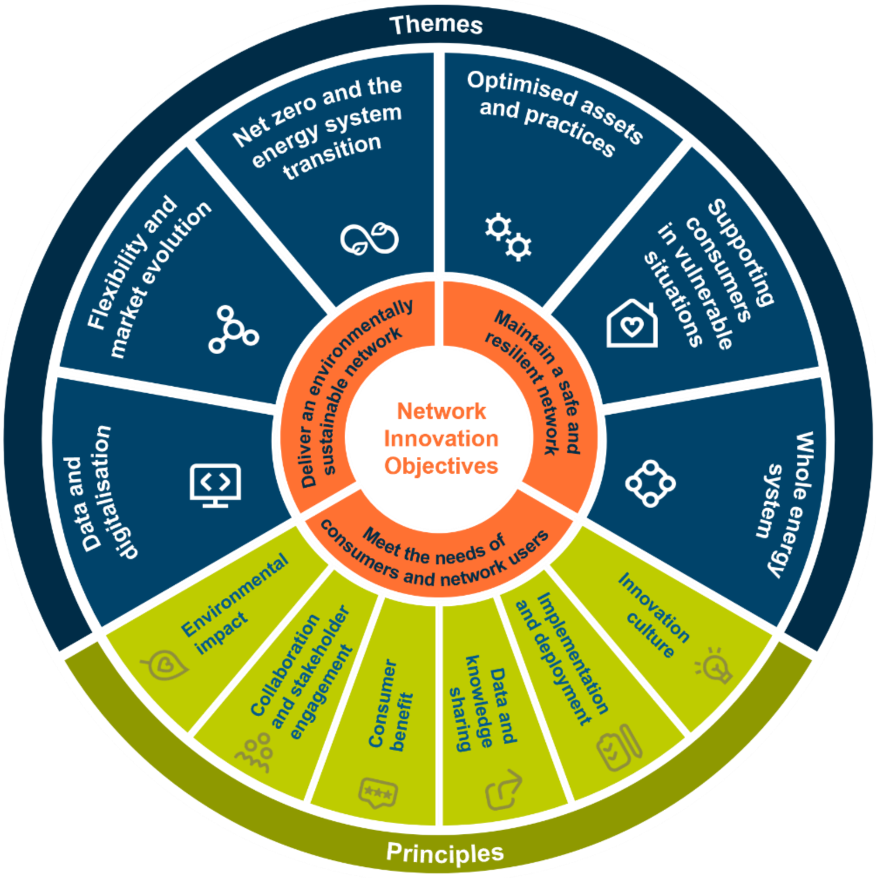


Figure 3. ENA Themes, Objectives, and Principles

The three consumer-facing outcome categories from Ofgem sit at the core of the Innovation Strategy and are the most important **objectives** for any innovation project. The focus of these objectives 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 relationship between 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.

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 the National Energy System Operator (NESO) functions.

Given the goal to decarbonise the power system by 2030, **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.

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.

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.

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.

Innovation Cycle

Network innovation projects follow a structured process from idea generation through to benefits realisation, regardless of theme or subject matter network. The process, illustrated in Figure 4 begins with **Stage 1** where ideas from networks and innovators are refined and aligned with the Joint Networks Innovation Themes. Once an idea progresses to **Stage 2**, the focus shifts to securing appropriate funding and successful delivery of the project. This stage includes critical steps of project registration, delivery, and dissemination of findings and lessons learnt. Dissemination of new knowledge created enables other projects to build on these insights. At this stage if a project demonstrates potential but requires further development, the project is cycled back to the first stage for additional trials or refinements, following a process of continuous improvement. In the final stage of the process, **Stage 3**, proven innovations are integrated into BAU operations and benefits are realised. Successful integration ensures that the benefits of innovation, such as improved network resilience, consumer benefits, and reduced environmental impact, are delivered to consumers, smoothly and cost-effectively. Even if a project does not progress to BAU operations, it can still deliver significant value by supporting policy decisions, contributing to evidence building, furthering learning and providing options to support a 'just' net zero transition. Throughout this stage, networks collaborate with regulators, policymakers, and supply chain partners to ensure that innovations are implemented safely and effectively. The Energy Networks Innovation Process Document (ENIP) provides more information about the innovation process and how to get involved.

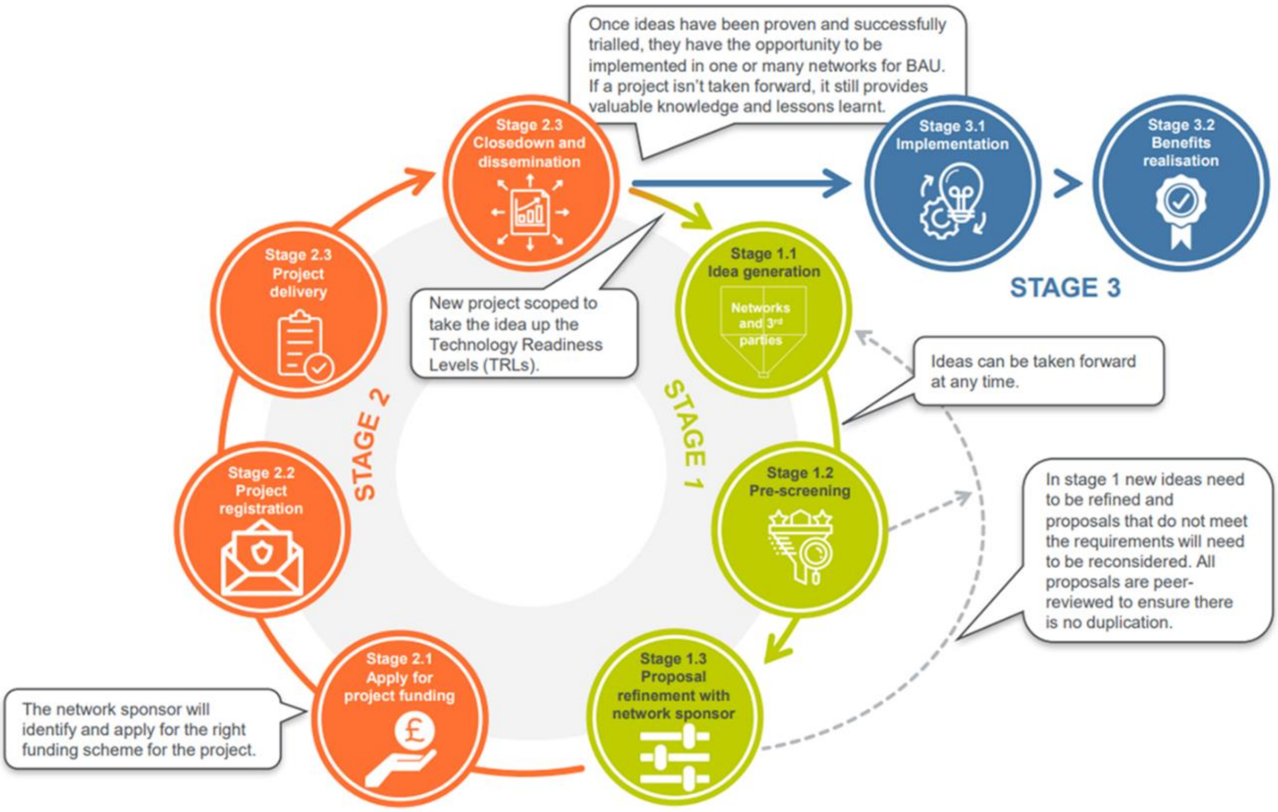


Figure 4. The innovation process

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. Recently, the SIF programme renewed its annual application structure to a cycle-based framework. This change means that from FY25 and onwards, funding for potential Discovery, Alpha and Beta projects can be applied for at four points during the year. Notably, this is the first time that SIF projects are entering into the Beta phase and forming a significant proportion of the project portfolio spend. Overall, SIF projects account for 35% of projects and 64% of the funding, indicating its increasing prominence as an innovation funding source. A key aim of the SIF is to accelerate the pace of innovation in the energy sector, with a particular emphasis on scaling up and demonstrating new technologies and approaches. The SIF promotes collaborative projects that bring together diverse stakeholders to tackle large-scale network challenges, helping build partnerships that can help address complex issues across the energy system. 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 has historically been the largest network-led funding source for innovation. This year, it represents 57% of the projects and 33% of the funding registered in the FY24 IMF[3]. Given the nature of this network-led funding, it promotes collaboration between networks, de-risks low Technology Readiness Level (TRL)

[3] In addition to projects funded via the SIF and the NIA, an additional 8% of projects, and 3% of project funding logged in the IMF are funded via BAU. Note that not all-BAU funded projects run by networks have been added to the IMF.

innovation work, allows for iterative learning, and permits innovation progress across a wide range of issues, all while complementing other project funding types. Additional unique benefits include flexibility and agility, allowing for innovation to progress and pivot as needed to support networks to reach government decarbonisation targets and improve system performance and resilience. Without NIA funding, innovation would likely be slower, less collaborative and more constrained, with less overall progress.

Table 1 below shows a high-level summary the value of innovation funding in the networks space.

Table 1. Benefits of innovation 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, allowing networks to solve relevant problems flexibly through a robust and established process.
Flexibility	Wide project variety; knowledge sharing; network improvements	NIA funding is flexible, supporting a wide range of innovation projects across different sectors and TRLs, from early-stage to advanced demonstrations.
Agility	Adaptability; Innovation pace	NIA funding allows for quick responses for emerging challenges, providing the agility needed to address urgent issues and to adapt to changing circumstances on-the-fly.
Collaborative working	Knowledge sharing; increased stakeholder engagement	All innovation funding fosters collaboration between networks, stakeholders, and third-party innovators, promoting knowledge-sharing and joint efforts, leveraging deep expertise and perspectives across a diverse range of stakeholders.
Non-competitive nature	Collaboration; Knowledge sharing	The nature of the funding encourages networks to work together more effectively on shared challenges and objectives.
Trial and error	Higher risk/reward; progress on lower TRL solutions	Innovation funding is key for funding projects with uncertain outcomes (i.e. higher risk, higher reward ideas), particularly those developing/progressing low-TRL solutions.
Breadth of approach	Cross-sector collaboration; Flexibility	The broad scope of innovation funding enables networks to evaluate innovation projects across various sectors and challenges, fostering a holistic approach to solving industry-wide issue sand promoting wide-ranging advancements in technology, which further leads to consumer benefits.
Working at pace	Innovation pace; proactive strategy and planning	The structured yet flexible approach to funding supports timely progress in innovation, enabling networks to meet fast-evolving challenges and decarbonisation targets.
Iteration over long periods	Continuous improvement; long term strategic approaches	Funding supports continuous development and refinement over extended periods, enabling iterative improvements and gradual integration of success demonstrations into BAU operations and wider implementation.
Risk mitigation	Risk management, progress on low TRL	Funding enables networks to explore high-risk, low TRL projects with uncertain outcomes, helping de-risk future technologies and strategies by providing opportunities to evaluate in controlled environments.
Consumer focus	Consumer benefit; social impact	Funding mechanisms have requirements associated with improving consumer outcomes via enhanced service reliability, supporting vulnerable customers, and providing cost savings, thus ensuring a consumer-centric focus to innovation efforts.

