Electricity System Operator

Innovation Strategy

2023/24

ESO

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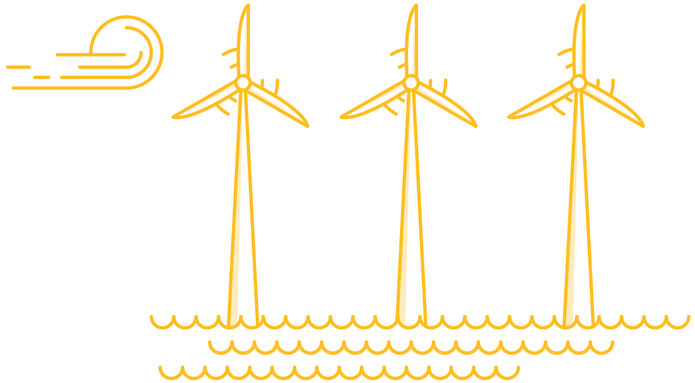


Introduction

As Great Britain's Electricity System Operator (ESO) we are at the heart of the nation's energy system. We make sure that the electricity network operates safely and efficiently around the clock, so that homes, businesses and industry always have the power they need. We're also helping to tackle one of the biggest challenges facing society: how to create a sustainable, low-carbon electricity system for the future that will help the UK meet its net zero commitments.

Innovation plays a vital role in this effort, which is why we're working with partners from the energy industry and beyond to harness new technologies, markets and ways of working to support the energy transition.

This refresh of our ESO Innovation Strategy sets out our innovation priorities for the year ahead (2023/24). These are longer-term priority challenges, with projects that are typically higher-risk and have greater uncertainty in their outcomes, as opposed to our Business as Usual activities – which our innovation projects will build upon and go beyond, to deliver benefits for the ESO, wider energy system and consumers.

Foreword

The ESO Innovation Strategy refresh is always a balancing act.

You need to have a good idea of what the future holds so that you can identify the right challenges the system will face, but also have a good grasp of the past to set the right level of ambition and prioritisation. What can actually be achieved, and by when?

This time it will be no different. As we look back at the past year, we can't ignore how much the world has changed. Russia's invasion of Ukraine fundamentally challenged the way Europe started thinking about energy security. In some cases, it resulted in governments having to rethink security of supply and entire generation fleets. At a minimum it added a true sense of urgency to the energy transition journeys each was on.

In our role at the centre of the energy system, the ESO recognised that the incoming winter would be particularly challenging and so developed and pursued a suite of new tools to manage the risk. Our ability to think innovatively and move bravely resulted in a world first Demand Flexibility Service, delivered by energy users who were incentivised to reduce consumption (turn off) power at key times. This is especially outstanding considering that barely a couple of years ago our Innovation Strategy explored the potential of consumer participation in these markets!

The past year has also seen our transition to FSO (Future System Operator) progress even further. This common goal will result in an increasing number of roles and responsibilities for the business, and the need for further development of our skills and abilities. As a result of all this, although our Innovation priorities remain largely unchanged, the scope that each encompasses has evolved, closely following our improved understanding of the energy system challenges. Our thinking now includes increasingly more energy vectors and the ability to think holistically for the whole country, not just in terms of electricity. Innovation needs to keep up with this ever-changing landscape, and we have responded by stepping up our work in optimisation by leveraging digital tools such as better data resources, and Machine Learning (ML) technology to improve our modelling.

Access to multiple sources of live, usable data has become essential in running the system efficiently and holistically. Our work in promoting the development of a Virtual Energy System, or an ecosystem of connected digital twins across the entire energy landscape, is a reflection of this need. We have spent the year identifying successful value propositions for data sharing, and campaigning for the convergence of data quality and exchange standards.

Expanding our Data and Digital ambitions however caused us to hit an engineering wall, which is limited computational power, or the inability to run too many calculations in short periods of time. We have now started to explore horizon setting, and optimisation of computation techniques, to become more selective and intelligent in determining what needs to be calculated, and when.

We also ran into what is now an industry wide concern, which is the worrying scarcity of Digital and AI skilled resources working towards the decarbonisation of the energy system. As we grow into our FSO ambitions, we have started to explore the creation of a Centre of Excellence, accessible to all industry. The ambition is to connect global, world leading AI/ML resources with the ESO and wider energy industry to solve business problems, inspire the next generation of data scientists in energy and create a space to collaborate. We also aspire to share best practice to drive research and deliver specific ML solutions for the energy industry.

As usual it is my hope that this document and our efforts be perceived as a call for "all hands on deck" to come join us.

Anna Carolina Tortora

Head of Digital Transformation and Innovation Strategy

Highlights of the year

Innovation Team

- Hosted the first post-pandemic **Open Innovation Event** since late 2019. The in-person-event enabled the rapid development of 5 innovation projects, selected from over 60 proposals received from industry, academia and other innovators
- Established a dedicated team for the **Virtual Energy System** programme, an ambitious, industry-wide mission to create interoperable digital twins of the energy system. The dedicated Stakeholder, Common Framework and Use Case teams are progressing the three workstreams of the programme
- Was awarded funding to progress **CrowdFlex**, a project that explores the role of domestic flexibility in grid management, to the Alpha phase of the Strategic Innovation Fund. The Alpha phase focused on gaining a better understanding of the system challenges and potential solutions using domestic assets

Was awarded a further increase in Network Innovation Allowance (NIA) funding for the remainder of the RIIO-2 price control period, bringing the total allowance for innovation projects to approximately £47M over the five years from April 2021 to March 2026.

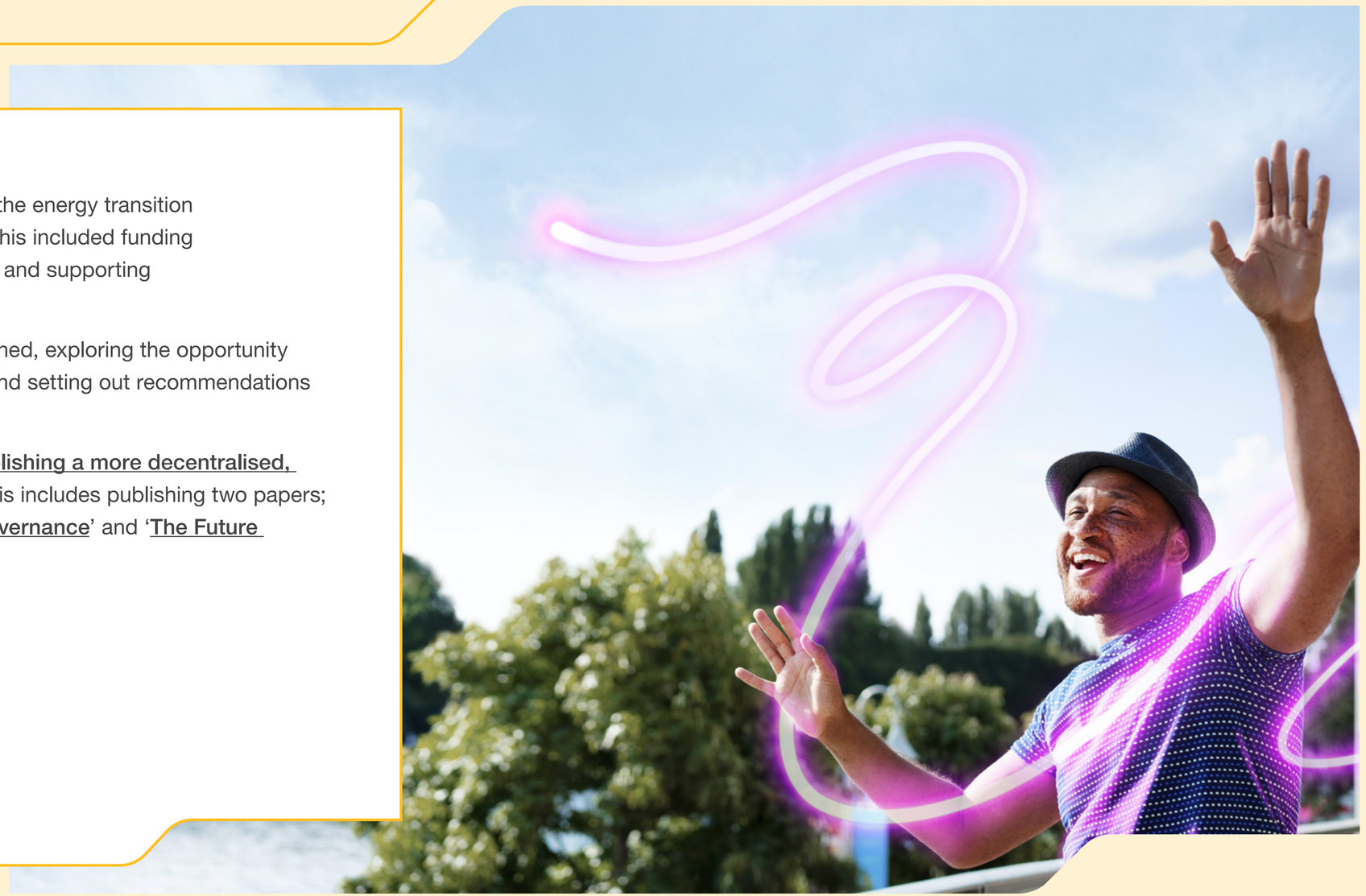
ESO

- ESO, BEIS, Ofgem and National Grid agreed to set up an expert, independent **Future System Operator (FSO)** with responsibilities across both the electricity and gas systems. The FSO will be in the public sector with operational independence from Government
- In collaboration with electricity suppliers and aggregators, ESO launched a new **Demand Flexibility Service** (DFS) for winter running between November – March 2023. The service incentivises consumers and businesses to reduce their power consumption at certain times to help ESO avoid using its emergency responses if electricity supplies are impacted
- ESO saw a number of electricity generation records broken last year, as detailed in our **Britain's Electricity Explained: 2022 Review**:
  - Second greenest year on record, second only to 2020
  - First time wind generation provided over 20GW of electricity
  - Lowest carbon intensity month since records began
  - Greenest day on record.

