Ofgem Strategic Innovation Fund - Round 5 Innovation Challenges

The Strategic Innovation Fund (SIF) is a major opportunity for businesses, academia, and innovators to collaborate with energy networks on game-changing projects that will transform our energy system and deliver real benefits to consumers.

For Round 5, the SIF is **launching seven strategic challenges until the end of 2026, providing longer-term market direction and enabling deeper innovation.** The selected challenges of the SIF Round 5 are the following:

1. **Advanced Energy Transmission and Networks:** How can we leverage breakthroughs in semiconductor, superconductor, and wireless power transmission technologies to enhance grid performance?
2. **Dynamic modelling:** How can we leverage advanced grid simulation and optimisation to "squeeze more capacity" from existing electricity networks?
3. **High-energy demand point integration:** How can we develop scalable approaches to integrate rise of large demands (e.g., Data Centres), ensuring an increase in capacity within the next decade?
4. **Consumer centric grid solutions:** How can we use novel technology and processes to deliver grid expansion in ways that enhance public support and deliver wider local and environmental benefits?
5. **Enhanced system visibility and control:** How can we integrate digital automation and enhanced system monitoring to support next generation power system control and operations?
6. **Green Gas:** How can we integrate low carbon gases such as biomethane and Bio-SNG in a cost-effective way, enabling networks to efficiently manage their injection while ensuring system stability and reliability?
7. **Whole system Optimisation:** How can whole system approaches enable gas and multi-vector decarbonisation?

By considering the broader regulatory landscape alongside pressing technical and commercial challenges, we identified where the SIF can bring true additionality - unlocking solutions that might not otherwise progress. These final 7 challenges reflect the most urgent opportunities for innovation, where targeted investment can drive meaningful transformation across the energy system.

SIF Round 5: Background and Context

The Strategic Innovation Fund (SIF) is designed to foster transformative projects that benefit consumers and revolutionise the UK energy system. By working with energy networks, businesses, academia, and other innovators, the SIF aims to:

- Accelerate UK's transition to net zero
- At lowest cost to the consumer
- And make the UK the best place for energy business to grow and scale

Ofgem is the primary decision-maker for the SIF, partnering with Innovate UK (part of UK Research and Innovation) to administer funding, monitor project delivery, and support the transition of successful projects into mainstream energy operations. The SIF is funded through the RIIO-2 network price control and is available to the Electricity System Operator, electricity transmission, gas transmission, gas distribution, and electricity distribution licensees.

Innovation Challenges Principles

Ofgem and Innovate UK have refined the SIF challenges to address strategic energy sector needs. Round 5 (R5) challenges focus on key areas necessary to achieving the UK's net-zero targets, at the lowest cost to consumers, ensuring energy security, and fostering system resilience. The selected challenges reflect a consensus-based approach that prioritises:

- **Strategic Importance:** Aligned with national and regional decarbonisation objectives.
- **Network Relevance:** Addressing critical innovation needs within the energy network sector.
- **Timeliness:** Solutions must be commercially scalable within a timeframe aligned to the urgency and specific market needs of each individual challenge.
- **Complementarity:** Avoiding duplication with other GB innovation initiatives.
- **Consumer focus:** So that networks deliver what the customers who pay for networks need now and in the future.

R5 challenges have been carefully selected through a rigorous process—refining 130 initial ideas down to the most critical opportunities. This selection was shaped by insights from 25 in-depth interviews, six targeted workshops, and a comprehensive portfolio analysis, ensuring alignment with policy frameworks, energy network priorities, and industry needs.

The SIF Innovation Operating Model – Round 5

The identification of Innovation Challenges marks the first stage of a structured two-year process designed to set clear and longer-term market direction. Following challenge setting, Innovate UK's ideation process helps build ideas, create partnerships, and develop high-impact project proposals. The aim is to support the most transformative project ideas and facilitate the right partnerships, to deliver high quality breakthrough innovation projects that achieve real-world impact.