Outcome areas

Reporting on innovation progress is measured against four outcome areas identified in the industry-wide IMF for RIIO-2. The four areas reflect on: i) the focus of innovation (the spread of projects across innovation themes), ii) collaborating with partners (collaboration in project work), iii) the innovation funnel (the success of turning ideas into practices), and iv) 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 1 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.

Just under half of the projects launched this year registered “net zero and the energy system transition” as their primary strategy theme (111 out of 235 total projects launched). This focus on net zero is in-line with the trends in projects launched in FY23 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 reference to where the list of projects and their associated themes can be found in noted in Appendix III. FY24 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. Projects in this area often span multiple themes. For example, the Digital Platform for Leakage Analytics (DPLA) SIF project initially focused on reducing methane leakage to improve system efficiency to support net zero targets. Now in its Beta phase, the project is expanding to address hydrogen leakage, integrating advanced analytics and machine learning to enhance network monitoring and environmental outcomes.

The Planning Regional Infrastructure in a Digital Environment (PRIDE) project has developed a digital twin of regional infrastructure in West Midlands to support decarbonisation of major energy demands (transport and heat). By leveraging advanced visualisation capabilities and scenario-based modelling, the project aims to accelerate the deployment of efficient and effective decarbonisation solutions. An expected outcome of PRIDE is a digital platform that empowers local authorities to share local area energy plans with networks. This streamlined approach is anticipated to yield benefits for networks including: reductions in connection enquiries, improvements in forecasting investment plans and cost savings in stakeholder engagement.

The Artificial Intelligence and Machine Learning project investigated the application of Artificial Intelligence (AI) and Machine Learning to existing network equipment databases. The project successfully developed new triggering mechanisms for low voltage monitoring, enabling early-stage fault prediction. The project also highlighted the need for a single point of truth when managing diverse data sources.

Another project delivering innovation for low voltage networks is the NCEWS2 – Network Constraint Early Warning System (Phase 2) project, which developed a platform that combines data from smart metering and operational systems to identify network issues before they develop into faults. By correlating smart metering, substation monitoring and other data sources, a methodology to highlight and prioritise potentially 'at risk' areas of the network was developed. The platform enables informed decision making that helps networks to target maintenance activities to prevent Customer Interruptions and reduce Customer Minutes Lost. The project has delivered real-terms benefits of £4.3m since inception and the solution developed as part of the project has since been extended to high voltage (HV) and the extra-high voltage (EHV) network.

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 the uptake of smart-enabled low carbon technologies (LCTs). A key project, CrowdFlex has scaled up the domestic flexibility models evaluated during the Alpha phase, focusing on real-world application and refining the market mechanisms that encourage consumer participation in demand-side flexibility.

> "I believe that innovation should help people, and with CrowdFlex we can save consumers money on their energy bills so it will have a positive impact on people's lives."
>
> *– CrowdFlex Project Lead*

This Demand Flexibility Service Evaluation project has provided critical insights into consumer behaviour, the effectiveness of incentives, and the potential benefits consumers can provide to reduce network stress. These findings are essential for refining future flexibility services and better integrating domestic flexibility into the energy system.

Another domestic flexibility focussed project is HOMEflex which has led to the creation and refinement of a "code of conduct" for energy flexibility services, which is critical for increased trust and participation in the system, and has further supported the wider adoption of flexible energy solutions.

> "Domestic flexibility has proven to be crucial already these past two winters and will continue to be an important part of reducing costs and increasing security on our journey to net zero."
>
> *– HOMEflex collaboration partner*

In the area of non-domestic flexibility, the Flexible Operation of Water Networks Enabling Response Services (FLOWERS) project has explored the potential value of flexibility from water networks (one of the largest consumers of electrical power) for distribution networks. The Diversified Flexible Queue Management project developed methods to accelerate renewable and flexible resource connections, reducing costly network reinforcements and speeding up clean energy deployment. Direct benefits of the project include: reducing the need for demand reduction during winter power shortages, allowing connected renewable energy sources to increase their export without non-firm connection agreements, and significantly reducing timescales for connecting new renewable generation.

Finally, the DSO and NESO further underscore the importance of this theme transitions which are underway.

Net zero and the energy system transition

Facilitating and accelerating the UK's transition to Net Zero greenhouse gas emissions and beyond to an inclusive, fully sustainable energy system.

As in previous years, this theme continues to be a priority as networks work towards net zero targets, including the sector wide decarbonisation target of 2030, set by the government in 2021. One key initiative, the Lessons from the Past project, has explored potential learnings for the gas networks from earlier energy transitions, such as the shift from town gas to natural gas in the 1960s and 1970s. The success and insights gained from this project have sparked interest among various stakeholders. In response, a follow-on project called “Lessons Learnt Phase 2“ is now in development. This upcoming phase will address specific stakeholder requests on deeper explorations of both upstream and downstream conversion processes with a particular focus on industrial consumers. This will in turn enable lessons learnt to contribute to the transition to the clean energy transition.

The integration of renewable energy sources and the future of how we visualise this have also been crucial areas of focus. The Collaborative Visual Data Twin – Phase 2 project has been instrumental in expanding the digital twin of the National Transmission system (NTS) to more effectively model hydrogen integration.

Another project accelerating low carbon heating adoption is the Emerge project. Through partnerships with meter operators, the project has reduced upgrade times for the estimated 11,000 fuse upgrades required during RIIO-ED2. This is a crucial advancement, as outdated fuses can significantly hinder the transition to low-carbon technologies. Without these upgrades, customers may have delays in installing EV charging points or heat pumps, leading to delays in adoption of cleaner energy solutions. The project’s innovative process has not only sped up these essential upgrades but also demonstrated a potential solution for a nation-wide rollout. By reducing wait times and streamlining the upgrade process, the project is enabling more households to rapidly transition to low-carbon technologies. Investigations are underway to consider whether this innovative process can be adopted / implemented by the wider industry to ensure it is rolled out nationwide. This is being facilitated through the dissemination of learnings, with presentations at the 2023 Innovation Summit, and through engagement with the industry via working groups facilitated by ENA.

Similarly, the Solar PV Nowcasting project has developed real-time forecasting tools to predict solar photovoltaic (PV) output, an essential step for improving grid management as renewable energy sources become ever more prominent. Accurate solar output prediction is crucial for multiple reasons: it allows grid operators to balance supply/demand more effectively and enables energy suppliers to forecast ‘greener’ days and offer agile daily discounts to customers.

Proper voltage management is crucial to prevent blackouts and protect electrical equipment. With this in mind, the QUEST project is developing a holistic voltage control system which coordinates current and future voltage management techniques across the distribution network. Using advanced and innovative software, the project aims to optimise network efficiency, facilitates low-cost connection of low carbon technologies, and maximise consumer benefits through energy consumption reduction. Probabilistic Modelling for Connection Studies is another project which has developed a probabilistic planning process to accelerate the deployment and connection of renewable generation and flexibility assets, facilitating the transition to Net Zero.

Additionally, the Novel Methods for Sealing SF_6 leaks project has trialled innovative techniques to reduce leakage of Sulphur Hexaflouride (SF6), a greenhouse gas approximately 23,500 times more potent than CO_2 over a 100-year period. SF_6 is a commonly used as an electrical insulator in high voltage electricity equipment. Reducing SF_6 leakage not only lowers network emissions but also helps maintain the insulating properties of the equipment, in turn reducing risk of outages for customers.

Finally, the Constellation project is exploring local intelligent control systems to forecast and analyse power flows, providing a foundation for future smart solutions that will support the energy transition and ensure the UK’s energy system remains robust and adaptable.

Optimised Assets and Practices

Developing and implementing industry-leading techniques for optimising existing core business and adopting new technologies.

The optimisation of network assets remains a core focus for network operations, ensuring they can meet current demands while preparing for future challenges. As such, this theme continues to be an important focus of network innovation. Aligned with ENA's strategic objective of maintaining a safe and resilient network, networks continue to leverage innovation funding to deploy advanced modelling techniques and trial new technologies to enhance operational efficiency and safety.

One such initiative is the Storm AI project, which addresses the growing challenge of extreme weather events and their impact on power supply. The project was developed in response to past difficulties, including those experience during Storm Arwen in 2021 where some customers faced prolonged power outages. The project leverages AI and machine learning techniques to provide more accurate re-connection estimates for customers during storms. By improving the speed and accuracy of reconnections, this project will enhance network resilience and help protect vulnerable customers from prolonged outages.

Infrastructure reliability during the energy transition is another critical concern. The Sprayed Metal for Effecting Leaking Transformer Repairs (SMELTeR) project is investigating the use of sprayed metal technology to repair leaking transformers, which is vital for maintaining network stability.

> "The SMELTeR project has identified a potential solution that will keep our transformer assets in good health for a longer period."
>
> *– Innovation Engineer*

In rural areas, where overhead networks are particularly susceptible to storm damage, the Sentinel project has made significant advancements. By deploying novel fault location sensors, the project has enhanced supply quality and safety for customers in weather-affected areas. Rural Electrification 2.0 is another innovation project focusing on rural areas and has highlighted the unique challenges of the agricultural industry. The project has reinforced the distinct challenges in decarbonizing rural communities and the need for tailored electrification approaches in agricultural settings.