Highlights of the year

Whole Energy System

- UK Government allocated funding to accelerate the energy transition in a number of industries, sectors and vectors. This included funding to develop cutting-edge energy storage projects and supporting hydrogen and nuclear innovation
- Earlier this year the Net Zero Review was published, exploring the opportunity that the net zero transition presents for the UK and setting out recommendations on how we can create a green economy
- Ofgem is 'consulting on the next steps in establishing a more decentralised, decarbonised and dynamic energy system'. This includes publishing two papers; the 'Future of Local Energy Institutions and Governance' and 'The Future of Distributed Flexibility'.



Portfolio Analysis

To monitor our success, we track alignment of the innovation portfolio against priorities for the previous year. This graph (Figure 1) shows the level of effort (indicated by Number of projects) and funding (Sanctioned value for NIA and SIF projects live in 22/23).

Digital & Data Transformation received the most attention as one of the top priorities but also due to being linked as a secondary priority on many projects.

The number of projects developed to address Constraint Management is lower than expected, however we recognise that this is due to the main activity addressing this priority being done through Business as Usual as part of the Constraint Management Pathfinder, and innovation projects will support this work where possible.

Key insights

- ESO had 62 live innovation projects last year

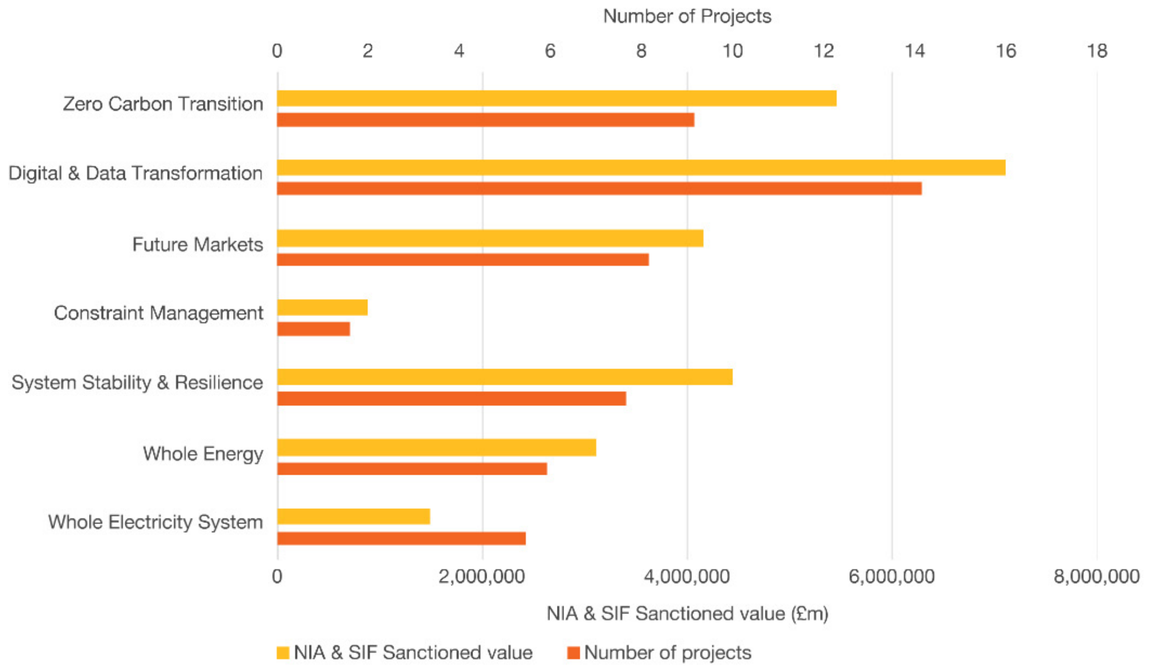
Network Innovation Allowance (NIA)

- 35 NIA projects were registered last year, with 13 NIA projects continued from the previous year
- 34 of the innovation projects addressed two priority areas (as a primary or secondary link)

Strategic Innovation Fund (SIF)

- SIF Discovery (Round 1) – ESO led 2 SIF Discovery projects and partnered with other networks on another 8 projects
- SIF Alpha (Round 1) – ESO led 1 SIF Alpha project and partnered with other networks on another 3 projects

Figure 1.



Performance against our 22/23 Innovation Strategy: Number of projects linked to the 7 priority areas and sanctioned value for NIA and SIF projects live last year linked to the 7 priority areas.

Drivers of Change

The four megatrends of Decarbonisation, Decentralisation, Digitalisation and Democratisation continue to drive change on the GB energy system. We refresh our priorities in the innovation strategy each year, partly in response to the changing dynamics of these four megatrends.

The ESO's Future Energy Scenarios (FES) work helps us to understand the potential impact of these changes by 2050. The UK government's clear target for the UK to be "powered entirely by clean energy" by 2035 makes the ambition clear and highlights the already significant progress of renewables and the closing down of large coal generators.

The ESO's Bridging the Gap work, which builds upon FES and identifies the tangible "what needs to happen now" actions, looks specifically at the 2035 Net Zero target and how this will be achieved. The question of how GB can deliver net zero through a 'whole system' approach to energy is also a key driver (and focus area for Bridging the Gap work).

Drivers of Change

Decarbonisation

The UK government has published clear policy and proposals for how the power system is to achieve net zero carbon by 2035. Decarbonising the heat and transport sectors is going to require a complete revolution in technology, markets and consumer behaviour. The knock-on impact on the power system is going to be huge.

Democratisation

Better access to information and technology will allow communities and consumers to be much more actively engaged in energy system operation. This important trend means we must continue putting the consumer at the heart of our innovation activities, not just ensuring delivery of robust consumer benefits from projects, but how we can facilitate better consumer participation in the energy markets.

Decentralisation

As energy resources become more decentralised (e.g. embedded solar and batteries), Distribution Networks will need to become DSOs (Distribution System Operators). We need to fundamentally rethink the various roles and responsibilities in the market and remove any barriers to ensure this transition continues.

Digitalisation

As exponentially more assets connect to networks and participate in energy markets, there will be increasing complexity and uncertainty in supply and demand forecasts. Better quality and more peripheral data will be required to optimise balancing actions in future. While open data and digitalisation are key to achieving whole system thinking and delivering net zero.

2023/24 Innovation Priorities

This table summarises our strategic innovation priorities for 2023/24, where you can expect to see us concentrating our innovation focus this year. A more detailed rationale for this prioritisation is given in the following pages, where we dive a bit deeper into each priority, as well as showcasing some of the projects in these areas that we are currently working on or have planned.

Order	Innovation Priority	Previous Order (22/23)	Rationale
1	**Zero Carbon Transition**	1	Remains a top priority to ensure the zero carbon transition is delivered in a timely and responsible way for the benefit of all consumers.
2	**Digital & Data Transformation**	2	Remains a top priority to drive digitalisation and ensure greater transparency and open access to make data more accessible and easily understood. Revised to also address the challenge of processing calculations from a vast number of data and algorithm intensive models, including how to incorporate them within existing ESO processes.
3	**Whole Energy System**	6	Becomes a higher priority as we explore how to optimise across different energy vectors as part of our transition to a 'Future System Operator'. This priority will incorporate remaining Whole Electricity System challenges
4	**Future Markets**	3	Remains a priority with ESO's ambition of enabling 'competition everywhere', more opportunities remain for understanding the long-term options for market design. Revised to include new market design across transmission and distribution networks.
5	**Constraint Management**	4	Still a key challenge for the ESO, more opportunities remain for innovation projects to help address this challenge.
6	**System Stability & Resilience**	5	Still a key challenge for the ESO, more opportunities remain for innovation projects to help address this challenge.
–	**Whole Electricity System**	7	This priority will be paused to reflect the increasing work on this challenge being addressed through Business as Usual (BAU) activity. The Whole Energy System and Future Markets priorities will incorporate any remaining innovations to address the challenges of DSO and ESO interaction.

Priority 1: Zero Carbon Transition

The need to rapidly decarbonise our power system is only becoming greater, therefore Zero Carbon Transition continues to be our top priority for 2023/24.

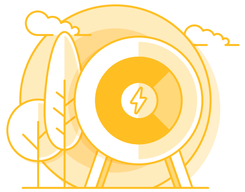
With the UK target to achieve this by 2035 fast approaching, we believe progress can be accelerated through innovation. We will continue to work with industry and our subject matter experts to enable new research and technology, development and testing of solutions to ensure the zero carbon transition is delivered by the ESO and wider energy system in a timely and responsible way for the benefit of all consumers.

Key Challenges

The key challenges of this priority remain the same

- As we move to an energy system with lower levels of carbon emissions, it becomes increasingly difficult to remove the final, harder-to-decarbonise aspects of the system.
- Fundamental changes need to be made to system planning and operation to ensure zero carbon is possible.
- Operating a zero carbon system while maintaining security and resilience.
- There is currently no standard way to calculate the carbon intensity of generators, making it hard to assess and track carbon intensity on the system.

Alignment



Supports ESO's commitment of ensuring the electricity system can operate carbon free by 2025

Supporting our RIIO-2 priorities

Innovation projects and initiatives developed to address this priority will support ESO's overarching priority of 'Holistic planning and development for net zero'.

Policy and regulation

Establishing a Department for Energy Security and Net Zero demonstrates the UK Government's focus on the energy transition as a priority.

Wider industry

We are collaborating with other networks on this priority through the theme of 'Net zero and the energy transition', a strategic theme of the Energy Networks Innovation Strategy 2022.

Priority 1: Zero Carbon Transition

Where we are today

Completed projects and those in delivery

*Year of completion

***2019**	Development of GB Electric Vehicle Charging Profiles Improving demand forecasting for electric vehicles by developing a series of hourly annual profiles.
2023	Carbon Intensity Modelling Using available data and relevant knowledge from scientific literature, researching and developing a refined model that will improve the accuracy of carbon intensity for power generation.
2024	Solar PV Nowcasting Exploring whether more accurate predictions for solar electricity generation could reduce the amount of 'spinning reserve' required, using deep machine learning techniques.

Pathway

We are currently developing projects looking at:

How best to assess, track and predict carbon intensity.

- Developing a tool to better inform customers and producers about carbon impact of connecting to and operating in the grid.