This two-year operating model consists of four key stages:

Phase	Timeline Year 1 and 2	Objectives
Challenge setting: Identifying the most important energy innovation challenges	Jan – March 2025	- Stakeholder engagement to gather innovation challenges relevant to the SIF. - Co-developing challenges with Ofgem, ensuring alignment with the issues faced by users and consumers. - Achieving broad consensus on the priority innovation challenges for R5. - Developing and publishing the Innovation Challenge document, outlining partnership requirements for the sector.
Ideation: Generating new ideas for projects/products/services to address these challenges	March 2025 – September 2026	- Engaging with a broad spectrum of energy and non-energy sector innovators on the SIF Challenges. - Helping innovators understand network needs and knowledge gaps while supporting their idea development. - Providing a streamlined process for third parties to communicate their expertise and engage with the SIF team. - **Events:** Ideation workshops for third parties and energy networks to explore potential solutions, refine ideas, and engage with energy sector experts. - **Events:** Technical webinars to explore specific problems areas in greater detail in the context of the current innovation landscape.
Incubation: Forming effective partnerships	May 2025 – September 2026	- Support the formation of impactful consortia through matchmaking in line with outlined partnership requirements. - Supporting energy networks and partners in developing high-quality applications for the SIF funding.
Acceleration: Selecting and funding the most transformational ideas	July 2025 – Dec 2026	- Provide three funding cycles per year to allow consortia to submit applications in a timely manner to accelerate game-changing innovations. - **Funding Cycle Dates:** See "When you can Apply" section at: https://www.ofgem.gov.uk/sif

Next Steps

More Information

Details on how to engage and participate in the Ideation and Incubation stages will be shared in April 2025. To stay informed, sign up for the SIF newsletter[1]. Where necessary, Ofgem and Innovate UK may extend the challenge period and issue new requirements or challenges as part of the competition brief.

Ofgem and Innovate UK recognise the valuable input provided by many experts and organisations in shaping these Innovation Challenges, thank you for your contributions. We look forward to working with the sector to deliver transformative innovation that benefits consumers and accelerates the transition to net zero.

Marzia Zafar
Deputy Director Strategy & Innovation, Ofgem

Jodie Giles
Deputy Director – Ofgem Strategic Innovation Fund, Innovate UK

[1] The SIF Newsletter: https://ukri.innovateuk.org/ofgem-sif-subscription-sign-up

Innovation Challenge 1:

Advanced Energy Transmission and Networks: How can we leverage breakthroughs in semiconductor, superconductor, and wireless power transmission technologies to enhance grid performance?

Context: Addressing the Future of Energy Networks

The electricity network is under growing pressure due to ageing infrastructure, rising electrification, and the integration of intermittent renewable energy sources. This drives the need for a smarter system that enables real-time monitoring, precise energy flow control, more efficient and cost-effective transmission, and improved management of intermittent resources like solar, wind, and battery storage. As these trends become more prevalent, advanced semiconductors and superconductors offer opportunities to enhance grid resilience and capacity, lower grid costs and support the transition to a fully clean power system.

Additionally, advancements in wireless power transmission, such as laser and electromagnetic beam-based technologies, are making it possible to envision the delivery of electricity over long distances without physical cables, reducing infrastructure costs and enhancing energy access in remote or difficult-to-reach locations.

Recent breakthroughs in **semiconductors[2], superconductors[3], and wireless power transmission** present transformative opportunities for the energy sector. Innovations in these areas can enable:

- **More efficient power electronics** to reduce transmission and conversion losses.
- **High-capacity superconducting cables to reduce energy loss and enhance power density**
- **Seamless integration of distributed energy resources (DERs) and energy storage improving grid stability at high renewable penetration**
- **Wireless transmission solutions** to enhance grid adaptability for remote locations
- **Advanced control mechanisms for real-time energy management.**

However, barriers remain, including high production costs, material availability, system integration challenges, and the need for large-scale demonstrations. The UK must coordinate efforts to accelerate research, integration, and

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[2] Pessoa, R. S., & Fraga, M. A. (2024). The Versatile Horizon: SiC Power Semiconductors in Electric Vehicles, Renewable Energy, Aeronautics, and Space Systems. *Journal of Aerospace Technology and Management*, 16, e3424

[3] Pandey, B. (2021). High-Temperature Superconductivity: A Prospective Remedy for Energy Crisis in Future. International Journal of Academic and Industrial Research Innovations, 5(2), 63-75.

commercialisation of **next-generation semiconductor, superconductor, and wireless transmission solutions** to modernise energy networks.