As networks become increasingly digitalised, safeguarding critical network infrastructure against cyber threats has become a top priority. The Cyber-SAFEN project is at the forefront of this effort, developing an integrated cyber defence platform that leverages AI and machine learning to protect vital network assets from advanced cyber threats. By enhancing the security and stability of network systems, this project also plays a key role in maintaining the integrity of the energy supply.

Supporting consumers in vulnerable situations

Exploring how best to support the needs of consumers who find themselves in vulnerable situations, where it lies within our power, to enable a just transition.

Supporting consumers in vulnerable situations is key priority for networks and many networks have updated and expanded their definitions of vulnerability to better capture the evolving challenges faced by consumers. Tools like the Vulnerability Visualisation Tool Phase 2 have been vital in identifying areas where additional support is most needed. This project combines various vulnerability metrics into a single point of reference, enabling the identification of key geographical areas based on multiple factors such as benefit claimant rate, health indicators and property types. By integrating these data points, the tool creates a comprehensive view of vulnerability across different regions. This information can then be used to strategically target areas for support, ensuring that the most at-risk customers receive the highest level of support.

Another key initiative under this theme is Project Vulnerability and Energy Networks, Identification and Consumption Evaluation (VENICE), which has explored the impact of the pandemic and the cost-of-living crisis on energy consumption. The project produced robust methodologies for local communities to ensure they are supported on their journey to Net Zero without leaving the most vulnerable and fuel poor behind.

Another example is the Additional Welfare Decision Tool which has improved the support provided to vulnerable off-gas customers; by providing an API with data access, this tool has ensured that up-to-date information is available to customer teams empowering them to provide timely welfare provision.

The Community Resilience project has taken a broader approach by identifying the quantifying the efforts already taken by networks to support customers in their communities. This project has assessed future risks to community resilience so that networks can continue to offer appropriate support to vulnerable consumers in a variety of future scenarios.

Whole energy system

Optimising system efficiency and reliability by integrating and coordinating the operation of electricity, gas, and heat networks with other sectors and utilities.

As the UK continues its decarbonisation journey, the interactions across the energy system become increasingly important. Meeting future demands will require energy networks to collaborate closely with a broader range of partners in exploring decarbonisation pathways. This collaborative need aligns with the shift towards greater responsibilities for distribution networks as they take on a broader range of system operation responsibilities at the regional level.

In late 2024, the Electricity System Operator (ESO) will transition to become Great Britain's National Energy System Operator (NESO). This new role includes oversight of the entire energy system including electricity, gas, and in the future, hydrogen networks. NESO will emphasise whole systems thinking, ensuring a more integrated and strategic approach to managing the UK's energy transition towards net zero goals.

To address these challenges, recent initiatives have concentrated on enhancing the resilience and efficiency of the network while preparing it for the future. One such effort is the Network-DC Circuit Breakers project, which has now moved into its SIF Beta phase. DC Breakers have the potential to reduce onshore build of infrastructure by allowing more renewable power to connect to a single point, reducing the need for multiple land-fall connection and thereby reducing impact of new buildings on coastal communities. In the Alpha phase, the project identified a key challenge: original equipment manufacturers (OEMs) require demand certainty to invest in product development; however, a market is unable to emerge without available products. The Beta phase involves evaluating a DC Circuit Breaker (DCCB) replica in a UK network model to demonstrate its performance with the aim of boosting OEM investment by reducing uncertainty, thereby increasing stakeholder confidence and paving the way for broader implementation. Gas Control System Impact Assessment (Future requirements) is a project that has provided insights to gas networks into future system operator needs. This provides an assessment of the current status while providing a roadmap for the future, highlighting follow-on projects and the areas of change required.

Another project that is accelerating the digitisation of networks is the ENSIGN (ENergy System dIGital twiN) project which aims to create a detailed digital representation of the network, including its physical infrastructure, asset data and real time data streams. ENSIGN will enable networks to predict and prevent outages, optimise asset management, network operations, and develop smart grid solutions by analysing data and simulating scenarios using a digital twin. The digital twin can then be used to simulate various scenarios, identifying efficiencies in network operation, helping reduce costs and improve customer satisfaction. For consumers, this translates to a more reliable electricity supply with fewer unexpected outages, lower energy costs, and improved communication during any service disruptions.

In parallel, the Hy-Voltage project is examining the viability of introducing flexible vector conversion links between the gas and electricity distribution networks, which could produce hydrogen for storage when electricity supply exceeds demand. This hydrogen could be stored directly within the network or distributed to the consumer, bypassing the high-pressure transmission system. It would also enable generation of electricity from the gas network during times of peak electricity demand (i.e. back-up power). Benefits include reducing overall energy system costs to the consumer by providing system flexibility and increasing energy security. If the project is successful, it will showcase how using the existing gas network infrastructure can be crucial to the UK meeting net zero targets. To support these technological advances, the Hydrogen Skills & Competencies (HGR&D NSIB) project focused on developing the necessary skills and training frameworks to equip the workforce for a potential transition to hydrogen, ensuring the industry is prepared for the future. The Equitable Novel Flexible Exchange (EQUINOX) project (discussed in more detail below is dedicated to addressing the challenges networks face with the electrification of heat.

Equitable Novel Flexible Exchange (EQUINOX)

Project ID: WPDEN05
Budget: £15,375,360
Networks: NGED, SPEN
Duration: Mar. 2022 – Dec 2024.
Status: Live

Overview: Upon its inception (2022), the EQUINOX project was the first NIC project dedicated to addressing the challenges networks face with the electrification of heat. Currently, limited viable solutions exist for DNOs to unlock flexibility from residential low carbon heat at scale in a dependable, cost-effective, and equitable way. The project is therefore developing novel commercial and technical arrangements to unlock the flexibility from residential low carbon heating, whilst meeting the needs of all customers, including those that are fuel poor and have vulnerabilities.

"As thousands more homes switch to heat pumps, flexible systems like this are going to be even more crucial to balance demand at key times. Trials like EQUINOX show that customers are willing to tweak their everyday lives to save money and help balance the system."
– *Network Head of Commercial & Operability*

Progress: The EQUINOX project is split into 3 trial stages which occur each winter between 2022 and 2025. Trial 1 was conducted between December 2022 and March 2023 and served as a proof of concept with 400 customers across 2 suppliers turning down around 9 MWh across winter 2022/23. The second trial ran from November 2023 to March 2024 with over 1,000 customers signed up. Trial 2 applied learnings from trial 1, alongside validating technical integration, automation, and the DNO-supplier interface. The variables evaluated in trial 2 included: payment amount, notice period, control method, and time of day.

Benefits: EQUINOX accelerates the uptake of flexibility from low carbon heat by unlocking flexible capacity of up to 779 MVA from heat pumps and hot water storage up until 2050. The project is estimated to bring £1.1 billion in direct financial benefits by 2050 across GB, supporting customers through network savings resulting in lower bills. EQUINOX will also contribute to faster adoption of heat pumps by reducing their total cost of ownership. It increases efficiency in flexibility procurement by leveraging low voltage (LV) connected flexibility. The project also provides increased opportunity for value stacking, as any capability to dispatch flexibility from the LV network could benefit network constraints up and down the network. There is a potential additional benefit for the ESO in system balancing cost reduction due to improved coordination. Finally, the project has the potential to directly reduce carbon emissions up to 1,900 tCO_{2e} by 2050 across GB.

Significant Learning: The EQUINOX project has led to learning across three main topics: decarbonisation of heat, collaboration, and domestic flexibility. The project focuses on an intersection of these topics which have historically not been assessed in detail, particularly in relation to heating assets. Key learning areas include understanding how much flexibility can be unlocked from residential low carbon heating, at what cost, notice period and reliability to the network operator, and what comfort, convenience, and control levels for the customer. Results from trial 2 demonstrated that heat pump flexibility can help to resolve distribution network Constraint Managed Zones (CMZs) when combined with other assets. Heat pumps can meet a significant amount of base weekday flexibility needs but are expected to reach around 20% of a CMZ's projected short term peak demand. This demonstrates that heat pumps are a valuable option for advanced dispatch to form a reliable peak reduction solution, but there is a need for additional assets for shorter periods to meet the remaining peak.

> “Grid interactions such as demand-side response are intrinsic to successfully delivering net zero. Doing this without impacting resident comfort whilst simultaneously reducing energy bills further demonstrates the positive impact of harmonising our homes’ ability to align energy demand to the grid’s delivery capacity.
>
> *– Chief Innovation Officer, Sero*

Next Steps: Now that trial 2 analysis is complete, the EQUINOX project will transition into trial 3 for autumn and winter 2024/25. This final trial aims to apply learnings from trials 1 and 2, demonstrating commitment to iterative development and continuous learning, whilst also testing novel capabilities. Trial 3 will focus on informing scaling to BAU by testing longer duration events, both sustain and dynamic type products, and by testing demand turn-up from heat pumps. As the project moves towards BAU, it is positioned to deliver significant impact by broadening our understanding of and ability to forecast low carbon heating and unlocking flexibility from residential low carbon heating, while meeting the needs of all consumers, including the fuel poor and vulnerable. The project will continue to maximise continuous learnings, iteration, and knowledge dissemination. By sharing insights widely, EQUINOX is contributing to accelerating the energy transition and creating a more flexible, efficient, and resilient power system for the future.

Outcome area 2: working with partners

Outcome area 2 is focused on the extent to which networks collaborate 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 return of the Basecamp programme and the 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, 500 project partners have worked together on innovation projects from a wide range of organisations as shown in Figure 5 below. The energy networks have worked with 213 small businesses, 72 medium businesses, and 89 large businesses. The list of project partners also includes a further five networks outside of GB, 36 academic organisations, 32 public-sector organisations, and 32 non-profit organisations.