Opportunities remain to:

- Predict how much reserve capacity is required to ensure security of supply from renewable sources and understand how long-duration storage can help support intermittent generators to allow the system to run with a higher penetration of renewables.
- Create new market mechanisms that account for carbon intensity of participants to optimise our future system, e.g., for lowest cost and least carbon intensity.
- Understand the long-term effects of climate change on the GB energy system and how to prepare – including how the transition to renewable generation and the electrification of transport and heat will change the energy landscape for all stakeholders.

Case Study: DER Visibility

As the volume of connected distributed energy resources (DERs) continues to grow, the ESO needs to develop greater visibility of data pertaining to DERs such as; power outputs, locations, availability etc. and forecasts for when new DERs will be connected and operational.

The Challenge

An increasing number of flexible assets are being connected to local distribution networks. These flexible assets can provide the ESO with balancing services such as the new Demand Flexibility Service. Flexible assets range from dedicated Distributed Energy Resource including solar, wind and battery storage through to devices in consumers' homes such as electric vehicles and heat pumps. The number of these flexible assets is growing quickly, but we don't always have definitive data that can tell us more about these assets, such as where they are located in the country or how they will be providing services to the ESO. This makes it difficult for us to predict how the grid will behave and where we might experience new operational challenges.

More detailed understanding of distributed flexibility could help providers access ESO markets and allow the ESO to operate the network more effectively and efficiently.

The Project

This is a brand new, two-stage project which has been proactively created in response to interest from the Whole Systems and Control room teams about the impact of the increasing volume of distributed flexibility on the network, recognising it as both a challenge for ESO and an opportunity to advance control room capabilities. While it is a standalone project, its findings will complement other innovation projects, particularly around market flexibility.

Through the project, the DER Visibility & Probabilistic Modelling team will explore what data is already available within the organisation and what information other industry stakeholders and partners have collated which could help improve ESO's visibility of these assets.

In the future, the project's learnings could be used as a springboard to develop an artificial intelligence (AI) forecasting tool, using the various DER data to inform Control Room decisions in real time.

Case Study: DER Visibility

Benefits

With greater visibility of distributed flexibility on the network, we can provide the Control Room with more accurate data which will help reduce the operational risk of managing a more decentralised energy grid and help ESO reach its net zero ambitions. It will also enable the expansion of the flexibility market for smaller assets and also the introduction of new models, such as third party aggregators, to make the network more cost effective to run, therefore delivering value for customers.

Next Steps

The first phase of the project will involve mapping out the current sources of Distributed Energy Resource Data.

The team will be identifying key internal stakeholders within ESO to build awareness of the opportunities and challenges DER visibility creates, and to agree a frame of reference for the data required for the project.

External partners, such as DNOs, will also be consulted in stage one as the data sought may already be available within the wider energy industry.

The findings of the discovery stage will inform the second stage of the project and what workflows are necessary to deliver the required outcomes.

Project Information

NIA Reference	Project Name	Status
NIA2_NGESO029	DER Visibility	*In delivery

Registered Value
TBC

*Status as of March 2023

Case Study: DER Visibility

Meet the project team

The project is very much in its infancy, so more colleagues and partners will become involved as it progresses. The ESO teams which will be involved in stage one are; Whole Electricity System, Policies & Frameworks, Regional Development Programme, Virtual Energy System and AI Centre of Excellence.

Deepak Lala: I am the DER Visibility Manager and I have just joined the team from the Control Room, so I bring a wealth of operational experience and insight to the project.

Andrew Wainwright: I am the Head of the Whole Electricity System team and will be overseeing how this data can be used across different aspects of the business such as in planning and demand forecasting.

Our Partners

UKRI Science and Technology Facilities Council
Hartree Centre

Interested in learning more about DER Visibility?
Contact Alex Hurley, Innovation Business Partner, to find out more.

Priority 2: Digital & Data Transformation

Digital & Data Transformation continues to underpin the success of ESO tackling almost all of its ambitions while leading the energy transition, therefore continues to be a top priority for 2023/24.

The digitalisation challenge remains great, but through collaboration with industry and other networks we are making progress. Programmes such as AI Centre of Excellence and Virtual Energy System are empowering the wider energy system to work together by setting up the tools, channels and frameworks required to drive digitalisation.

Key Challenges

The ongoing challenges of this priority are still a focus

- The energy sector is becoming more integrated, with the number of new participants and systems rapidly increasing.
- Driving digitalisation and a whole system approach requires greater transparency and open access to data.
- Risk of cyber-attacks is growing as electricity networks become more reliant on data and aging technologies.
- Consumer choices need to be informed by insights and data provided by industry in an accessible way.
- To unlock flexibility as a trusted and cost-effective solution to intermittent generation ESO will require access to large volumes of open data to support better forecasting and market signals.

A new challenge to address

Over recent years we have seen an increase in the number of innovation projects developing new data intensive models and scripts to address current and future system challenges. Following the development of these new products, the ESO now faces the challenge of processing the vast number of calculations resulting from these data and algorithm intensive models, and how to incorporate them within existing processes.

Digital & Data Transformation will now address this improvement process, considering:

- What do we need and when – to ensure we can access (only) the data we need in the correct format at the time we need it.
- How can we be more efficient in how we model the data and have capacity to analyse increasingly large, complex datasets?
- How do we make better use of the data and insights we have access to, in a way that enables more efficient and optimised decision making?

An example of this is the Advanced Dispatch Optimisation project – this work aims to understand what could be possible with existing, or new data and optimisation techniques, to improve the way actions are taken in the Balancing Mechanism.

Priority 2: Digital & Data Transformation

Alignment

Supports ESO's ambition of being 'innovative, digital and data driven'

Supporting our RIIO-2 priorities

Digital & Data Transformation is also a top priority for the ESO in Business as Usual activity with our RIIO-2 Business Plan 2023-2025 estimating £556 million investment in IT, an increase of £149 million since the previous plan.

Innovation projects and initiatives developed to address this priority will support ESO's overarching priority of enabling 'Innovation and change through digital, data and technology'.

ESO's Digitalisation Strategy and Action Plan

ESO's Digitalisation Strategy and Action Plan sets out our digitalisation plans across the different roles (Control centre operations, Market development and transactions, and System insight, planning and network development). Although the plan is focused on Business as Usual activity, it shares the same view that 'digitalisation and data will underpin the transition to net zero' by addressing the challenges of:

- 'Better monitoring and management of the system'
- 'Improved sharing of large quantities of high-quality data and the analytics this enables'
- 'Developing customer centric digital capabilities'

Policy and regulation

In July 2022 BEIS, Ofgem and Innovate UK responded to an Energy Digitalisation Taskforce report, highlighting the importance of innovation in digitalisation to 'enabling the transition to a smart, flexible, and decarbonised energy system at the lowest cost'.

Wider industry

We are collaborating with other networks on this priority through the theme of 'Data and digitalisation', a strategic theme of the Energy Networks Innovation Strategy 2022.

Priority 2: Digital & Data Transformation

Where we are today

Completed projects and those in delivery

*Year of completion

*2021	Control REACT Understanding the cost impacts of forecast errors and demonstrating how probabilistic forecasts can lead to more efficient decision making.
2022	Advanced Dispatch Optimisation Assessing the feasibility of developing an advanced dispatch optimisation tool for the Balancing Mechanism (BM). A Common Framework for a Virtual Energy System Exploring the scope for the Common Framework – the technical standards and engagement principles which stakeholders can follow to build an interoperable ecosystem of digital twins (Virtual Energy System). Optimal Outage Planning System Developing a tool that facilitates the most efficient economic decision making from the year-ahead plan to three-weeks ahead, in addition to identifying and tracking risks.
2023	Peak Demand Forecasting Studying the latest advancements in peak demand forecasting, both in GB and globally, in addition to quantitatively assessing the drivers of peak electricity demand. Virtual Energy System – Common Framework Demonstrator Small-scale demonstrator to test the ability of the Common Framework and develop best practice guidance through application to a tangible use case centred on whole-system flexibility. Probabilistic Machine Learning Solution for Dynamic Reserve Setting Setting reserve levels dynamically, day ahead, using artificial intelligence and machine learning. AI Centre of Excellence Assessing the value and business impact of advancing data science, artificial intelligence and machine learning capabilities available to the ESO and determining whether an AI Centre of Excellence model is the optimal route for building this capability and driving innovation in collaboration with external stakeholders.
2024	Balancing Costs Forecasting Improving existing short term forecasts by applying machine learning and cutting-edge forecasting methods. Co-optimisation of energy and frequency-containment services (COEF) Developing a novel prototype software tool for achieving co-optimisation of energy and frequency control services.

Priority 2: Digital & Data Transformation

Pathway

We are currently developing projects looking at:

Giving teams access to better quality data and models

- Developing model-driven strategy for balancing optimisation to enhance the capability of balancing transformation to define their requirements and understand candidate solutions.
- Demonstrating how the EFCC Monitoring and Control System can be installed and integrated within the existing communications network and connect to commercial generation sites.

Working towards faster decision-making using AI and machine learning

- Developing an enhanced fast-driven artificial intelligence tool to extract network stability constraints close to real-time and investigating possible interactions of future market participants.

Processing large amounts of data to make the most economic, efficient and effective decisions

- Delivering decision support to the control room using advanced optimisation techniques and data-driven approaches.

Opportunities remain to:

- Give teams access to better quality data and models to produce useful insights about the system as its characteristics continue to get increasingly complex.
- Work towards faster decision-making to match our more complex, faster-moving electricity system using AI and machine learning.
- Understand how these techniques can process the large amounts of data required to make the most economic, efficient and effective decisions, in sufficient time – from long-term network planning, to running new markets, to real-time operations in the Control Room.

Case Study: AI Centre of Excellence

Being able to interpret and use data effectively is key to solving some of the big challenges associated with operating a net zero electricity network, and this is why we need to attract more brilliant and talented people with data science skills to join the energy industry.

The Challenge

Artificial Intelligence (AI) and Machine Learning (ML) are increasingly being used in our innovation projects to solve some of the complex problems uncovered by the energy transition. Using AI and ML we can interpret and analyse large amounts of data in different ways to create useful tools, algorithms, valuable insights and predictions that we can use to operate the electricity network with more renewable energy resources.