Challenge Objectives

The **Advanced Energy Transmission and Networks** challenge seeks to:

- Advance the integration of next-generation power electronics and semiconductor technologies to enhance grid efficiency, stability, and capacity.
- Demonstrate and validate superconducting transmission technologies to support scalable, high-capacity, and low-loss electricity networks.
- Develop technical and economic evidence on wireless power transmission in the UK to support evaluation of its potential and feasibility.

Scope of Projects

Project proposals must focus on at least one of the following priority areas:

1. **Advanced semiconductor technologies for power networks**
    - Deploy next-generation power electronics to enhance grid stability, and efficiency in high-voltage applications.
2. **Superconducting technologies for high-efficiency transmission**
    - Demonstrate scalable high-temperature superconducting (HTS) cables and components in real-world grid environments to enable low-loss, high-capacity electricity transmission.
3. **Wireless power transmission for grid expansion and resilience**
    - Conduct techno-economic feasibility studies and prototype demonstrations to assess the viability of wireless power transfer for remote areas, offshore renewables, and emergency applications.

Cross-Cutting Themes

All projects must address the following themes:

- **Customer focussed –** The SIF is funded via customer bills so all projects must ensure the solution is inclusive and accessible to diverse customer and consumer segments through relevant partnerships with third parties, stakeholder engagement and user centric design principles, with the aim of saving customers money.
- **Scalability and Replicability** – Developing solutions that can be deployed across multiple regions and scaled to meet future grid needs.
- **Data and digitalisation** - Harness digitalisation and implement Energy Data Best Practice across all areas.
- **Shared learning** – not all innovation projects will lead to deployment, the learning and how it is shared openly across the energy sector and wider is critical.
- **Skills and capability –** Consider throughout the project where upskilling and new capability development is needed and signalling those needs to

relevant third parties like academics, training institutes and key supply chain partners.

- **Supply chains** – Assess the deliverability and scalability of the solution across the GB network from a supply chain perspective including maturity of supply chains, potential vulnerabilities such as labour requirements, logistical challenges and environmental risks.
- **Resilience** – Strengthening the adaptability and security of energy networks to withstand extreme weather events, cyber threats, and fluctuations in energy demand.

Project Partner Requirements

Project Scope	Discovery Project Partner Requirements	Alpha Project Partner Requirements
Advanced Semiconductor Technologies for Power Networks	A research organisation or industry partner with experience in power electronics for grid applications	No additional partner requirements
Superconducting Technologies for High-Efficiency Transmission	A research institution or industry partner with expertise in superconducting technologies	No additional partner requirements
Wireless Power Transmission for Grid Flexibility	A research organisation or technology provider in wireless power systems	An Electricity Transmission Network licensee (in addition to the network lead).

Relevant Projects and Programmes

Projects applying to this challenge should align with and build upon existing UK and international initiatives in advanced energy transmission. Applicants should consider how their innovations complement prior research and industry developments.

1. **DARPA's Persistent Optical Wireless Energy Relay (POWER) Program –** Developing airborne optical energy transfer for long-range wireless power delivery[4].
2. **Innovate UK's Power Electronics, Machines and Drives (PEMD) Programme** – Driving semiconductor innovation for clean energy applications.
3. **Superconducting Power Network (SPN) Trials** – Developing and testing **HTS-based transmission solutions**.

[4] Defense Advanced Research Projects Agency (DARPA) (2025) *Persistent Optical Wireless Energy Relay (POWER)*. Available at: https://www.darpa.mil/research/programs/power

4. **Innovate UK Wireless Power Transfer Research (WPT) Projects** – Exploring the feasibility of **long-distance, efficient power transfer**[5].
5. **National Grid's Pathfinder Projects** – Investigating advanced system stability solutions using **emerging grid technologies**.
6. **Energy Innovation Centre (EIC) Projects** – Supporting next-generation **transmission, distribution, and control innovations**.[6]

By addressing these priority areas and leveraging existing expertise, this challenge will accelerate the deployment of cutting-edge energy transmission technologies, enhancing the GB's grid resilience, efficiency, and performance.