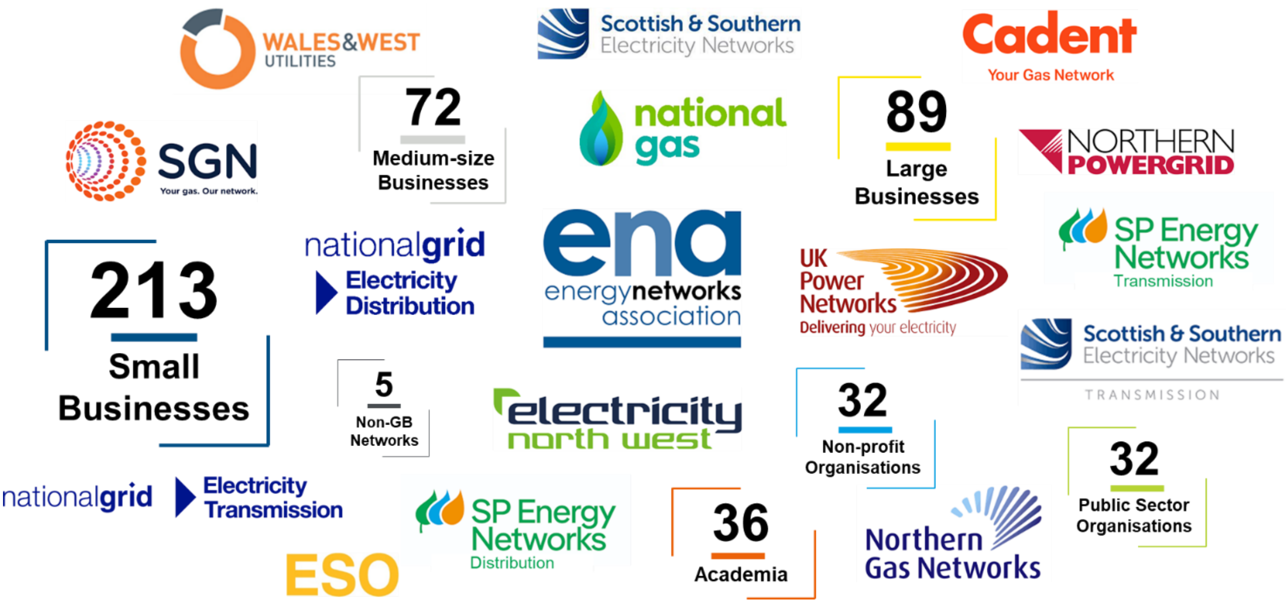


Figure 5. GB energy networks and their innovation partners in FY24

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 84 collaborative projects (with more than one network operator providing funding).

Homeshield exemplifies gas networks working together to enhance safety and independence for vulnerable consumers. This collaborative effort includes the development of an active acoustic monitoring device to detect alarms in the homes, not only alerting consumers but also notifying key contacts, thereby promoting safer independent living.

> "VoltXpanse will help us develop onshore energy highways capable of transferring bulk power from big energy sources such as offshore wind to demand centres."
>
> *– Senior Innovation Engineer*

An example of collaborative efforts between electricity transmission networks is the VoltXpanse: Ultra high voltage onshore energy highway project. This project aims investigates ultra-high voltage transmission technologies for the GB network, with an aim to increase bulk power transfer capability while reducing power losses. This in turn has the potential to lead to increased reliability and reduced costs for consumers.

The Intelligent Gas Grid project showcases collaborative efforts between multiple gas networks and the private sector. The project refines AI and machine learning techniques for real-time pressure management and predictive maintenance. This reduces gas escapes, and improves efficiency of mains replacements, in turn leading to cost benefits for consumers. The Beta phase of the project involves technology scale-up to enhance network reliability by automating pressure adjustments and reducing methane leaks. It builds on insights from the Alpha phase, where the focus was on proving the concept through targeted research and operational data collection. A project delivering using advanced modelling techniques to improve deliver innovation in transmission networks is TOTEM (Transmission Owner Tools for EMT Modelling) Extension, discussed in further detail below.

TOTEM (Transmission Owner Tools for EMT Modelling) Extension

Project ID: NIA_SHET_0035
Budget: £437,000
Networks: SSEN-T, SPEN-T, NGET, ESO
Duration: May 2022 – Jul. 2023
Status: Closed

Overview: The UK's power system is rapidly evolving with increased renewable energy, resulting in reduced system inertia and short circuit levels. The TOTEM Extension project, an extension of TOTEM, completed the development and validation of a full-scale model of the GB transmission system in electromagnetic transient (EMT) power system computer-aided design (PSCAD) simulation software. The project produced a model enabling the analysis of complex control interactions between power electronic devices. This analysis is critical for underlying the risks to network stability and allows for informed investment decisions to reduce risk of system outages or other effects that could damage connected electrical equipment. This collaborative effort between multiple transmission networks and the system operator demonstrates the value of joint initiatives in addressing complex challenges in the evolving UK power system.

> "This will be the first time in GB that a whole electrical network will be modelled, it will provide each of the TOs and the System Operator with much improved network models of their counterparts. It will be only the second time in the world that large scale EMT modelling of a system is created, following the successful demonstration of the Australian network. A joint project and will enhance learning, knowledge and ability for all three Transmission Owners and the System Operator."
>
> – *Innovation Project Manager*

Progress: The project positively developed a multi-party agreement that enables the GB transmission operators to work together to acquire and validate a new system model to enhance and de-risk the integration of new technologies. An in-person knowledge transfer workshop fostered collaboration between transmission operators, enhancing cross-organisational learning and strengthening partnerships across the GB network. The models delivered as part of the TOTEM and TOTEM Extension projects have enabled the development of the UK's first whole system model. This gives the transmission networks a much greater modelling ability for planning HV DC and renewable connections in the evolving system as we see the networks removing or replacing older generation facilities.

Benefits: By developing innovative tools and resources for power system modelling and analysis, the project has delivered the following advantages. By implementing this project into BAU, it has resulted in continued reduced system risk by avoiding control interactions, which could lead to major system disturbances. The multi-party agreement enhanced collaboration among GB transmission operators, unifying model development and risk mitigation strategies. By equipping transmission operators with advanced PSCAD models and fostering knowledge transfer, the project has enhanced technical capabilities across the GB network, thus preparing the grid for future challenges, benefiting both networks and consumers through increased reliability and increased potential for new connections.

Significant Learning: The project has led to significant learnings. Multi-party agreements have revealed contracting differences and complexities among transmission network operators. Another learning was the benefit of early data sharing and robust timeline planning. The Covid pandemic emphasised the importance of flexible contracts and transparent communication among partners. Additionally, the complexity of the software highlighting the need for adaptable and robust IT infrastructure.

Next Steps: The models delivered as part of the TOTEM and TOTEM Extension projects have enabled the development of the UK's first whole system model. The learnings from these projects have helped to positively shape the TOTEM 2 project, which aims to incorporate these additional capabilities into the current system.

Collaborative initiatives in FY24

Beyond project work, networks have also continued to develop industry-wide programmes to support collaboration throughout the innovation process. The Basecamp 2024 programme generated 183 new ideas targeted across the 27 released problem statements identified by networks. 77 of those ideas were invited to pitch to networks in London in July of this year. Following the pitching session, 24 proposals were agreed to be taken forward with the networks, with an additional eight proposals pending final decision. As this is a recent programme the ideas generated through this process were not captured in the IMF or included in the Balanced Scorecard. Going forward, networks will decide if and how ideas will be taken forward.

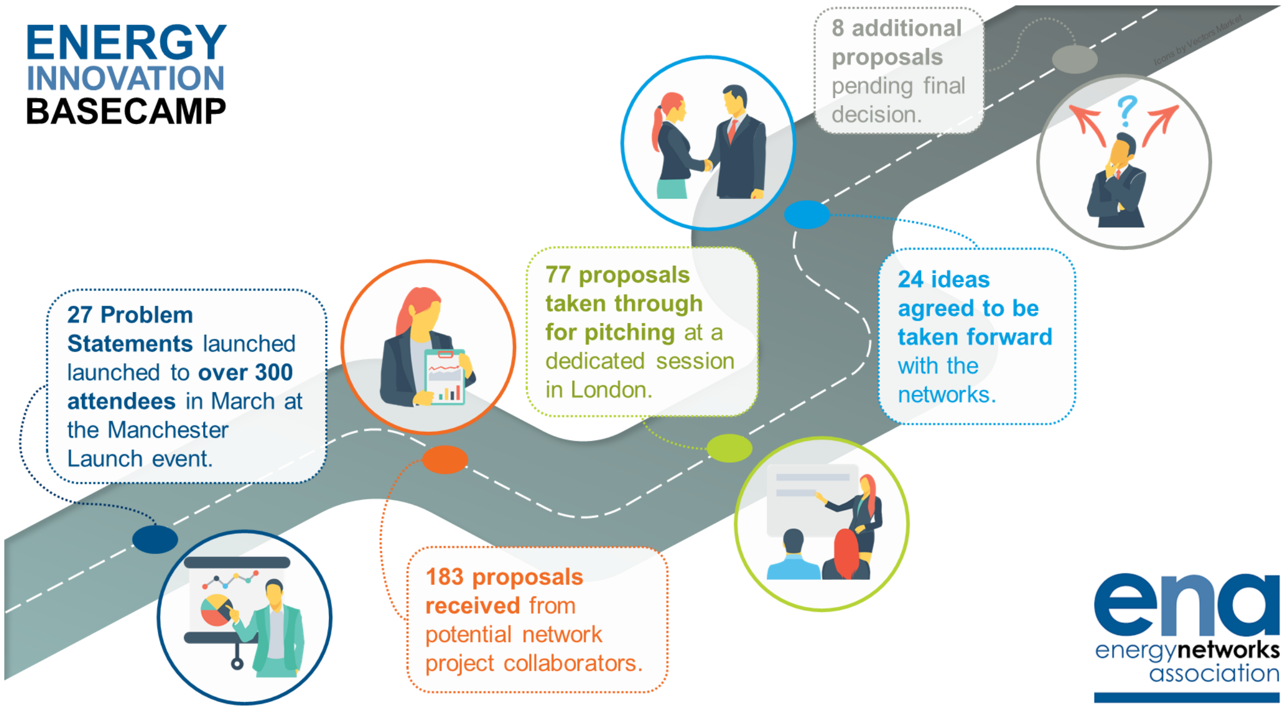


Figure 6. ENA Basecamp 2024 roadmap

The SIF process has remained another important point of collaboration in FY24. 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 UK Research and Innovation (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. To date, the networks have run 137 SIF Discovery projects (across Rounds 1, 2 and 3), of which 76 have been funded for subsequent stages (Alpha and Beta) with decisions on Round 3 Alpha funding expected shortly.

FY24 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 1,110 network and industry representatives from 44 organisations alongside 13 networks. With 57 speakers presenting, attendees had the opportunity to discuss lessons learned from innovation projects and reflect on the progress made against innovation targets.