To maximise the potential of AI and ML, we need to improve data science capabilities. This requires advanced IT Infrastructure and new ways of working so that data can be used effectively and shared across different teams.

We also need to attract more people with the necessary skills and experience in AI and ML to solve our big data challenges. However, attracting data scientists to the energy sector is very difficult as they are in high demand across a range of industries, which is increasing competition in recruitment.

The Project

The AI Centre of Excellence project has been established to put the necessary structures and world-class resources in place to grow the organisation's data science capabilities and help make ESO an attractive place for data scientists to come and work.

The project will create an ongoing pipeline of talent by building partnerships with academia, industry, networks and tech ecosystems. It will make the ESO more appealing to prospective candidates by promoting opportunities to work on cutting edge projects where data science skills also positively impact society and the planet.

The long-term vision for the AI Centre of Excellence is for it to establish a collective AI workforce which can be used by the wider energy industry to accelerate decarbonisation and digitalisation to meet net zero targets.

Case Study: AI Centre of Excellence

Benefits

Expanding data science capacity and capabilities in the ESO and the wider energy industry will open up a whole new world of possibilities not seen or considered before, where AI and ML is used to deliver the insights and tools required to meet net zero targets. The AI Centre of Excellence will provide an expert resource pool which will improve existing data-focused activities and therefore the safety and reliability of operating the electricity network, and drive forward the ESO's digitalisation strategy which is integral to the energy transition.

Next Steps

After successfully outlining its vision, the project is now moving into the Minimal Viable Products (MVP) stage where the team will start the build process and expand on the five core functions the AI Centre of Excellence was designed to create. Through this work, the project team will prove the value of AI and ML to the ESO, and the value of partnerships in finding AI solutions.

Project Information

NIA Reference	Project Name	Status
NIA2_NGESO021	AI Centre of Excellence	*In delivery

Registered Value
£266,000 (excl. extension)

*Status as of March 2023

Case Study: AI Centre of Excellence

Meet the project team

The AI Centre of Excellence will utilise the skills and experience of colleagues from a variety of ESO teams including Operational, Human Resources, Future System Operation and IT.

Lyndon Ruff: I am the AI Centre of Excellence Manager, based within the Innovation team. I lead the team responsible for building the AI Centre of Excellence and engaging key stakeholders from within the ESO, industry and academic institutions.

Darya Nizhnikova: I am the Customer Innovation & Technology partner, responsible for integration of the AI Centre of Excellence across ESO, wider energy industry, technology companies and academia.

Arman Sarjou: I am a Data Scientist at the ESO, working on building robust, data-driven software products to help optimise our energy transition.

Our Partners

Capgemini

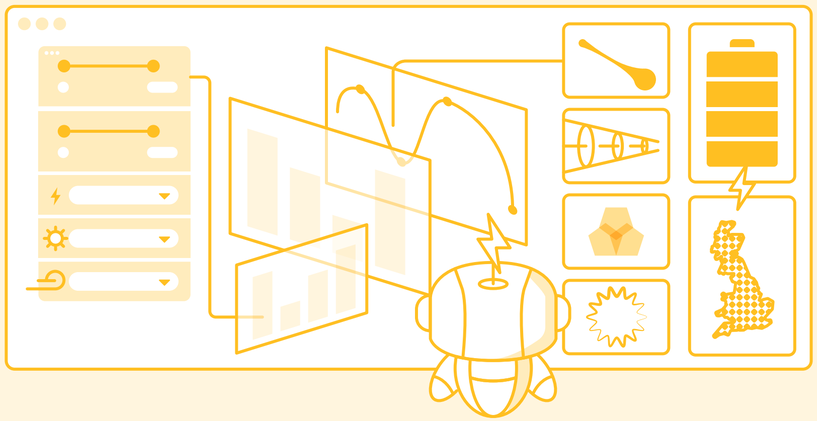
We are also engaged with a wide range of stakeholders including Edinburgh University, University of Bath, Google DeepMind, Octopus Centre for Net Zero, Centre for AI & Climate and Faculty.

Interested in learning more about AI Centre of Excellence?
Contact Charlotte Horne, Innovation Business Partner, to find out more.

Virtual Energy System: Powered by ESO

As we progress towards net zero emissions, we are driving ahead with our initiative to develop an ecosystem of connected digital twins of Great Britain's energy system through the Virtual Energy System (VirtualES) programme.

Our ambitious, industry-wide mission to digitise Britain's energy system could provide the ability to generate insights, and model solutions to cut real-world carbon emissions, accelerating the transition to net zero.



Projects

Having launched the VirtualES in late 2021, the past year saw completion of the project's Discovery phase through the Strategic Innovation Fund. During Discovery we worked to evaluate key factors setting the scope of the Common Framework, testing against real-world scenarios. We are now stress-testing the standards and governance framework that will soon facilitate collaboration and compatibility across the energy industry as we move to turn the VirtualES into a reality.

In 2022 we were awarded funding to progress CrowdFlex, a VirtualES use case project that explores the role of domestic flexibility in grid management, to the Alpha phase of the Strategic Innovation Fund. The Alpha phase focused on gaining a better understanding of the system challenges and potential solutions using domestic assets.

We are also developing innovative use cases for the future digital twin. The Advanced Dispatch Optimiser (ADO), once operational, will rapidly analyse data from the VirtualES, helping grid operators plan for a range of potential system scenarios, and improve dispatch decisions within our transforming energy system.

The more data provided within the Common Framework, the more powerful the VirtualES becomes and the more accurately tools like the ADO will be able to analyse the system.

Virtual Energy System: Powered by ESO

Advisory Groups

Three industry advisory groups are being established to facilitate expert input, support, and overview of the Virtual Energy System programme:

- Data & Technology – connecting physical infrastructure, enhancing modelling & analysis and creating an interoperable technology stack
- People & Process - building capabilities & skills, engaging stakeholders, and creating a governance framework
- Use Cases – providing expert input and insights, enabling ESO to make informed decisions regarding prioritisation and development of use cases for the VirtualES.

Seats will be held by senior representatives across industry and academia with the first advisory group meetings due to take place in the first half of 2023.

Next Steps

We are excited to be announcing the next major step for the VirtualES project this summer, when we will share the principles for the Common Framework used to build the VirtualES, to industry. The principles will enable industry players, with support from the project advisory groups, to prepare to share data through the VirtualES and build out longer-term roadmaps of use cases.

Visit our website to find out more or contact us.
Join our mailing list to stay updated on the latest VirtualES news and events.

Priority 3: Whole Energy System

As ESO transitions to become Future System Operator (FSO) with responsibility across both the electricity and gas systems, we will leverage our unique position and collaborate with industry to find efficiencies and optimise across different energy vectors to transform the whole energy system.

Key Challenges

The previous challenge of this priority is still a focus

- How can we improve efficiency and enable decarbonisation by considering energy vectors (electricity and multiple gas types) and sectors (heat, power, transport and industry) alongside each other?

Also now incorporating any distribution and transmission interaction challenges from the previous Whole Electricity System priority

- How can products, markets and best practice be aligned across distribution and transmission networks?

Alignment

Supporting our RIIO-2 priorities

Innovation projects and initiatives developed to address this priority will support ESO's overarching priorities of 'Driving towards a whole energy system approach' and 'Transitioning to FSO'.

In addition to the existing roles the ESO undertakes today, whole energy planning will become a key activity of the FSO; with strategic network planning and market strategy across both gas and electricity to provide a whole energy system view.

Future Energy Scenarios

A key recommendation of the ESO's Future Energy Scenarios (FES) 2022 is that 'strategic coordination and whole energy system thinking, especially across the electricity and hydrogen sectors, is required to achieve decarbonisation targets'.

Wider industry

We are collaborating with other networks on this priority through themes of 'Whole energy system' and 'Optimised assets and practices', both strategic themes of the Energy Networks Innovation Strategy 2022.