[5] Buchanan, Neil, Principal Investigator. 2019. "New Technologies for Efficient Wireless Power Transfer at Distance." Project Reference No. EP/S007954/1. Engineering and Physical Sciences Research Council.
[6] Energy Innovation Centre. (n.d.). *More Low Carbon Technologies, Better Network Resilience*. Available at: https://www.ukeic.com/opportunity/more-low-carbon-technologies-better-network-resilience/

Innovation Challenge 2:

Dynamic Modelling: How can we leverage advanced grid simulation and optimisation to "squeeze more capacity" from existing electricity networks?

Context: Addressing Grid Efficiency and Capacity Constraints

As GB transitions to a low-carbon energy system, the demand for electricity network capacity is increasing. However, traditional grid planning approaches often rely on conservative or static assumptions about capacity limits, leading to underutilisation of existing infrastructure. Rather than costly physical upgrades, real-time dynamic modelling and control offers a way to actively manage network constraints.

By improving the real-time estimation of network loading and dynamically adjusting the import/export of resources such as solar PV, battery storage, and demand-side flexibility, grid operators can safely operate the system closer to its true limits. Advanced modelling techniques enable better forecasting of network conditions, accounting for load variability, generation intermittency, and asset performance. This approach allows the grid to be run at higher capacities while maintaining stability, unlocking additional capacity and improving overall system resilience.

Challenge Objectives

The Dynamic Modelling challenge seeks to:

- Reduce network constraints and improve grid planning by developing advanced simulation and optimisation techniques for real-time network management.
- Minimise congestion and maximise asset use by enhancing forecasting capabilities for load variability, generation intermittency, and asset performance.
- Increase the efficiency and stability of network operations through predictive modelling of power flows, voltage stability, and operational constraints.
- Enable better integration and utilisation of Distributed Energy Resources (DERs) and flexibility services by improving dynamic system representation and real-time coordination.

Scope of Projects

Project proposals must focus on at least one of the following priority areas:

1. **Advanced grid simulation and optimisation**

    - Develop real-time network models with improved forecasting and load flow analysis to dynamically manage grid constraints, unlock capacity, and improve operational decision-making.

2. **Control Strategies for coordination and dispatch of flexible resources**

    - Develop and implement advanced controls to optimise distributed resource coordination and maximise capacity utilisation.

Cross-Cutting Themes

All projects must address the following themes:

- **Customer focussed –** The SIF is funded via customer bills so all projects must ensure the solution is inclusive and accessible to diverse customer and consumer segments through relevant partnerships with third parties, stakeholder engagement and user centric design principles, with the aim of saving customers money.
- **Scalability and Replicability** – Developing solutions that can be deployed across multiple regions and scaled to meet future grid needs.
- **Data and digitalisation** - Harness digitalisation and implement Energy Data Best Practice across all areas.
- **Shared learning** – not all innovation projects will lead to deployment, the learning and how it is shared openly across the energy sector and wider is critical.
- **Skills and capability –** Consider throughout the project where upskilling and new capability development is needed and signalling those needs to relevant third parties like academics, training institutes and key supply chain partners.
- **Supply chains** – Assess the deliverability and scalability of the solution across the GB network from a supply chain perspective including maturity of supply chains, potential vulnerabilities such as labour requirements, logistical and environmental risks.
- **Resilience** – Strengthening the adaptability and security of energy networks to withstand extreme weather events, cyber threats, and fluctuations in energy demand.

Project Partner Requirements

Project Scope	Discovery Project Partner Requirements	Alpha Project Partner Requirements
Advanced Grid Simulation and Optimisation	A research institution or technology provider with expertise in real-time network modelling, forecasting and optimisation.	Electricity transmission or distribution licensees (in addition to the project lead).
Control Strategies for Coordination and Dispatch of Flexible Resources	Organisations with capability in dynamic modelling, network control or automation for resource coordination	Electricity transmission or distribution licensees (in addition to the project lead).