FY24 also featured the Oxford Energy Innovation Forum (EIF), an in-person event held in September 2023. This was notable for being the first time the industry gathered to examine real-world energy assets in the field. The event was highly successful, bringing together over 130 delegates to discuss the future of domestic and commercial flexibility. A highlight of the forum was a walking tour showcasing various community flexibility assets. The forum served as a platform to spotlight innovation projects from all networks, fostering collaboration and knowledge sharing across the sector.

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[4] showed that networks reviewed 927 ideas with 629 of those ideas coming from external partners, the progress of those ideas is shown in Figure 7 below.

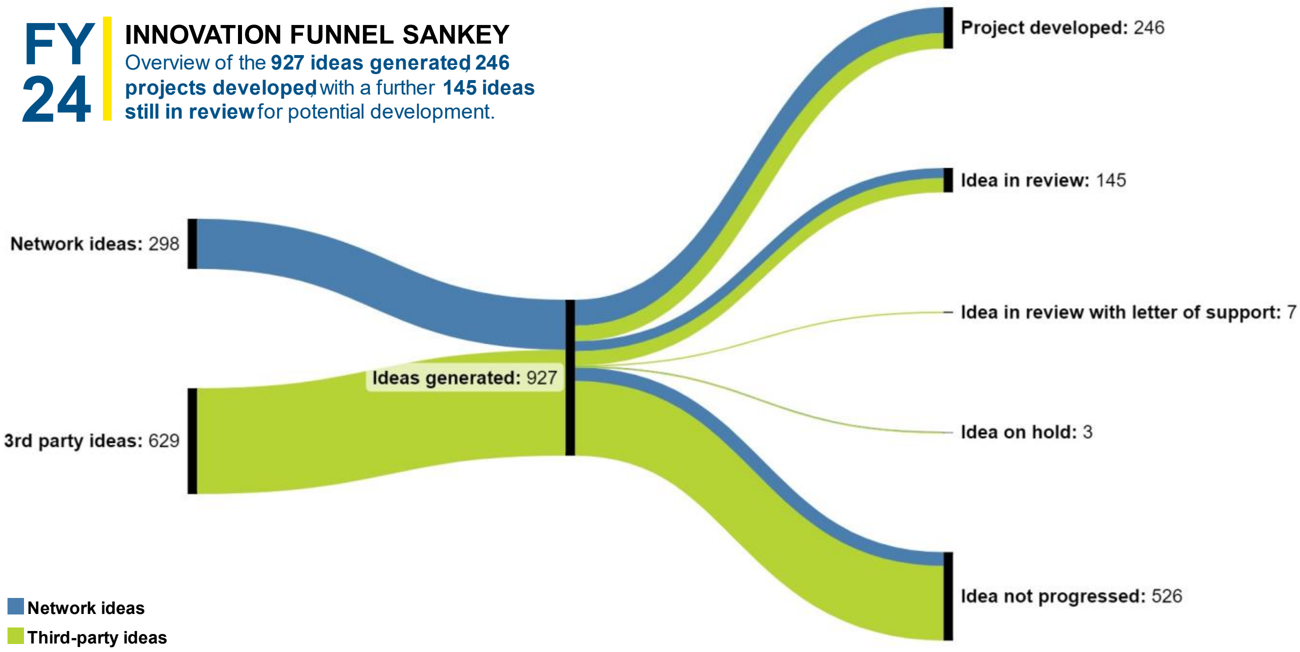


Figure 7. The innovation funnel for ideas received in FY24

Approximately a quarter of the ideas generated in FY24 were developed into projects; over half of the ideas generated were not progressed further by networks for not having sufficiently aligned with innovation aims or for not providing a strong business/investment case. The remaining projects are either on hold or are still

[4] The data behind Figure 7 has been taken from the Idea Log in the FY24 combined IMF entries from the networks.

under review with the networks. The robust governance process used to evaluate these ideas ensures that those that progress into projects are good value for money and are aligned to the shared set of network goals. Out of the 246 ideas developed into projects, 92 of those ideas came from third parties.[5]

Previous projects and learnings were also important drivers of network innovation in FY24 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. The Hydrogen Production for Thermal Electricity Constraints Management project is a prime example of a project that has built on learnings from at least five previous projects and is discussed in detail below.

Hydrogen Production for Thermal Constraints Management

Project ID: NIA2_NGESO036
Budget: £520,000
Networks: ESO, NGGT
Duration: Mar.2023 – Aug.2024
Status: Live

Overview: There are limits in the transmission system on the amount of electricity that can be transferred without overheating (thermal constraints). As renewable energy generation increases, and there is insufficient capacity to transfer power from generation sites to consumption areas. This is projected to cost consumers between £0.5-3 billion a year by 2030. Hydrogen electrolysis presents a potential solution by storing excess energy during high renewable generation periods. This project explores: i) the feasibility of using hydrogen electrolysis facilities for constraint management, ii) optimal facility locations for maximum system benefit, and iii) the necessary market signals to encourage strategic investment. Building on the learnings from at least five directly preceding projects, this project demonstrates the value of innovation funding in facilitating iterative and collaborative learnings, enabling continuous refinement, and knowledge sharing across diverse stakeholders, as shown in Figure 8.

Progress: The project has made significant strides in several areas. An interactive map tool was developed to visualise optimal sites for hydrogen production facilities based on thermal constraints. Three commercial pathways for hydrogen production including electricity balancing, hydrogen to grid, and hydrogen to refuelling station were considered. Economic and regulatory modelling efforts led to the identification of potential contract options for hydrogen facilities to provide a constraint management service, complemented by a technology evaluation comparing plant designs of various sizes. Additionally, the project assessed the technical and regulatory considerations for hydrogen blending into the gas transmission network. These outcomes collectively provide a comprehensive framework for understanding and implementing hydrogen production strategies in relation to thermal constraints and energy system optimisation.

Benefits: This analysis reveals significant advantages in utilising curtailed renewable electricity for green hydrogen production. Hydrogen production facilities can potentially mitigate the high costs of utilising generators in the balancing mechanism (BM) to resolve thermal constraints. This approach has key benefits including: i) reducing costs for both ESO and consumers in managing thermal constraints (the proposed funding for hydrogen producers through contracts is expected to be lower than the cost of curtailing renewable generation), ii) contributing to the decarbonisation of GB energy system by harnessing excess renewable

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

generation that would otherwise have been wasted, and iii) lowering costs of low-carbon hydrogen production, potentially reducing government costs on subsidising hydrogen production.

Significant Learning: This innovation project has provided valuable insights into the role of hydrogen production facilities in managing thermal constraints on the electricity network. The project demonstrates that it is technically possible to operate these facilities in a way to support constraint management. However, a key finding is that current market arrangements do not provide sufficient commercial incentives for hydrogen producers to actively participate in this role without additional support. The project demonstrates that a viable commercial case for hydrogen facilities to assist with thermal constraint management does exist, provided an access to an alternative electricity supply is available. The learnings highlight the potential of hydrogen production in constraint management and the need for market structure updates to fully realise this potential. The project underscores the need to align technical capabilities with economic incentives to drive energy system management innovation.

Next Steps: The project has led to multiple actionable recommendations. The first being the need to conduct a comprehensive Cost Benefit Analysis (CBA) to fully understand the economic implications of integrating hydrogen production facilities into thermal constraint management. The project also highlights the importance of engaging with Ofgem to determine whether the proposed solutions can be implemented within existing regulatory frameworks. These next steps are essential to translate the findings of the project into practical, implementable solutions that can enhance the efficiency and sustainability of the energy system.

> "Green hydrogen is a key enabler to unlocking net zero for the electricity network and understanding more about through this project will help to inform our decisions in the future about how we operate the network with more renewables on the system."
>
> *– Project Lead*

> "With the electricity generation continuing to transform at the same time as we expect to see new demands from hydrogen electrolysis, it has been extremely valuable to explore the potential links between the two systems and explore new ways of managing existing issues of transmission system constraints. This innovation project will directly inform our work investigating market options for constraint management, for example under the ESO's Constraints Collaboration Project."
>
> *– Project Lead*

Figure 8: Hydrogen Production for Thermal Constraints Management Constraints Innovation Roadmap

Innovation Cycle and Outcomes in FY24

Building from new ideas, previous projects, and ideas from FY23, the networks launched 235 innovation projects in FY24. With the 188 projects launched before FY24 which were still active, this totals 423 active innovation projects managed by networks throughout FY24.

In FY24, the networks have brought 208 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 208 projects which closed this year, 20% (42 projects) have been identified to lead to another project to further develop or trial the innovation being evaluated. This follow-on work will build the TRL of the solution being trialled or evaluate 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), is suited to the current regulatory environment, aligns with the overall strategic direction, and the network has the resources to implement, it can be embedded into BAU. A total of 20 projects have been brought into BAU during FY24, bringing the total number to 34 projects transferred into BAU within the first three years of RIIO-2. As networks are still in the early stages of RIIO-2, few projects have been fully deployed. However, it is important to note that the rollout of a project into 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).

Examples of Projects Informed by Past Learnings

The 220kV Single Circuit Low Profile Design project focusses on developing a 220kV single circuit low-profile design for overhead transmission lines to connect renewable energy developments with increasing electrical capacity, enabling cost savings by avoiding the need for additional power lines and reducing visual impact. The low-profile designs aim to provide a lower-cost solution for the energy system transition by reducing construction costs compared to conventional steel lattice towers. The project is expected to lead to 60% saving in construction per kilometre compared to conventional steel lattice towers. The project builds on the Low Profile 132kV Steel Poles project which designed innovative 132kV steel poles for overhead lines at altitudes above 300m, providing an alternative to steel lattice towers. Learnings from the 132kV project, including testing requirements and design considerations, informed the development of the new 220kV design.