Priority 3: Whole Energy System

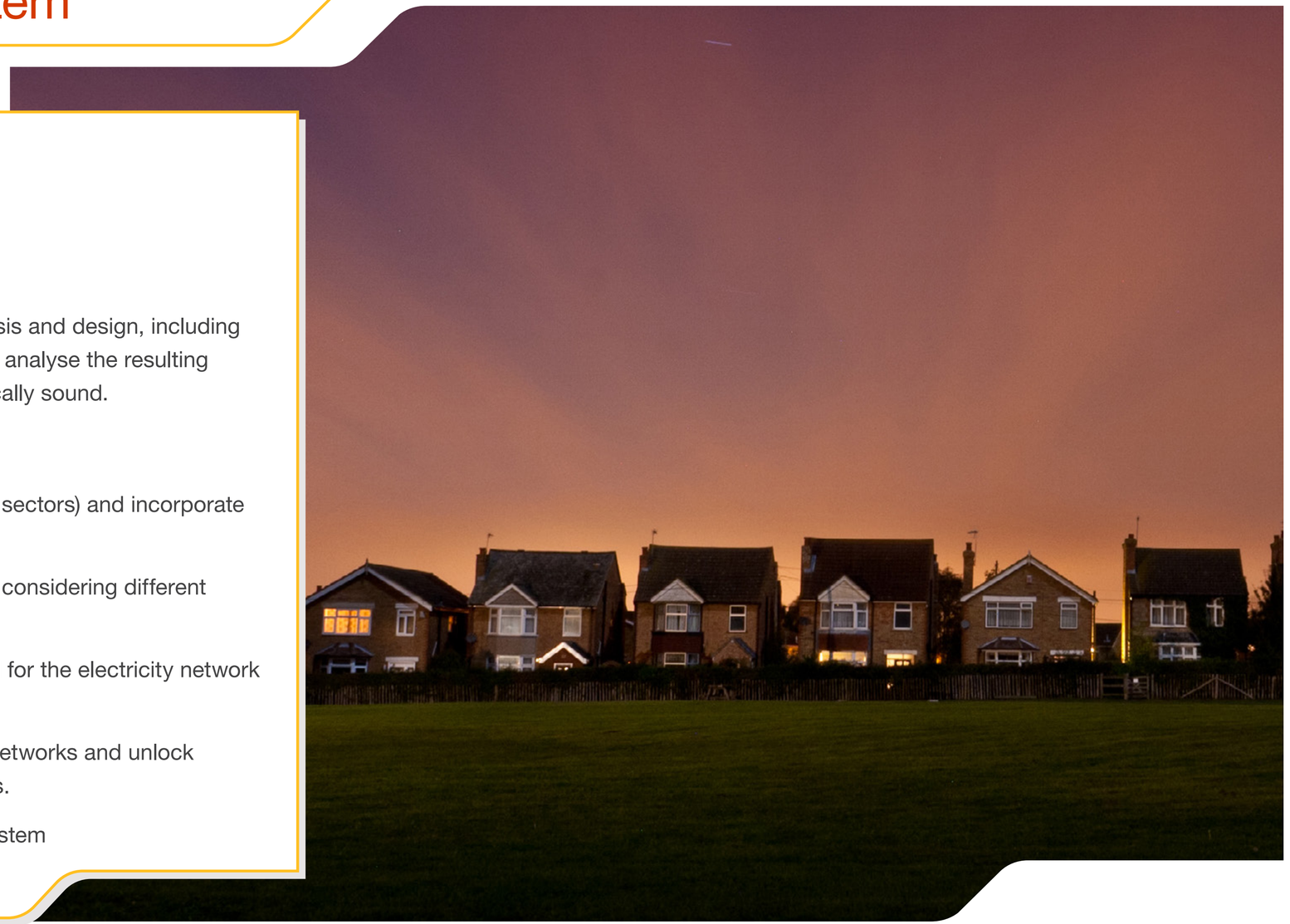
Where we are today

Completed projects and those in delivery - this includes projects addressing both the Whole Energy System priority and previous Whole Electricity System priority

*Year of completion

*2022	The Role for Hydrogen as an Electricity System Asset Understanding how the development of hydrogen markets will interact with the electricity system, and how targeted hydrogen investment can more effectively support the electricity system.
2023	Gas and Electricity Transmission Infrastructure Outlook Creating knowledge in the transmission approach to whole systems that can utilised by UK networks to determine future strategies and approaches.
2023	ANM – Balancing Coordination Demonstration (ABCD) Building on a previous project that looked at options for coordination between balancing services and ANM systems to specify, build and test upgrades to an ANM system to enable coordination of balancing services under a range of operational scenarios.
2023	System value from V2G peak reduction in future scenarios based on strategic transport and energy demand modelling Developing tools and methods to better understand the potential of V2G in reducing the peak demand in the network and identifying the impact of different parameters on the success of V2G.
2023	Consumer Archetypes Developing a set of consumer archetypes covering gas, electricity and hydrogen to benefit the further development of future energy scenarios across the whole system; gas, electricity and hydrogen, transmission and distribution.
2023	Role and Value of Electrolysers in Low-Carbon GB Energy System Analysing the benefits of linking electricity and hydrogen vectors from a whole system perspective to determine the optimum capacity, location, technologies, and system benefits of electrolysers under different future development scenarios.
2024	COMMANDER – Coordinated Operational Methodology for Managing and Accessing Network Distributed Energy Resources Conducting a techno-economic feasibility assessment, impact assessment and producing a roadmap of the ESO and DSO coordination schemes.

Priority 3: Whole Energy System



Pathway

We are currently developing projects looking at:

Improving how we model the whole energy system

- Research into best practises on whole energy system analysis and design, including case studies and examples of models that could be used to analyse the resulting network design to ensure it's both economically and technically sound.

Opportunities remain to:

- Improve how we model the whole energy system (across all sectors) and incorporate this into our work with FES, NOA, and Early Competition.
- Support further impact assessments and feasibility studies, considering different energy vectors in parallel.
- Identify and explore flexibility services that could be created for the electricity network – as other sectors, like transport and heating, decarbonise.
- Solve issues that affect both transmission and distribution networks and unlock additional network capacity through joint innovation projects.
- Develop methods for how we build more complex, whole system models, which use data from both ESO and DSO.

Priority 4: Future Markets

Designing markets that are fit for purpose continues to underpin the ESO ambitions of ‘competition everywhere’ and achieving zero carbon operation.

We are continuing to develop innovation projects to explore the long-term options for market design and whole system solutions required to reach net zero.

Key Challenges

The key challenges of this priority remain the same

- Understanding what and how different aspects of the energy system will change how markets function e.g. technologies, consumers, characteristics of the system and business models.
- Understanding and testing different market reforms.
- Exploring how consumers, including those in vulnerable situations, can become active participants in the system and identifying how to best facilitate their engagement.

With the Whole Electricity System priority being merged, Future Markets will also address new market design across transmission and distribution networks.

Alignment

Supports ESO’s ambition of ‘driving competition for the benefit of consumers’

Supporting our RIIO-2 priorities

- Innovation projects and initiatives developed to address this priority will support ESO’s overarching priorities of ‘Reforming our balancing and ancillary markets’ and ‘Supporting wider market reform’.

Wider industry

We are collaborating with other networks on this priority through themes of ‘Flexibility and market revolution’ and ‘Supporting consumers in vulnerable situations’, both strategic themes of the Energy Networks Innovation Strategy 2022.

Priority 4: Future Markets

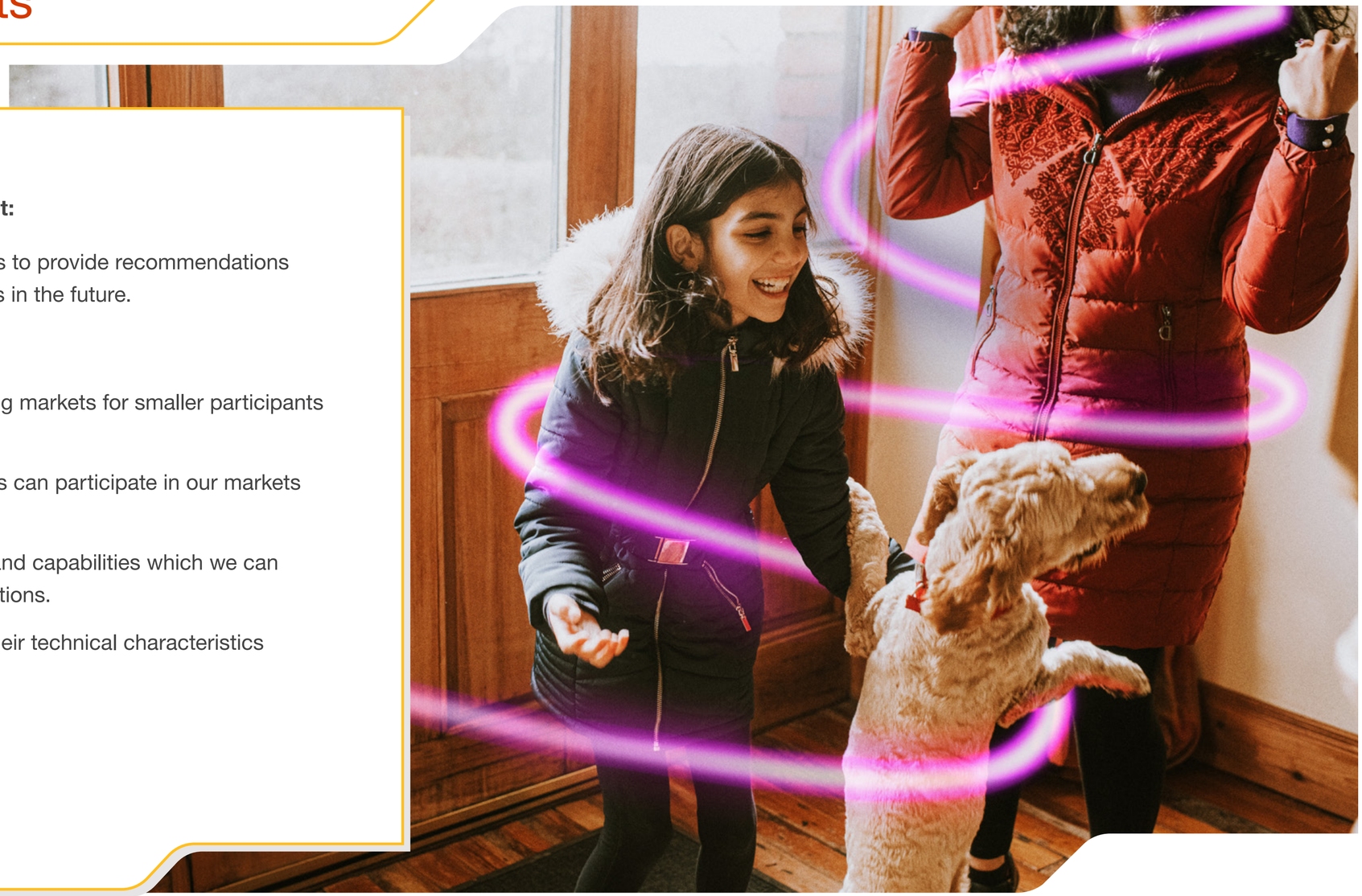
Where we are today

Completed projects and those in delivery

*Year of completion

*2021	Frequency Response Auction Trial Testing whether closer to real-time procurement of frequency response will lower overall procurement costs by increasing liquidity and transparency in the market, and deliver a stable market price for the relevant products.
2022	Stability Market Design Considering current stability arrangements and investigating the best option for an end-to-end stability market.
	Mass Market Flexibility (CrowdFlex) Exploring the opportunities for households providing a reliable support to the network through aggregated energy flexibility and developing a baseline methodology with recommendations for adoption.
	CrowdFlex: Discovery Exploring how the energy industry would like to see domestic flexibility resources play an active role in energy markets and services.
	Reactive Power Market Design Exploring if a reactive power market could be developed to help ESO access more reactive power in the right location, create market access for more providers, incentivise new technologies and lower overall spend on reactive power control.
2023	CrowdFlex: Alpha Delivering an innovative specification for consumer demand and flexibility models and developing a plan for conducting randomised control trial to study and gather data covering different aspects of demand-side services.
	REVEAL Investigating the feasibility of and developing a proof of concept for a digitally ringfenced, balancing and constraint market which enables ESO to act autonomously in building innovative concepts, services and solutions.
	Service Provider Capability Mapping Addressing the knowledge gap and generating guidance on how to design future markets and better account for changing asset types.
	Enduring Cross-Border Balancing Exploring the possibilities and implications associated with the introduction of a new balancing market in GB, able to interact with EU balancing markets.
	Future of the Transmission Network Charging Methodology Exploring the feasibility and impacts of future options for change to the transmission network charging methodology to send insightful long-term decisions.
	3MD Market Monitoring Model Development Development of a more sophisticated machine learning based solution to monitor the market for suspicious activity relating to manipulating, insider trading and breach of Grid Code.