Relevant Projects and Programmes

Projects applying to this challenge should align with, and build upon, existing GB and international initiatives in advanced grid simulation and optimisation. Applicants should consider how their innovations complement prior research and industry developments.

1. **NESO's Stability Pathfinder Programme** – Investigating new ways to enhance system stability using real-time dynamic modelling and optimisation.
2. **Enhanced RMS (e-RMS) Models for Stability Assurance (NIA2_NGESO050)** – Developing an enhanced RMS modelling framework to provide dynamic stability assurance in planning studies and operational timescales, facilitating higher integration of inverter-based resources without compromising grid stability.[7]
3. **AI for Visibility and Forecasting of Renewable Generation (NIA_UKPN0104)** – Developing a machine learning algorithm to enhance forecasts of metered and behind-the-meter solar and wind generation, improving flexibility procurement efficiency, reducing curtailment, and informing network investment decisions.[8]
4. **SETTLE (NIA_SHET_0051)** – Developing a real-time alert and control system to monitor, detect, interpret, and mitigate power network oscillation events, thereby reducing system stability risks.[9]
5. **UKERC (UK Energy Research Centre) Whole Systems Modelling Programme** – Exploring integrated modelling approaches to optimise electricity network capacity.
6. **Flexibility Markets and Local Energy Initiatives** – Exploring how dynamic models can enhance participation in grid flexibility services.

By addressing these priority areas and leveraging existing expertise, this challenge will accelerate the development of advanced dynamic modelling solutions, enabling GB to optimise electricity network capacity and improve system resilience.

[7] National Grid Electricity System Operator (2023) 'Enhanced RMS (e-RMS) models for stability assurance'. Available at: https://smarter.energynetworks.org/projects/nia2_ngeso050/
[8] UK Power Networks (2024) 'AI for Visibility and Forecasting of Renewable Generation'. Available at: https://smarter.energynetworks.org/projects/nia_ukpn0104/
[9] Scottish and Southern Electricity Networks Transmission (2025) 'SETTLE'. Available at: https://smarter.energynetworks.org/projects/nia_shet_0051/

Innovation Challenge 3:

High-Energy Demand Point Integration: How can we develop scalable approaches to integrate the rise of large demands (e.g. Data Centres), ensuring an increase in capacity within the next decade?

Context: Addressing Large-Scale Energy Demand Growth

The UK is experiencing an increase in energy-intensive demand, driven by the expansion of AI clusters, data centres and industrial decarbonisation efforts. These sectors are not only critical for technological advancement but also for regional economic development, attracting investment and supporting job creation. However, slow grid connection processes and infrastructure constraints pose significant barriers to integrating these large, concentrated loads efficiently. If industries and digital infrastructure face multi-year delays in securing grid connections, GB risks stalling regional growth, limiting innovation, and falling behind in global competitiveness. To unlock economic potential, network capacity must be expanded through more agile, scalable, and sustainable approaches.

Beyond these economic concerns, network capacity allocation has broader social implications. High-revenue industries such as AI-driven data centres often have the ability to pay premium prices for connections, potentially accelerating their access at the expense of other critical but less commercially dominant sectors which may face prolonged delays. Without a balanced approach, there is a risk that network expansion disproportionately benefits a few, while essential services that support local economies and sustainability goals struggle to secure access.

Meeting this challenge requires a combination of innovative connection processes, enhanced grid flexibility, improved demand forecasting, and strategic integration of clean energy sources. Solutions must ensure that high-energy demand industries—such as data centres—can access the power they need efficiently and cost-effectively. At the same time, these industries should leverage grid investments not only to support their own operations but also to enhance energy access for local communities and regionally significant projects, all while maintaining system stability and resilience.

Challenge Objectives

The High-Energy Demand Point Integration challenge seeks to:

- Reduce the risk of stranded capacity by improving grid planning and forecasting to better anticipate and allocate capacity for high-energy demand centres.
- Accelerate grid connection processes to reduce delays while ensuring fair and efficient access for different types of demand centres.