> "This has been a really exciting project to be involved in. Not only has it been a great opportunity to connect green energy more efficiently, but it has also provided the chance to offer improvements to the safety of the operatives who will be working on the structures."
>
> *– Senior Overhead Line Engineer*

The HV Pinpoint project builds on findings from the Pre-Fix project. While the Pre-Fix project demonstrated that HV pre-faults can be detected, it also highlighted the need for new tools to take advantage of this. A pre-fault is an early sign of cable deterioration that occurs before a full fault develops, potentially causing an outage. Detecting pre-faults allows for proactive maintenance, significantly reducing the number of unexpected system outages, effectively providing consumers a better service. "HV Pinpoint is addressing this by developing several innovative technologies to find and respond to pre-fault activity. This includes advanced cable sensors, Precision Event Timing Units, a Pulse Injection Generator (PIG) for location validation and a sensor mat for pinpointing. The resulting system can either be used in conjunction with the Pre-Fix method to provide a more precise defect location, or as an alternative pre-fault method.

Another example of an iterative project is the Running Cool project which stemmed from the successful completion of the Overhead Line (OHL) Power Pointer project. The former project demonstrated the ability of the OHL monitoring devices to track live temperature of the conductor (along with other parameters) and to transfer the information into a distribution management system. Running Cool has utilised that development and demonstrated that live temperature of the conductor can be used to derive dynamic (short-term post-fault) ratings. This in turn enables increased network capacities without the need for reinforcement and the reduction of curtailed generation.

I've been using the NeRDA data for day ahead and half-hourly ahead grid load forecasting, and then calculating a dynamic grid tariff. This enables the control of flexibilities within the distribution network (such as EVs, heat storages, and heat pumps) to mitigate distribution grid congestion. The NeRDA API operates seamlessly, and the team's responsiveness and assistance have been exemplary.
– Collaboration Partner Lead Data Scientist

Another example of project iteration is the NeRDA project which has been successful in delivering real time power flow data from extra-high voltage (EHV), high-voltage (HV) and low-voltage (LV) networks for stakeholders in Oxfordshire. This enables stakeholders to derive maximum value from the use of the data. Local energy projects can now access near real-time information on connections opportunities and network constraints, allowing for better informed decision-making. A follow-on project, Near Real-time Data Access 2 (NeRDA 2) builds on the learnings from the earlier project and makes a series of enhancements, including increasing the amount of LV data that is made available to stakeholders, covering the whole of SSEN licence areas, as well as delivering additional data sets (such as transformer ratings) that contextualise the real-time data that is available.

The HyScale Liquid Organic Hydrogen Carriers (LOHC) Phase 2b SIF Alpha phase project exemplifies iterative innovation in hydrogen storage research. This project aims to conduct a CBA, technical analysis and create a research roadmap. It builds upon the HyScale LOHC Phase 2 project, which delivered a front-end engineering design (FEED) study for a 20kg/day hydrogen demonstration unit. The Phase 2 project explored LOHCs as a storage solution for managing seasonal fluctuations in domestic heat demand within a decarbonised hydrogen network. The Phase 2 project itself was an iteration on the earlier HySCALE – Feasibility study of the use of LOHCs for bulk hydrogen storage and transport Phase 1 project. This step-wise progression, including peer review of the Phase 1 project through the HyScale Academic Review project demonstrates iterative innovation in hydrogen storage technology development.

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 collated and reported in the IMF. The qualitative or non-financial benefits are by their nature more difficult to calculate but are essential to innovation progress. These benefits are widespread, coming in the form of progress towards government decarbonisation targets, technological advancement, improvements to system performance and resilience, improving the customer experience, supporting consumers in vulnerable situations, and much more. As underscored by the breadth of 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. As highlighted in the FY23 Annual Innovation Summary Report, the networks and ENA have continued to collaborate on a framework for measuring the social value created by GB energy networks over this past year.

Examples of individual project benefits

The IMF data can also provide valuable insights into the quantitative financial benefits innovation projects bring. These benefits typically range from the low £100,000s to forecasts exceeding £1 billion in net financial benefits by 2050, demonstrating the significant potential impact of innovation initiatives. SIF Beta projects show particularly promising financial forecasts. For example, the Digital Platform for Leakage Analytics project, which addresses the issue of gas leakage via enhanced network monitoring, is expected to deliver net benefits up to £524 million.

Predict4Resilience (P4R), a project that has developed a 'weather fault' tool for improved weather forecasting, is expected to deliver net benefits up to £7.8 million. It uses innovative machine learning to better pinpoint where weather-related faults will occur on the network, up to 7 days ahead. This allows networks to better position crews to respond to severe weather events and so reduce outage times and storm disruption.

NIA projects also showcase a wide range of potential benefits. Notable examples including the 220kV Single Circuit Low Profile Design project, which focusses on improving electrical capacity through enhancements in overhead transmission lines. The estimated net lifetime benefit value for this project ranges from £16.2 million to £71.2 million. The Satelline project, which explored satellite and AI alternatives to Light Detection and Ranging (LiDAR) surveys for vegetation management has an estimated benefit of £15 million. These figures underscore the substantial financial value that innovation brings, alongside the qualitative benefits discussed earlier.

The Environmental Risk and Assurance (ERA) project is all about improving network resilience in the face of climate change. It gives much better situational awareness so networks can pinpoint where and when network assets could be at risk from severe weather and decide how to manage the emergency. Through this project consumers benefit from improved network resilience and reliability.

The Storm Triage project is developing a dedicated network damage data capture tool to improve response to storms and prioritisation processes. By establishing robust communication channels between field operatives and coordinators, the project aims to improve Estimated Time of Restoration (ETR) for customers while reducing reliance on consumer-reported outages and empower trained members of the public to contribute to storm response efforts, ultimately reducing restoration times and minimise impacts of power outages on vulnerable communities.

> "We all recognise that severe weather events are happening more often. The ERA project will help us to protect vulnerable assets and keep power flowing to customers."
>
> *– Innovation Engineer*

> "We have a passion to drive the Storm Triage solution from an innovation output to an adoptable BAU tool that we truly believe will revolutionise storm response across the industry. None of this would have been possible without the support and faith of the ENA."
>
> *– Collaboration partner Engineer*

The Swarfless Cut Isolation System for SF6 Outages and Repairs (SCISSORs) project has developed a system to safely cut into and isolate Gas Insulated System pipework without producing metal shavings or debris (swarf), reducing the risk of new SF_6 leaks during repairs. This project has contributed to reducing SF_6 emissions, alongside providing consumers with potentially lower costs associated with efficiencies in defect repair activities and reduced gas top-ups. Another project which has led to environmental benefits is the Active Creosote Extraction (ACE) project which has demonstrated a new method to reduce the environmental hazards from redundant wood poles.

> "The SCISSORs project will help reduce repair costs and gas call-outs for SF6 top-ups, while avoiding new SF6 emissions."
>
> *– Senior Innovation Engineer*

Producing collective network and consumer benefits

The true power of the innovation process lies in the combined impact of innovative projects on system transformation. When the collective progress is viewed, it can be seen how these individual projects lead to significant impact. Projects like the ERA, Storm Triage and P4R collectively make a step change to enhance network resilience and energy response capabilities. By improving situational awareness, weather forecasting, and damage assessment, they create a more robust and responsive energy network. Environmental sustainability is enhanced through projects such as SCISSORS and ACE, which address different aspects of environmental impact, from reducing SF6 emissions to managing hazardous materials from old infrastructure. Improvements in asset management and operational efficiency are seen through projects such as Digital Platform for Leakage Analytics and Satelline. These innovations leverage advanced technologies to enhance monitoring and maintenance. This multifaceted innovation approach is key to produce whole system transformation. In combination, these projects lead to enhanced resilience, improved efficiency and a more sustainable network that is better equipped to meet future challenges. A prime example of an innovation project that has the potential to lead to system transformation is the NextGen Electrolysis - Wastewater to Green Hydrogen project and is discussed in detail further below.

A single project has multiple beneficiaries via direct and indirect benefits in both the immediate and long term. For example, networks benefit from improving their forecasting and investment planning resulting in lowered reinforcement spend for the network; these savings then pass on via cost reductions to the end customers. The whole host of innovation and BAU benefits, from physical operational improvements to leveraging iterative learnings and the creation of evidence base to support policy decisions have multiple downstream benefits. As such, for organisational and accounting purposes, it is typical to simplify project benefits based on their direct or immediate outcomes. To showcase a non-exhaustive list of benefits organised across relevant categories, acknowledging this simplification, the below figure has been produced. It depicts a sample of known BAU benefits that have been brought to bear by leveraging innovation funding for networks and non-network actors, organised on two axes to show the type of benefit and the primary beneficiary. As already highlighted, 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.