Priority 4: Future Markets



Pathway

We are currently developing projects looking at:

- Building on the Demand Flexibility Service trials to provide recommendations for increased participation and improve offerings in the future.

Opportunities remain to:

- Learn how to remove barriers to new and existing markets for smaller participants and new technology types.
- Investigate how highly distributed, smaller assets can participate in our markets and how we can support this.
- Develop more effective market modelling tools and capabilities which we can use to assess future market designs and interactions.
- Understand potential new consumer markets, their technical characteristics and their entry requirements.

Case Study: CrowdFlex

Domestic consumers could help ESO, Distribution Network Operators (DNOs), suppliers and flexibility providers to manage the grid in the future by being flexible about when they connect and switch on their electric vehicle (EV) chargers, heat pumps and even white goods.

The Challenge

A key challenge of the energy transition is how to balance supply and demand when there is more renewable energy generation on the network – which is not as able to flex up and down as required to meet peaks and troughs in demand – especially with the current, rapidly growing demand from consumer's shifting to Low Carbon Technologies such as EV chargers and heat pumps.

One solution is to shift flexibility from being a service delivered supply-side (generators) to something delivered demand-side (consumers) to help keep the network balanced. Domestic flexibility services could include new tariffs and incentives which would help consumers to reduce their energy bills – for example by charging their EVs when wind generation is high – in a way which benefits the energy system too.

However, domestic flexibility is complex. It is statistical in nature - while a given household may or may not respond to a request for flexibility, in aggregate many households will. But how do ESOs, DNOs and flexibility providers predict and manage this type of uncertainty?

The Project

In response to these challenges, CrowdFlex, a Virtual Energy System (VirtualES) project, is exploring how demand and flexibility models can enable the forecasting, planning and delivery of useful day-to-day domestic flexibility.

CrowdFlex also aims to utilise trialling to generate the modelling data and explore how domestic consumers can be used as a flexibility resource. This will include using smart, automated devices (including smart white goods, EV chargers and heat pumps) to change consumer demand to match supply. For example, the study will examine day ahead scheduled services where consumers in different regions adjust their demand up or down to help manage any forecasted constraints on the network.

CrowdFlex builds on the pioneering work done by the previous CrowdFlex NIA project and the Domestic Reserve Scarcity Trial, which addressed how changing consumer behaviour can influence decarbonisation and create options to help operate the whole energy system.

Case Study: CrowdFlex

Benefits

The CrowdFlex project is demonstrating how ESO may be able to turn the challenge of additional EV chargers and heat pumps into domestic demand-side services that will support greater penetration of renewable generation and the delivery of a low carbon energy system.

Demand-side flexibility could also reduce the cost of network reinforcements, as there is less stress on the system, and cut the cost of procuring grid balancing services by enabling greater market participation from smaller assets, which ultimately lowers energy bills for consumers.

Next Steps

CrowdFlex completed its Alpha phase at the end of January 2023. As well as a wealth of background research, the team has delivered an innovative specification for consumer demand and flexibility models, as well as a plan for conducting randomised control trials to study and gather data covering many aspects of demand-side services.

Several periods of trialling are planned, covering at least two winters and one summer. These trials will develop the data for the demand and flexibility models, helping the ESO and flexibility providers to forecast consumer flexibility. The project will also contribute to the development of domestic flexibility services, providing insight on the effectiveness of domestic demand-side response services and how these could work day-to-day to help with issues such as local and national constraints, for example.

Project Information

SIF Reference	Project Name	Status
10037410	CrowdFlex: Alpha	Complete

Registered Value
£606,196

Case Study: CrowdFlex

Meet the project team

The CrowdFlex project is being supported by teams from across ESO, including; Virtual Energy System programme, Customer & Stakeholder, Networks (Zero Carbon Operations), IT, National Control and Markets teams.

Dozie Nnabuife: I am the Use Case Manager for the Virtual Energy System, leading the Use Case workstream of the programme to identify and deliver innovation projects, like CrowdFlex, for use case challenges.

Mark Sunderland: I am the Use Case Project Lead for Virtual Energy System, leading the delivery of Use Case projects such as CrowdFlex.

Joanna Webb: I am a Stakeholder Engagement Lead for the Virtual Energy System, looking after stakeholder engagement and communications for the Use Case workstream.

James Kerr: I am the Consumer Strategy Lead for ESO's Consumer Stakeholder team and a Project Sponsor for CrowdFlex.

Catherine Colvin: I am a Senior Operability Analyst in ESO's Zero Carbon Operation team and a Project Sponsor for CrowdFlex.

Our Partners

octopus energy

Ohme

Centre for Net Zero
Powered by Octopus Energy

Scottish & Southern Electricity Networks

elementenergy
an ERM Group company

nationalgrid

Interested in learning more about CrowdFlex?
Contact Lauren Cooper, SIF Innovation Business Partner, to find out more.

Priority 5: Constraint Management

The cost to manage transmission system constraints continues to have an impact on consumers.

ESO's Constraint Management Pathfinder focuses on reducing the need for build solutions and seeking services from new constraint service providers to help with cost reduction. The Anglo-Scottish Intertrip scheme from the Constraint Management Pathfinder has already saved consumers £80million between April 2022 – January 2023. Another ESO pathfinder, EC5 Constraint Management Intertrip Service (CMIS), aims to reduce network congestion costs in the East Anglia region by building post-fault intertrip links between generation across the East Anglia region and the East Anglia Operational Tripping Scheme (EAOTS).

However, we still need to test a variety of innovative market-led solutions and technologies to ensure the most economic solution for consumers.

Key Challenges

The key challenges of this priority remain the same

- Changes in the volume and location of electricity generation will lead to significant constraint costs.
- One of the key areas of congestion is the Anglo-Scottish boundary (B6). The area is limited by a constraint, so sometimes requires renewable generation to be turned down pre-fault. This can lead to higher costs which are then passed onto consumers.

Alignment

Supporting our RIIO-2 priorities

Innovation projects and initiatives developed to address this priority will support ESO's overarching priority of 'Managing balancing costs'.

Priority 5: Constraint Management

Where we are today

Completed projects and those in delivery

*Year of completion

*2020	Impact of Long-duration Energy Storage Systems on GB Transmission Planning Analysing the impact of a range of energy storage systems on transmission network constraints.
2021	Probabilistic Planning for Stability Constraints Exploring, developing and testing cutting-edge automated and probabilistic approaches for modelling of angular stability.
2024	Hydrogen Production for Thermal Electricity Constraints Management Increasing our understanding of how electrolysis technology could help reduce constraint costs, lowering the costs to consumers of integrating renewable technology.

Pathway

We are currently developing projects looking at:

- Developing a probabilistic model solution that quantifies the risk of congestion in day-ahead forecasting.
- Understanding whether automatic network topology optimisation is possible and if it can be used in real-time to optimise network constraints.
- Investigating whether low-carbon hydrogen production could be sited at advantageous locations to reduce constraints.

Opportunities remain to:

- Understand how we can use data and new technologies to increase transfer or provide a fast acting, automated response to a system condition, to increase boundary capacity.

Case Study: Hydrogen Production for Thermal Constraints Management

This project is exploring whether excess renewable energy generation could be used for green hydrogen production to help manage thermal constraints on the network.

The Challenge

The transmission network, which takes electricity from where it is generated to where it is used, has physical limitations on how much power it can carry (thermal constraint). If the limit is reached or exceeded, it will cause overheating which damages the network, potentially leading to a loss of supply in some areas.

To avoid this, generation is often curtailed (for example, turning off wind turbines) which is costly and wastes zero carbon energy. It can also be managed by network reinforcement, but this is very expensive and the timescales for delivery are long.

As more and more renewable energy generators and continental interconnectors are added to the network, the problem of thermal constraint is growing. By 2030, some areas of the network will see peak power flows 400% greater than the transmission network capability, and as a result thermal constraint management costs are forecast to rise to between £500m and £3bn a year.

The Project

This is a new 18-month project exploring whether there is an opportunity to utilise large-scale green hydrogen facilities – which make hydrogen using electrolysers - to provide a flexible resource that will help manage thermal constraints on the electricity network.

Working alongside Arup and National Gas Transmission, the project will use desktop research to build models and tools to get a detailed understanding of the potential for hydrogen production to be used in this way as a balancing service to benefit both the operation and decarbonisation of GB's electricity and gas networks. Technical considerations, along with commercial and regulatory viability, will be considered, so we understand what obstacles need to be overcome to allow a commercial facility to offer constraint management.

Case Study: Hydrogen Production for Thermal Constraints Management

Benefits

The project will ascertain whether green hydrogen plants are an attractive prospect for ESO to reduce its thermal constraint costs and/or defer network reinforcement works, to help run the network in a more cost-efficient way and improve value for consumers. As well as providing cost savings, green hydrogen has the potential to improve system operability by delivering flexibility at times of high generation, supporting the increased use of renewables and the decarbonisation of the network.

Next Steps

The first step in this project is a workshop to determine the scope of the project. Early priorities will be to lay the groundwork for the first work package, which looks at evaluating potential sites for green hydrogen plants. Location decisions will need to take into account thermal constraints – such as in Scotland and the East of England where there is a lot of wind generation, and in the south where interconnectors are sited – as well as the potential users of hydrogen, which could include injection into the gas network.

Early discussions will also seek to scope out questions around the necessary gas interface required to inject green hydrogen into the gas grid and what commercial pathways and modelling is required to find out how green hydrogen facilities could be commercially viable.