- Reduce peak demand and optimise network capacity by implementing flexible demand management and real-time coordination of large, continuous loads.

Scope of Projects

Project proposals must focus on at least one of the following priority areas:

1. **Improving demand centre energy forecasting and understanding load growth**
    - Enhance data collection and modelling methodologies to improve forecasting of when, where, and how much capacity energy-intensive demand centres will require, reducing uncertainty in grid planning.
2. **Implementing flexibility and efficiency strategies to reduce grid impact**
    - Develop and deploy demand-side flexibility mechanisms, advanced efficiency measures, and on-site energy optimisation to reduce peak demand, improve load management, and minimise strain on the grid.
3. **Accelerating grid connections and infrastructure scaling**
    - Streamline grid connection processes and develop scalable approaches to rapidly and equitably integrate high-energy demand centres while ensuring efficient capacity allocation.

Cross-Cutting Themes

All projects must address the following themes:

- **Customer focussed –** The SIF is funded via customer bills so all projects must ensure the solution is inclusive and accessible to diverse customer and consumer segments through relevant partnerships with third parties, stakeholder engagement and user centric design principles. With the aim of saving customers money.
- **Scalability and Replicability** – Developing solutions that can be deployed across multiple regions and scaled to meet future grid needs.
- **Data and digitalisation** - Harness digitalisation and implement Energy Data Best Practice across all areas.
- **Shared learning** – not all innovation projects will lead to deployment, the learning and how it is shared openly across the energy sector and wider is critical.
- **Skills and capability –** Consider throughout the project where upskilling and new capability development is needed and signalling those needs to relevant third parties like academics, training institutes and key supply chain partners.
- **Supply chains** – Assess the deliverability and scalability of the solution across the UK network from a supply chain perspective including maturity of supply chains, potential vulnerabilities such as labour requirements, logistical and environmental risks.

- **Resilience** – Strengthening the adaptability and security of energy networks to withstand extreme weather events, cyber threats, and fluctuations in energy demand.

Project Partner Requirements

Project Scope	Discovery Project Partner Requirements	Alpha Project Partner Requirements
Improving Demand centre energy forecasting and understanding load growth	A research institution or industry partner with expertise in energy forecasting, demand modelling, and load profiling	An energy network licensee, or energy-intensive industry partner (e.g., data centre, manufacturing hub)
Implementing flexibility and efficiency strategies to reduce grid impact	A research institution or technology provider in demand-side response and grid flexibility.	A hyperscale data centre operator, AI computer infrastructure provider, or large industrial energy user
Accelerating grid connections and infrastructure scaling	A policy expert, regulatory specialist, or network planner with experience in grid connection processes and infrastructure planning.	A data centre or other energy intensive industry partner

Relevant Projects and Programmes

Projects applying to this challenge should align with and build upon existing UK and international initiatives in grid flexibility, energy demand management, and clean energy integration. Applicants should consider how their innovations complement prior research and industry developments.

1. **National Infrastructure Commission (NIC) Reports**: The NIC provides assessments and recommendations on the UK's infrastructure needs.
2. **National Grid's Connections Reform Programme** – Accelerating grid connection processes for new large energy users, including data centres.
3. **Innovate UK's AI for Energy Demand Forecasting Programme** – Advancing AI-driven solutions for dynamic grid balancing and large-scale energy forecasting.
4. **Flexibility Innovation Programmes (Ofgem and DESNZ)** – Supporting innovative demand-side management and energy flexibility solutions for high-intensity loads.
5. **Energy Networks Association (ENA) Open Networks Project** – Driving digitalisation and smarter grid integration for new large-scale demand points.

6. **International Case Studies on Large-Scale Demand Integration** – Leveraging insights from global leaders in hyperscale data centre energy management and industrial electrification (e.g., Lawrence Berkeley National Laboratory's Data Center Efficiency Research[10]).

By addressing these priority areas and leveraging existing expertise, this challenge will accelerate the deployment of scalable energy demand integration solutions, ensuring the UK's electricity networks can support the next generation of energy-intensive industries.