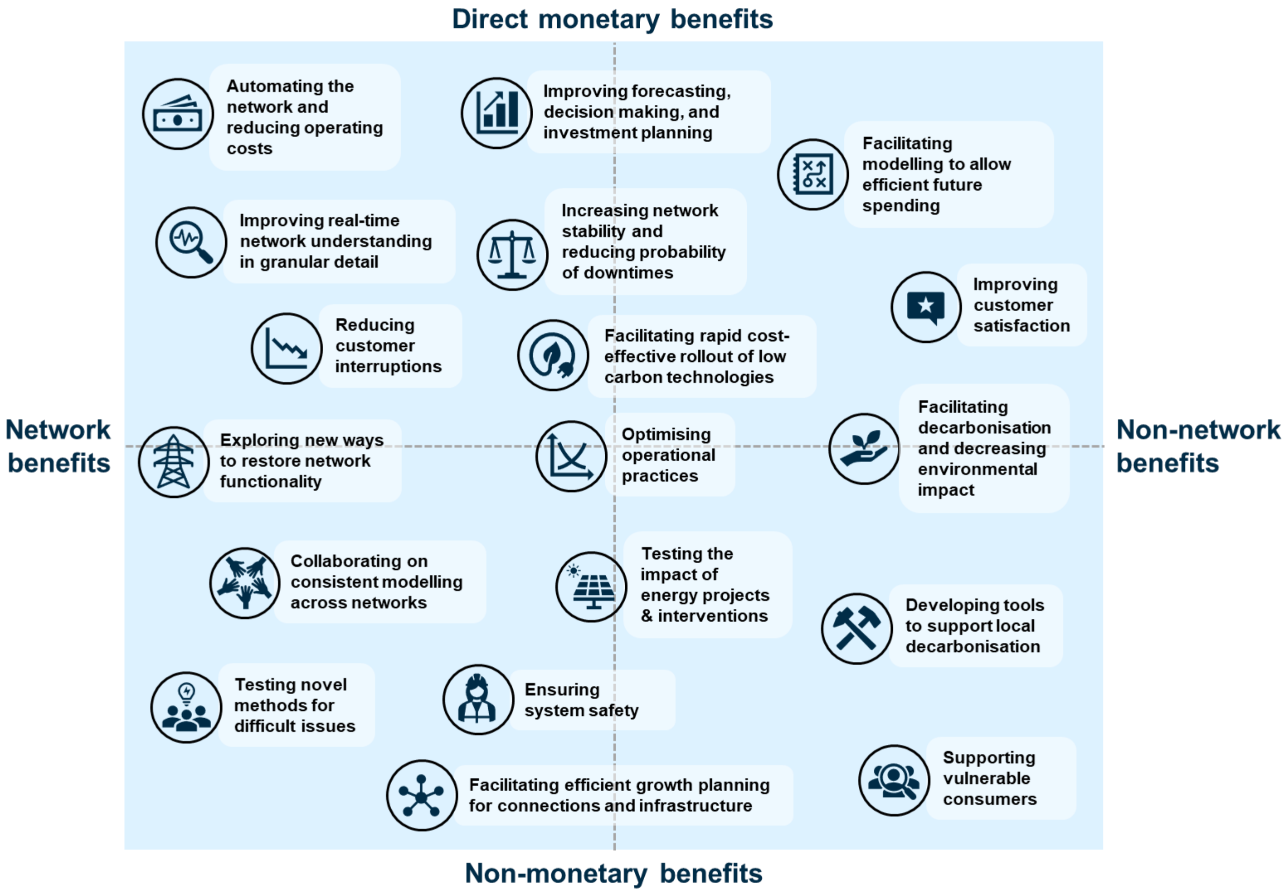


Figure 9. FY24 BAU innovation benefits by type and beneficiary

NextGen Electrolysis - Wastewater to Green Hydrogen

Project ID: SIF_WWU_2_3A
Budget: £328,761
Networks: WWU, NGED
Duration: Oct. 2023 – Apr. 2024
Status: Live

Overview: This project aimed to develop a more affordable and widely accessible electrolyser model for green hydrogen production, focusing on enabling the use of impure water sources that can be co-located around the network. This approach seeks to reduce costs and increase flexibility in hydrogen production. The project addresses limitations of the conventional polymer electrolyte membrane (PEM) electrolysis for green hydrogen production, which requires carbon-free electricity, purified water, and expensive rare earth metal membranes. By exploring impure water utilisation, the project sought to overcome barriers to efficient and cost-effective green hydrogen production. The research focussed on developing a flexible and economically viable method for green hydrogen production across diverse environments and scenarios.

Progress: This SIF project has successfully completed both Discovery and Alpha phases, with plans to progress onto the Beta phase. During the Discovery phase, the project revealed insights into water and energy demands of current methods for green hydrogen production, identifying potential challenges in water availability and infrastructure constraints. The project demonstrated that in order to produce 1 litre of purified water for electrolysis requires 6 litres of tap water. Extrapolating this to the Government's 5GW hydrogen production target for 2030 translates to a daily water requirement of 50 million litres, raising concerns about water availability in resource and infrastructure constrained locations. Feasibility studies confirmed the technological viability of new approaches and quantified the benefits of eliminating water purification from the process entirely. Building on these insights, the Alpha phase focused on experimental development and involved the deployment of an innovative membrane-less electrolyser and green noncorrosive electrolyte. These innovations enable the use of impure water feedstock and allow for better matching to fluctuating renewable energy sources, providing an experimental demonstration of the Discovery phase feasibility studies. The project is ready to be further refined and scaled during the upcoming Beta phase.

Benefits: The project has the potential to led to significant consumer benefits by making green hydrogen more affordable and accessible. By using impure instead of purified water, the project has the potential to reduce the lifetime cost of hydrogen (LCOH) by 19%, which can translate to direct savings for consumers. Environmental benefits are also substantial, with potential annual carbon savings of 2,345 $MtCO_2$ compared to natural gas. The project also has leads to water conservation with the potential to save up to 8000m^3 of water per GW of electrolyser capacity. The project suggests co-location services for water treatment and onsite gas demand production, as well as nodal hydrogen injection services for specific network locations, helping to lower the requirements of large electrical grid connections and minimising disruption to consumers while supporting reaching net zero targets.

Significant Learning: The project has yielded a range of interesting insights and outputs that have enhanced the understanding of integrating green hydrogen into existing gas networks. A comprehensive nodal gas network flow analysis has enabled for a precise matching of onsite hydrogen generation potential from renewables to energy demands, demonstrating the feasibility of hydrogen blending. Another key learning emerged from the seasonal analysis, illustrating significant variations in hydrogen production and deblending requirements throughout the year. Specifically, during summer, hydrogen production exceeded the combined demand of the site and the 20% blending potential, highlighting the need for storage solutions. This seasonal fluctuation presents both challenges and opportunities for efficient year-round hydrogen utilisation.

Next Steps: The project is now set to enter the Beta phase in September 2024 and aims to demonstrate the viability of a distributed hydrogen production model. This stage will focus on reducing operational barriers for small scale hydrogen production, potentially making the technology more widespread and accessible. A key component of this phase is a full-scale demonstration for up to 5 years, allowing for long-term testing and refinement. This extended trial period will target the resilience of energy systems and robustness of supply lines in gas distribution, which are crucial aspects of eventual BaU implementation. The Beta phase will provide valuable insights for both producers and distributers, supporting the transition to a low carbon economy.

"The project aims to improve the green hydrogen production process and reduce demands on water resources, by developing new electrolyser prototypes that can directly use impure water sources, like rainwater, final effluent, and seawater. So far, the technology has successfully produced over 94% purity green hydrogen from multiple sources."

– Collaboration Partner

Energy Innovation Atlas

Alongside the Energy Networks Innovation Strategy, a forward looking infographic – i.e. the Energy Innovation Atlas – was produced which provides a clearer articulation of the vision up until 2050 for enabling the full decarbonisation of the UK through the delivery of a resilient and sustainable future energy system. It aims to set out the key areas where change and innovation are required to achieve our shared decarbonisation milestones. The key areas and the objectives are as follows:

- **2050 infrastructure** – *Enhancing and transforming energy infrastructure to support a sustainable, efficient, and resilient future by improving network efficiency, adaptability to market and environmental changes, and reducing environmental impact.*
- **2050 system** – *Develop integrated and technologically advanced energy systems that facilitate seamless interactions between various sectors and industries, achieving operational efficiency and supporting the goal of Net Zero emissions.*
- **2050 operation** – *To cultivate a highly collaborative, flexible, and consumer-engaged operation model for energy networks, driving fair participation and innovation in the sector.*
- **2050 consumer interactions** – *To transform consumer interactions within energy networks to be more inclusive, responsive, and resilient, ensuring that all consumers, especially those vulnerable or with high demands, receive optimal support and services.*
- **2050 industry** – *To strengthen the energy industry's infrastructure and operational efficiency through strategic oversight, skilled workforce development, and robust regulatory frameworks.*

The infographic on the next page visualises the Energy Innovation Atlas, providing a visual representation of an exemplary set of relevant innovation projects under each of the five key areas. While the Innovation Atlas extends to 2050, the timeline displayed focuses on the near-to-medium term actions. Intermediate goals and milestones are represented by flags in the timeline and example projects that support these are listed below each flag. It is important to note that the Innovation Atlas key areas are neither mutually exclusive internally nor externally against the joint industry's identified themes, objectives, and principles. Many projects have overlaps across multiple areas. Additionally, almost every project incorporates some aspect of consumer interaction (the fourth key area), highlighting the central role of consumers in the energy transition.

Energy Innovation Atlas – Charting a Net Zero Course to 2050

	2024	2026	2028	2030	2032	2034
2050 infrastructure	**Developing a hydrogen pipeline** HyNTS Deblending HyNTS Compression	**Innovating assets and approaches** VoltXpanse Pre-Fix		**Improved connections** BLADE High Voltage Auto Quote		
2050 system			**Enabling whole energy systems** HyNTS Maritime H_2 Production for Thermal Electricity Constraints Management	**AI-enabled optimisation** Intelligent Gas Grid Powering Wales Renewably		**Optimised systems** QUEST Sentinel
2050 operation		**Eased participation** Constellation Demand Flexibility Service Evaluation			**Leveraging storage** HyVoltage Net Zero Terrace	**Flexibility required** Development of Microgrids Consumer Building Blocks
2050 consumer interactions		**Vulnerable customer support** VENICE Power Protect		**High energy users** INDUS PRIDE	**Improved communication** Homeshield Lessons learnt from the Past	
2050 industry		**Clear delineation of roles** Hydrogen Clusters Gas Control System		**Training and upskilling** AI Centre of Excellence Hydrogen Skills and Competencies	**Improved public knowledge** Headroom – Whole Systems thinking	

Next Steps

Opportunities Ahead

Reflecting on the RIIO-2 period to date, innovation has shown progress across all strategic themes, with a particularly strong focus on the themes of 'Net zero and the energy system transition' and 'Optimised assets and practices.' Of the 235 projects launched this year 73% (172 projects) were registered with one of these as their primary theme, representing 63% of funding registered over the financial year.

Beyond the registered themes, the expanded PEA requirements for RIIO-2 (including ensuring NIA-funded 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 wider lens. The updated 2024 Energy Networks Innovation Strategy, a combined (electricity and gas) network strategy, further reinforces this approach. The joint approach ensures that network innovation takes a whole system approach and aligns with the UK's overall low carbon innovation portfolio. The strategy also introduces the Innovation Atlas which establishes 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 individual network strategies for the next year highlight a continued focus on the net zero and optimisation themes, while also developing projects across the other strategy themes. A varied pool of innovation projects throughout RIIO-2 will ensure that networks are addressing the full range of challenges facing the future energy system. Additionally, there is a notable trend of increasing transition to BAU. During FY24, 20 innovative project solutions were successfully integrated into BAU, bringing the total to 34 within the first three years of RIIO-2. This momentum is expected to continue as we progress further into the RIIO-2 period, with an increasing number of innovation projects making the transition to BAU.