Project Information

NIA Reference	Project Name	Status
NIA2_NGESO036	Hydrogen Production for Thermal Electricity Constraints Management	*In delivery

Registered Value
£520,000

*Status as of March 2023

Case Study: Hydrogen Production for Thermal Constraints Management

Meet the project team

This project is of interest to a number of teams at ESO including Strategic Network Development, Future Energy Scenarios (FES) and Zero Carbon Operation.

Louis Priday: I am the project lead, based within the Strategic Network Development team. 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.

Our Partners

ARUP

national gas transmission

Interested in learning more about Hydrogen Production for Thermal Constraints Management?
Contact Caroline Rose-Newport, Innovation Business Partner, to find out more.

Priority 6: System Stability & Resilience

As we transform to a zero carbon electricity system, system stability and resilience remains a key area of investment.

The NOA (Network Options Assessment) Stability Pathfinder has looked for the most cost-effective ways to address stability issues in the electricity system created by the decline in transmission connected synchronous generation. On 23 November 2022, ESO published the results of the Stability Phase 3 tender, successful companies are now working on delivering solutions in line with their contracts.

Key Challenges

The key challenges of this priority remain the same

- As we move towards zero carbon operation and synchronous generation capacity decreases, the system becomes less stable. This means faster frequency changes, less voltage and fault ride-through stability which makes it more difficult for both synchronous and non-synchronous generators to operate safely.

Alignment

Supporting our RIIO-2 priorities

Innovation projects and initiatives developed to address this priority will support ESO's overarching priority of 'Maintaining resilient and secure operations'.

Priority 6: System Stability & Resilience

Where we are today

Completed projects and those in delivery

*Year of completion

*2020	Demonstration of Virtual Synchronous machine control of a battery system Developing validated models for one approach to VSM control of batteries.
2021	DETECTS – Developing Enhanced Techniques to Evaluate Converter-dominated Transmission System Operability Researching practical tools for the application of advanced grid modelling for system operations. Mapping the Impacts and Visualization of Risks of extreme weather on system operation (MIVOR) Evaluating the impacts of extreme weather events on system operation up to 2050 to produce a map demonstrating the risks, probabilities and consequences of such events at a 25km grid level of GB.
2022	Resilient Electric Vehicle Charging (REV) Analysing the impact of electric vehicle charging on grid short term frequency and voltage stability, and cascade fault prevention and recovery. Stability Market Design Considering current stability arrangements and investigating the best option for an end-to-end stability market.
2024	Automated Identification of Sub-Synchronous Oscillations (SSO) Events Exploring, developing and testing a combination of novel frequency domain methodologies and machine learning techniques to identify potential system operating conditions which can lead to Sub-Synchronous Oscillations (SSOs) and implementing an automated control interaction studies framework. D3 – Data-driven Network Dynamic Representation for Derisking the HVDC and Offshore Wind Developing advanced tools for obtaining accurate grid dynamic models which don't reveal confidential system data and can be shared with outside stakeholders. Strength to Connect Exploring appropriate alternatives to short circuit level to measure grid strength in the future GB system, particularly with high penetration or dominance of inverter-based resources. Inertia Measurement Method Optimisation Analysing and verifying data from new commercial inertia monitoring tools and compare to NGESO operational data, establishing different generation and demand scenarios for inertia and Rate of Change of Frequency.

Priority 6: System Stability & Resilience

Pathway

We are currently developing projects looking at:

Finding better ways to model stability

- Real-time simulation of a region of the GB power system in both phasor and EMT models to assess the impact of controllers on transient stability and analyse different contingencies in the system.
- Enhancing the DETECTS models with further analysis for more scenarios and operating condition.

Identifying what tools can be developed to support the system in a decarbonised network

- A cost benefit analysis review of possible solutions to address changing ramping arrangements to ensure security of supply with increases to cross border capacity.
- Delivering a new tool to improve forecasting of contribution of inertia from demand to reduce procurement of inertia through markets.

Developing new ways to speed up our processes or automate them

- Enhancing EMT model of the GB network to speed up processes when performing simulation and improve the flexibility of performing transient studies.
- Investigating options to forecast inertia based on machine learning models using Scottish metered inertia values.

Investigating what kinds of data or metadata could further support system operation

- Injecting a small high frequency signal at optimal locations on the GB system to identify the root cause of oscillations and mitigate potential risks.

Opportunities remain to:

- Find better ways to model stability in an increasingly non-synchronous system.
- Identify what tools can be developed to support the system in a decarbonised network.
- Develop new ways to speed up our processes, or automate them, to keep up with a lower inertia system.
- Investigate what kinds of data or metadata could further support system operation and improve how we manage stability into the future.

Case Study: Strength to Connect

Strength to Connect is an exciting new project which is looking to reconsider how we measure system strength. The influx of inverter based resources (IBRs) means that new methods are needed to more accurately predict system strength with changing parameters.

The Challenge

When the electricity system was largely run using fossil-fuel synchronous generators – such as gas and coal power plants - they provided the ESO with a predicable set of operability-related parameters which meant that the ESO could be confident in how the grid would behave for stable and secure operation (or so-called system strength). This 'ruler' was the basis of system strength analysis and it informed policies, calculations methodology and many different aspects of the planning, design and running of the network.

The electricity system has been evolving since the original parameters were created and deployed, and nowadays there are more non-synchronous, Inverter-Based Resources (IBRs) on the system – such as onshore/offshore wind farms, battery storages and interconnectors - which make the grid behave differently.

We have a window of opportunity to review these parameters and to find innovative ways to measure system strength during ESO's such journey towards zero-carbon operation.

The Project

Strength to Connect is an 18-month Network Innovation Allowance (NIA) project which started in October 2022. Its primary purpose is to create a new set of metrics which will enable ESO to accurately evaluate as well as confidently operate and secure the grid in the future with high penetration or even dominance of IBRs, once remaining fossil-fuelled synchronous generators are phased out. The new metrics will focus on providing updated and relevant parameters that meet the ESO's future needs for both network planning and operation and market design.

Benefits

This project will help facilitate the energy transition and the higher penetration of IBRs on the grid. With a detailed understanding of how to measure grid behaviour and the risks associated with more IBRs on the network, we can quantify the system services required in the future more accurately which will improve stability, lower our operating costs and create value for consumers in a consistent manner.

Case Study: Strength to Connect

Next Steps

In the first phase of the project, the Strength to Connect team will be screening pros and cons of existing metrics to address certain emerging operability challenges when more IBRs are connected to the system. This involves primarily working with other internal teams (technical and non-technical) within the ESO to establish what their challenges are and what areas can be influenced or improved with new metric(s) to be investigated in this NIA project.

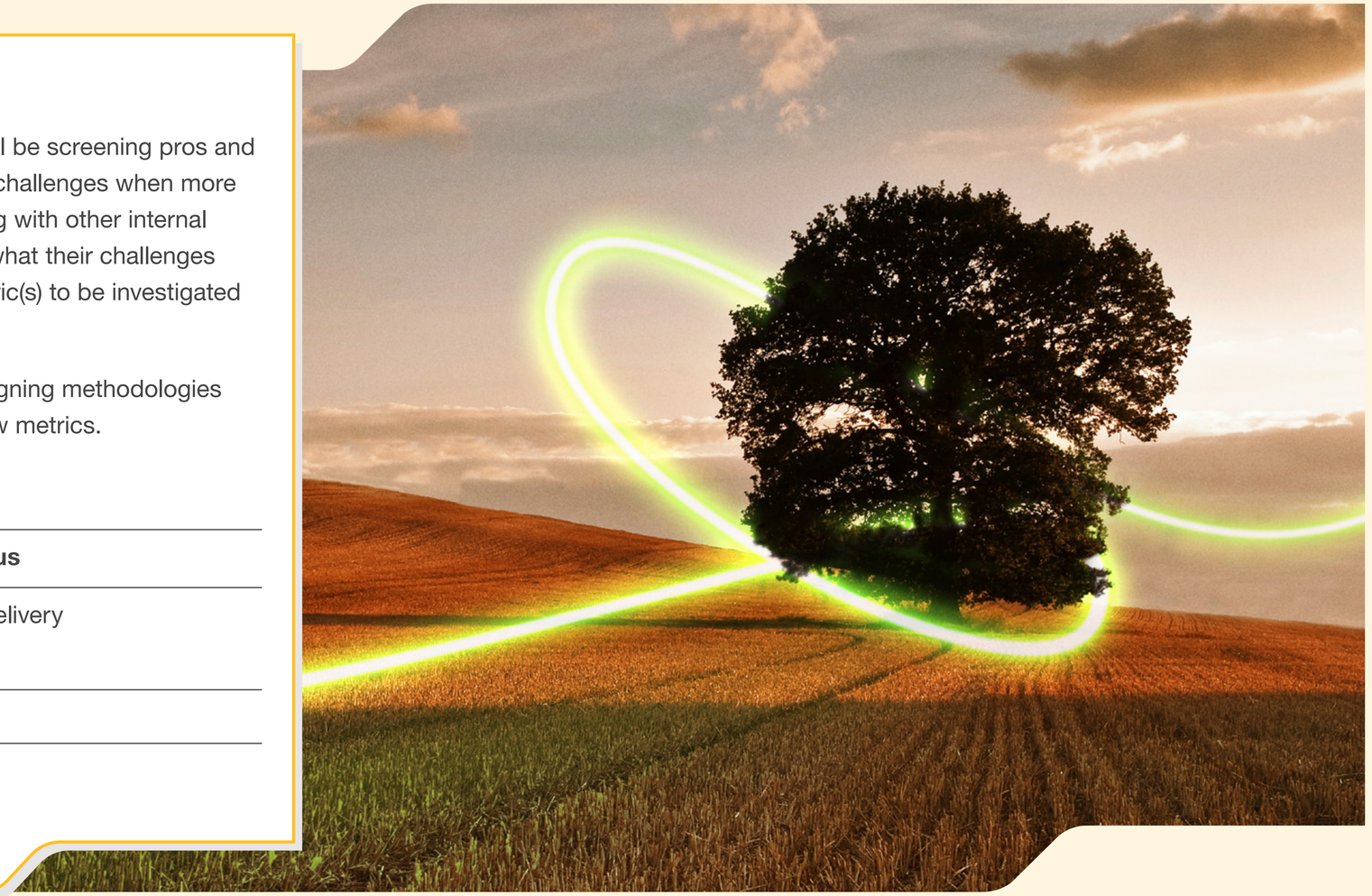
Once the first phase has been completed, work will start on designing methodologies and validate processes to develop, design and validate those new metrics.