[10] Lawrence Berkeley National Laboratory (LBNL) (2025) *Center of Expertise for Energy Efficiency in Data Centers*. Available at: https://datacenters.lbl.gov/

Innovation Challenge 4:

Consumer-Centric Grid Expansion: How can we use novel technology and processes to deliver grid expansion in ways that enhance public support and deliver wider local and environmental benefits?

Context: Improving public engagement in grid expansion

The UK's transition to net-zero requires a significant and rapid expansion of electricity transmission and distribution infrastructure to support growing renewable generation and electrification of demand. However, public opposition — particularly to new overhead power lines and substations — creates delays and barriers to delivery. Ensuring that grid expansion progresses at the pace required for decarbonisation demands a shift towards more commercially viable, technologically advanced, and consumer-aligned approaches. Building public trust in conjunction with wider social and environmental benefits is therefore critical.

A key challenge lies in balancing technical feasibility, cost-effectiveness, and public acceptability. New approaches to grid expansion must consider how infrastructure can be deployed in ways that minimise disruption, reduce visual impact, and integrate with wider energy system needs. Opportunities exist to explore multi-vector solutions that optimise existing assets, reduce reliance on large-scale reinforcements, and enhance the role of flexibility and storage in mitigating grid constraints. Addressing distribution-level constraints is also critical to ensuring that all consumers — including those located in areas of limited capacity — benefit from a more resilient and future-proofed electricity system. The development of scalable technical solutions that unlock capacity and improve reliability across the grid will be key to delivering a just and inclusive energy transition.

Beyond infrastructure design, consumer engagement must evolve to create more meaningful, transparent and inclusive planning processes that build trust and align national energy priorities with local interests. There is an opportunity for the energy sector to learn from the third sector, community groups, and local energy organisations that have successfully implemented innovative public engagement techniques. Strengthening the link between grid expansion and local economic, social, and environmental benefits could help improve public perception and accelerate project approvals. Additionally, commercial models need to adapt, ensuring investments in network upgrades are not only cost-effective but structured to deliver long-term value to consumers, communities, and other local stakeholders.

By combining technological innovation, commercially scalable solutions, and a more consumer-centric approach, grid expansion can be delivered at the speed and scale required to enable a net-zero energy system while maintaining public confidence and ensuring that no consumers are left behind.

Challenge Objectives

The **Consumer-Centric Grid Expansion** challenge seeks to:

- Accelerate grid expansion by developing solutions that improve public support and reduce opposition to new infrastructure.
- Identify and test scalable technical innovations that minimise visual and spatial impacts, addressing common distribution-level constraints.
- Explore multi-vector and alternative grid expansion approaches to reduce reliance on traditional reinforcements while enhancing system resilience.
- Advance community engagement strategies that build trust, improve transparency, and integrate local priorities into grid planning.
- Align regulatory, commercial, and policy mechanisms to support faster, more publicly acceptable approaches to transmission and distribution upgrades.
- Deliver local financial, societal, and environmental benefits through infrastructure planning that aligns grid expansion with broader regional development goals.

Scope of Projects

Project proposals must focus on at least one of the following priority areas:

1. **Scalable technical innovations for grid expansion**
   - Innovations to expand grid capacity while minimising disruption and key perceived impacts (e.g. visual impacts). This could include advancements in undergrounding technologies, modular substation designs, or multi-vector approaches that optimise infrastructure use.
2. **Community engagement and public acceptance strategies**
   - Solutions to enhance public trust and transparency in grid expansion, involving new engagement models that integrate local perspectives, digital tools, or strategies to demonstrate tangible benefits for communities.

Cross-Cutting Themes

All projects must address the following themes:

- **Customer focussed** – The SIF is funded via customer bills so all projects must ensure the solution is inclusive and accessible to diverse customer and consumer segments through relevant partnerships with third parties, stakeholder engagement and user centric design principles. With the aim of saving customers money.
- **Scalability and Replicability** – Developing solutions that can be deployed across multiple regions and scaled to meet future grid needs.
- **Data and digitalisation** - Harness digitalisation and implement Energy Data Best Practice across all areas.