As we progress through RIIO-2, several key trends are emerging in the ways innovation is being approached and executed. Projects are increasingly iterative, building on learning from previous projects and continuously learning over extended periods of time and across funding streams. Wide and open dissemination has helped spread learning from projects carried out by other networks. In addition, collaboration has remained a key component of network innovation with projects fostering partners between networks and third-party innovators. This collaborative model promotes knowledge sharing and leverages diverse expertise, leading to impactful innovation and a feedback loop to pass learnings into future projects in an iterative fashion. Moreover, this collective learning enables a holistic transformation of the networks towards a net-zero future, moving beyond point-to-point solutions to create systemic change across entire energy systems. This long-term strategic approach also enables gradual refinement and a more effective integration of successful demonstrations as solutions into BAU. A prime example of a project that is being rolled out into BAU and has delivered real customer value is the Power Protect project and is discussed in detail below.

Power Protect

Project ID: NIA_UKPN0084
Budget: £246,250
Networks: UKPN

Duration: Oct. 2022 – May 2024
Status: Live

Overview: Power Protect was a project aimed at supporting the most vulnerable customers during power outages. The project provided portable power supplies to these customers when they faced extended periods of time without electricity. The focus of the project was to develop tools and processes to proactively identify customers who are medically dependent on electricity, experiencing unplanned power cuts, and are expected to be without power for more than four hours.

Progress: The project involved the development and testing of a robust process to provide eligible customers with portable battery packs in specific circumstances. This included establishing collaboration teams across the network taking place in London, Maidstone, Canterbury, and Bury St Edmunds regions. As part of the trial development, the Research Institute for Disabled Consumers (RiDC) were engaged to conduct research to understand the needs of targeted customers through surveys, in-depth interviews, and trials. The detailed recommendations that came from the interviews fed directly into the Power Protect procedure before the trial began.

Benefits: The project developed and trailed a proactive identification system for vulnerable customers, an automated support offering and battery dispatching tool along with forecasting capabilities. These innovations enhanced customer safety, reduce operational cost during power outage restoration and improve service delivery. The project provided critical support for medically dependent customers, offering faster responses to their needs during power cuts, reducing the risk to their health and their comfort.

"For people who depend on potentially-lifesaving medical equipment, they need the confidence they'll be safe on those very rare occasions when power is temporarily unavailable, and this new scheme is doing just that."

– *Innovation Program Manager*

Significant Learning: The project has led to several key insights. Firstly, that existing work processes may require adjustment in order to tailor support to customers with varied and complex needs. Another key learning relates to continuous charging of battery units being problematic and logistically challenging; this was addressed during the project by using smart timer plugs which enabled automated control of charging periods. Finally, the project also demonstrated key patterns in medical device usage; for example, some devices are only used during night-time, providing important information for improved targeting of support and efficient resource allocation.

Next Steps: The project is now being extended to all three of UKPN's licence areas. Additionally, the hours of operation are being increased to 24/7. Another key activity is to complete a second phase of work with the RiDC involving a trial with ten customers to robustly evaluate the Power Protect service and provide feedback. In line with continuous improvement, the network is also considering any improvements to the service for those with complex needs. Other networks have also been engaged to share learnings and approach to support their ambitions to roll out a similar service offering to their customers.

Key Learnings

Moving into the third year of Ofgem's RIIO-2 price control period, an additional 235 projects have launched, a further 208 projects have been completed, and the networks have integrated 20 additional solutions into BAU (bringing the total over the RIIO-2 regulatory period so far to 34). As these projects progress and many come to a close, networks are increasingly looking to deploy the developed solutions and their learnings into BAU. However, this process is not always simple or straightforward and can bring about its own set of challenges – networks face limitations and high-level strategic changes; innovation takes time, and the process is not always linear; innovation does not always lead directly to a BAU rollout; and some projects focus on creating evidence or testing future feasibility and so are developed without the intention of being rolled out into BAU as they support the wider learning and knowledge required to transform the network. A summary of these challenges and the lessons learned is presented below in Figure 10.

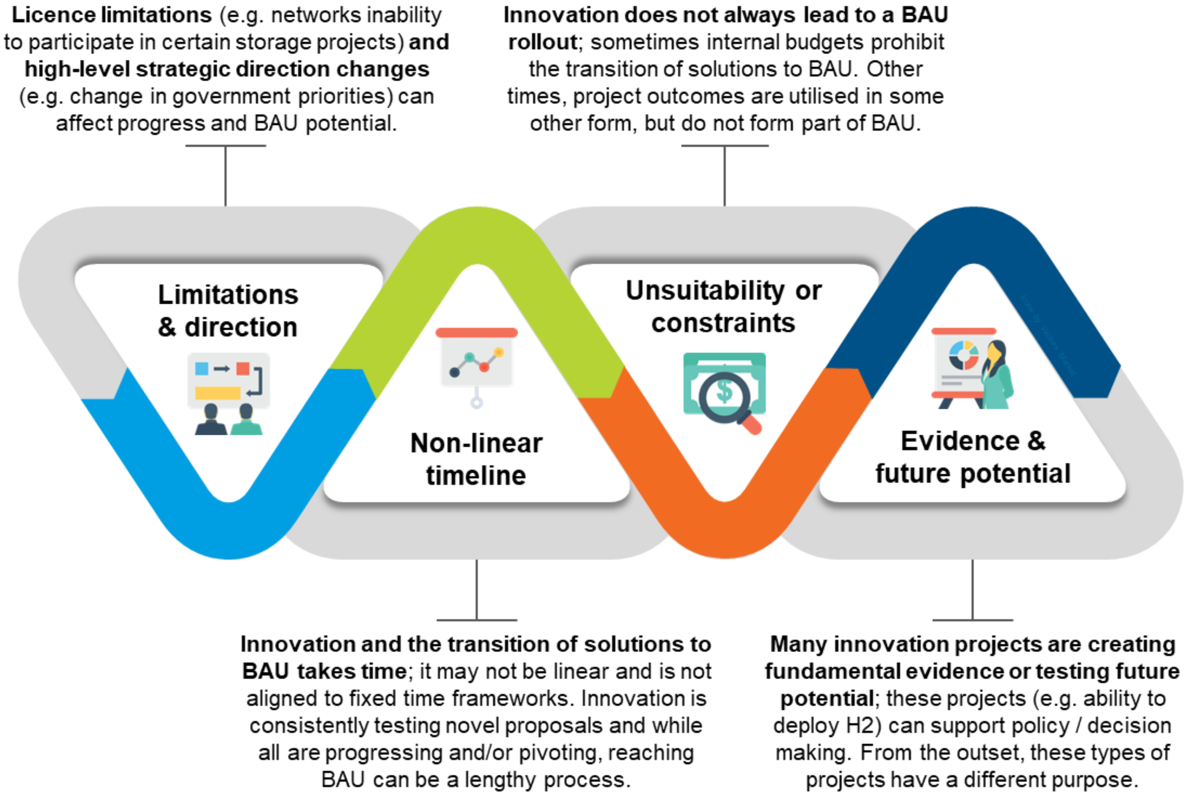


Figure 10. BAU challenges and lessons

Recommended Actions

In line with the noted 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 solution development process 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 return on investment for these projects to both senior leadership and the wider energy industry. Compounding this challenge is the high proportion of low TRL projects, which are critical for pushing innovation forward, however, make quantification of benefits challenging due to their experimental nature and uncertain outcomes. ENA will also be looking to ensure future updates and improvements to the IMF feed in to and align with this piece of work.

Some networks also feel that additional funding earmarked for deploying innovative work into BAU would help overcome the resourcing/policy/organisational practice hurdles to integrating these solutions into everyday operations. To address some of these challenges, Ofgem are proposing to introduce a Future Regulation Sandbox (FRS), an innovative policy instrument to test and trial changes to the energy rulebook in a controlled environment before implementing them. This initiative could help mitigate some of the regulatory barriers to innovation. However, the specifics of deployment are often outside of the scope of innovation projects, and networks still 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.

Appendix I. Network overview

Energy Networks

As this report is focused on RIIO-2 funded innovation over FY24 (April 2023 to April 2024), its focused on the key innovation progress by the gas and electricity networks in the third year of the RIIO-2 period. Unlike last year's FY23 report (where the electricity distribution networks had not yet entered their ED2 period), projects initiated by electricity distribution networks are reflected in key reporting metrics (such as the balanced scorecard) as well as in the case studies and projects linked throughout the report.

Each network has prepared an individual innovation summary for FY24 (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-D
	SSEN
	UKPN
	ENWL
	NPg
Electricity Transmission	NGET
	SPEN-T
	SSEN-T (SHET)
Electricity System Operator	ESO
Gas Distribution	WWU
	NGN
	Cadent Gas
	SGN
Gas Transmission	NGT

About 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, 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 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 III. FY24 Project List & Status

The projects active over FY24, as identified in the IMF, are organised according to their "primary strategy theme". A name-matching process has been used to ensure accuracy in categorization. These details are now available in the companion Excel tile titled "Project Log for Annual Innovation Report - 2024", which accompanies this report and includes a comprehensive log of projects over the RIIO-2 period.

Appendix IV. Future Project Log

The ideas from the IMF "Idea log" have been reviewed by the networks over FY24 with some launching in FY24 and others set to launch in the coming years. The IMF "Idea log" tracks innovative concepts reviewed by the networks, and the entries marked as "project developed" have been included in the "Future Project Log." A name-matching process has been used to exclude ideas already recorded as projects in Appendix III. FY24 Project List & Status. These details are now available in the companion Excel file which accompanies this report on the sheet titled "FY24 Future Project Log".

Appendix V. Acronyms

Acronyms	Description
AI	Artificial Intelligence
BAU	Business As Usual
CBA	Cost Benefit Analysis
DNO	Distribution Network Operator
DSO	Distribution System Operator
ENA	Energy Networks Association
EHV	Extra-High Voltage
FRS	Future Regulation Sandbox
HV	High Voltage
IMF	Innovation Measurement Framework
LCT	Low Carbon Technology
NIA	Network Innovation Allowance
NIC	Network Innovation Competition
NTS	National Transmission System
LV	Low Voltage
LAEPs	Local Area Energy Plans
NESO	National Energy System Operator
OHL	Overhead Line
Ofgem	Office of Gas and Electricity Markets
PV	Photovoltaic
RIIO	Revenue = Incentives + Innovation + Outputs
SF_6	Sulphur Hexaflouride
SIF	Strategic Innovation Fund
TRL	Technological Readiness Level
UKRI	UK Research and Innovation

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