Project Information

NIA Reference	Project Name	Status
NIA2_NGESO020	Strength to Connect	*In delivery

Registered Value
£350,000

*Status as of March 2023



Case Study: Strength to Connect

Meet the project team

Technical and non-technical teams at ESO have intensive interests in the outcomes of this project at different stages, including the ESO's cross-functional teams across Networks, Markets and Electricity National Control Centre (ENCC).

Dechao Kong: I am the project lead, based within the Operability Policy team. Strength to Connect is an exciting project as an industry-first for the GB system and we have been engaging a range of stakeholders from across the sector to share our approach and understand how we can collaboratively address key energy transition challenges.

Jian Sun: I am a Senior Power System Engineer, based in the Operability Product team, focusing on future requirements to manage stability and other network operational challenges. System strength is a key indicator in helping ESO to form a better understanding of the network strength for real-time operation and facilitate the connection of more renewable energy sources to the grid.

Kelly Larkin: I am a Senior Operability Analyst, based in the Commercial Operability Strategy team. I ensure we have a coordinated strategy, with plans to continually enable more and more operable periods of zero carbon from 2025 to 2035. I also create our overarching strategy for the stability workstream, ensuring all future challenges relating to system stability are identified and managed - Strength to Connect will help address some of these challenges and find new and innovative ways of measuring and monitoring the strength of the system.

Our Partners

Imperial College London
Consultants

Interested in learning more about Strength to Connect?
Contact Alex Hurley, Innovation Business Partner, to find out more.

How to get involved

There are several ways to collaborate with us and develop innovation projects to address our strategic innovation priorities outlined in this document. We're eager to hear your thoughts and ideas about finding new ways to meet the challenges of transitioning to a zero carbon future.

You can also learn more about how to get involved on our website.

Submit a Big Idea

We provide funding for projects which link to at least one of ESO's innovation priorities (detailed in this report) through Ofgem's Network Innovation Allowance (NIA), a set amount each Energy Network receives as part of their price control allowance. The focus is on earlier stage research and development, or small-scale demonstration projects.

We welcome your project proposals throughout the year, you can find out more about our process and how to Submit a Big Idea on our website.

Partner with us on Strategic Innovation Fund (SIF) projects

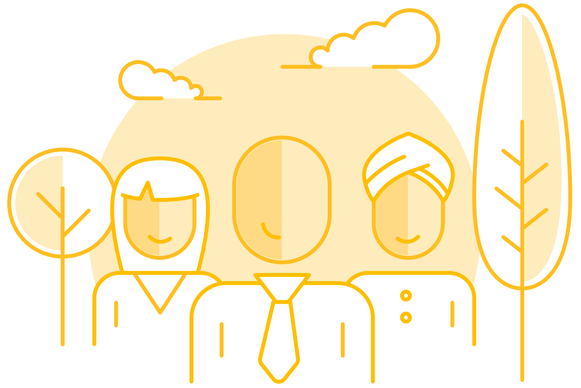
As part of RIIO-2 price controls, Ofgem introduced the Strategic Innovation Fund (SIF) to support the transition to net zero, while delivering net benefits to energy consumers. This replaces Network Innovation Competition (NIC) and supports large-scale transformational research and development projects. Ofgem, working with UKRI, sets the strategic direction of the fund by developing Innovation Challenges while coordinating with other public innovation bodies. This ensures greater flexibility and alignment in innovation funding, eliminating both duplication and funding gaps.

SIF is competitive, therefore any project ideas we receive must be developed in line with the following requirements:

- Project ideas must move through the sequential phases of SIF, starting with Discovery (Discovery, Alpha, Beta)
- Project ideas need to meet one of the SIF Innovation Challenges and address at least one of ESO's innovation priorities (detailed in this report)
- We ask that project ideas are submitted to us at least two months before the SIF Discovery application deadline set by Ofgem and UKRI

We currently receive project ideas through our Open Innovation Events, pitching sessions organised by UKRI and other events such as Energy Networks Association's Energy Innovation Basecamp.

You can also contact us directly with project ideas at Innovation@nationalgrideso.com and keep up to date with the latest SIF Innovation Challenges and deadlines on Ofgem's website.



How to get involved

Co-create with us

Our Open Innovation Events give industry, academia and other innovators the opportunity to fast-track the development of innovation projects with ESO subject matter experts. We invite innovators to submit proposals through an open call, with details of the challenges we are looking to address and the strategic innovation priorities they relate to.

The best ideas are then taken forward to a two-day event where the project teams collaborate with subject matter experts from ESO and other networks to develop their initial concepts into full project proposals, these are then pitched to a panel of industry judges.

Find out about our previous Open Innovation Event July 2022 on the following page.

Stay up to date with ESO Innovation

Visit our website to find out about events we are hosting and attending and view our publications

Sign up to our mailing list to be notified of future events, news and publications

Case Study: Open Innovation Event July 2022

Creating a dedicated environment for the ESO to collaborate with innovators across the energy sector.

The Event

Our Open Innovation Events enable us to rapidly develop innovation projects to address challenges that the ESO is facing. In July 2022 we invited innovators to submit project proposals addressing the following challenge areas:

- Use Cases for Virtual Energy System

- Network Modelling 2.0

- Strategic Innovation Fund Challenge Areas

We received over 60 proposals and worked with our subject matter experts to select 5 to take to the event for further development.

The two-day in-person event consisted of collaborative proposal development, including a pitch to an industry judging panel on the second day. 24 subject matter experts from the ESO and other networks worked with 14 proposal team representatives across the two days, supported by the ESO Innovation team.

To find out more about the challenge areas and the Open Innovation Event process, visit our website

Hear from our attendees

"… great help for shaping and finalising the innovation proposal, we received **overwhelming support from ESO** and its expert teams"

"Genuinely felt like **working in a team**, couldn't expect anything better than that!"

"Access to SMEs, innovation team and partners was **invaluable**"

"… **effective and efficient way to promote innovations and accelerate the development of innovation projects**…"

"The assignment of relevant experts from NGESO to work with us on the pitch was perfect. **Great teamwork**..."

Case Study: Open Innovation Event July 2022

Projects developed at the event

- **Arup:** Demonstrating how the large-scale production of green hydrogen can support the management of regional electricity transmission network constraints during times of high output from intermittent renewables generation.
- **Imperial College London & University of Bath:** Identifying emergent risks of oscillations and their root causes through perturbation injections at optimal locations on the GB system.
- **Manitoba Hydro International:** Practical transition into wider EMT (electromagnetic transient) GB Modelling - speeding up the process of performing electromagnetic transient simulations and increasing the flexibility of performing transient studies.
- **Microsoft:** Collectively developing a tool to better inform customers and producers about carbon impact of connecting to and operating in the grid to minimize carbon intensity.
- **N-SIDE:** Developing a probabilistic model solution that quantifies the risk of energy flow congestion within day, therefore improving constraint forecast accuracy and helping to better understand the risks, focus on the correct scenarios, and justify decisions.

Sign up to our mailing list to ensure you are notified of future Open Innovation Events

Meet the team

We're always on the look-out for new project ideas and collaboration opportunities. Whether you are interested to find out more about our innovation process and portfolio or one of our flagship programmes, there is a team in ESO Innovation who can help.

Anna Carolina Tortora
Head of Digital Transformation and Innovation Strategy

Strategy & Stakeholder

Our purpose is to support innovation across the business, through close engagement and communication to ensure stakeholders are aware of the Innovation team's activities and how they can get involved. We also lead on developing the Innovation Strategy to help innovation funding to be focused on the right priorities each year to deliver the energy transition.

Joshua Visser
Innovation Manager

Isla Martin-Abel
Stakeholder Engagement Lead

Abigail Mills
Innovation Analyst

Arwen Seymour
Team Assistant

Innovation Delivery

Our purpose it to build a robust pipeline of innovation projects to deliver the energy transition. We engage with ESO subject matter experts and external partners to support and deliver these projects.

Geoff Down
Innovation Manager

Charlotte Horne
Innovation Business Partner - National Control

Caroline Rose-Newport
Innovation Business Partner - Markets

Alex Hurley
Innovation Business Partner - Networks

Alison Dineley
Senior Innovation Analyst

Meet the team

Strategic Innovation Fund (SIF)

Our purpose is to seek large-scale project opportunities for application to the Strategic Innovation Fund (SIF). We ensure projects support network innovation to contribute to the achievement of net zero, while delivering net benefits to energy consumers.

Justina Zvirblyte
SIF Process Lead

Lauren Cooper
SIF Business Partner

Technology Insights

Our purpose is to drive open innovation with technology experts and innovators. We aim to achieve this through raising our colleagues' awareness of relevant technology developments, facilitating networking and ideating with external organisations, and centralising the knowledge created by the ESO's various strands of technology research.

Alexi Reynolds
Technology Insights Manager

AI Centre of Excellence

Our purpose is to unify and grow a collective AI workforce in the energy industry; creating a collaborative space where people can use their skills to help decarbonise the whole energy system and discover, learn and contribute positively towards improving society and saving our planet.

Lyndon Ruff
AI Centre of Excellence Manager

Darya Nizhnikova
Customer and Technology Innovation Business Partner

Meet the team

Virtual Energy System

The Virtual Energy System is an ambitious, industry-wide mission to digitise Britain's energy system. Our dedicated Stakeholder, Common Framework and Use Case teams are progressing the three workstreams of the programme.

James Edwards-Tombs
Stakeholder Engagement Management

Anca Marinescu
Stakeholder Engagement Lead

Divya Mahalingam
Stakeholder Engagement Lead - Common Framework

Jo Webb
Stakeholder Engagement Lead - Use Cases

Jonathan Barcroft
Workstream Manager

Sooraj Soman
Process Manager

Dozie Nnabuife
Use Cases Manager

Vikaran Khanna
Use Cases Analyst

Mark Sunderland
Use Cases Project Lead

Shaun Clohessy
Business Change - Project Manager

Contact us

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