- **Shared learning** – not all innovation projects will lead to deployment, the learning and how it is shared openly across the energy sector and wider is critical.
- **Skills and capability –** Consider throughout the project where upskilling and new capability development is needed and signalling those needs to relevant third parties like academics, training institutes and key supply chain partners.
- **Supply chains** – Assess the deliverability and scalability of the solution across the GB network from a supply chain perspective including maturity of supply chains, potential vulnerabilities such as labour requirements, logistical and environmental risks.
- **Resilience** – Strengthening the adaptability and security of energy networks to withstand extreme weather events, cyber threats, and fluctuations in energy demand.

Project Partner Requirements

Project Scope	**Discovery Project Partner Requirements**	**Alpha Project Partner Requirements**
Scalable Technical Innovations for Grid Expansion	Consumer representative organisation	An industry partner **or** research organisation with expertise in specific technical solutions being explored.
Community Engagement and Public Acceptance Strategies	Consumer representative organisation	A local authority **and** an industry partner with expertise in using digital tools for infrastructure

Relevant Projects and Programmes

Projects applying to this challenge should align with and build upon existing UK and international initiatives in grid expansion, infrastructure planning, and public engagement. Applicants should consider how their innovations complement prior research and industry developments:

1. **Innovate UK's Prospering from the Energy Revolution programme –** Demonstration and detailed designs of Smart Local Energy Systems, exploring decentralised and multi-vector energy solutions to enhance grid flexibility[11].
2. **PRIDE-Beta (SIF Beta - Round 2)** - Planning Regional Infrastructure in a Digital Environment ('PRIDE'): Combining novel governance structures with a cutting-edge digital tool to enable local authorities, energy networks, and regional stakeholders to collaborate effectively, facilitating the delivery of local and regional decarbonisation ambitions.[12]

[11] Innovate UK Business Connect: *Enabling smart local energy systems*. Available at: https://iuk-business-connect.org.uk/programme/smart-local-energy-systems/
[12] National Grid Electricity Distribution (2024) 'PRIDE-Beta'. Available at: https://smarter.energynetworks.org/projects/10120244/

3. **Powering Wales Renewably (PWR) - Beta (SIF Beta - Round 2)** - Developing a digital twin of Wales's energy transmission and distribution systems to enhance locational visibility of system challenges and accelerate renewable generation integration, supporting the Welsh Government's decarbonisation plans.[13]
4. **Net Zero Society: scenarios and pathways -** A report designed to help policy makers test the UK's net zero strategy against scenarios for how society could look in future.
5. **National Grid's Great Grid Upgrade Programme** – Expanding and modernising transmission infrastructure to support net-zero targets.
6. **Ofgem's Strategic Innovation Fund (SIF) for Energy Infrastructure** – Supporting innovation in grid expansion and community-led energy planning.
7. **International Case Studies on Community-Led Infrastructure Development** – Learning from global best practices in public engagement and consent-building for energy projects.

By addressing these priority areas and leveraging existing expertise, this challenge will accelerate the deployment of socially acceptable, environmentally beneficial, and technologically advanced grid expansion solutions, ensuring that the UK's electricity networks can meet future demand while maintaining public trust and support.

[13] National Energy System Operator (2024) 'Powering Wales Renewably (PWR) - Beta'. Available at: https://smarter.energynetworks.org/projects/10121485/

Innovation Challenge 5:

Enhanced System Visibility and Control: How can we integrate digital automation and enhanced system monitoring to support next-generation power system control and operations?

Context: Enabling Advanced Grid Operations for the Future

Future power systems face growing stability and operational challenges as the transition to inverter-based resources (IBRs) reduces system inertia and changes traditional frequency and voltage dynamics. The increasing penetration of grid-following inverters impacts system frequency response, while increasing use of power electronics can cause expected grid interactions leading to new stability risks. Additionally, weak grids make it difficult for synchronisation of inverters leading to challenges in maintaining stability and resilience. This creates a strong driver for development in advanced control strategies and enhanced system monitoring to allow greater renewable integration whilst maintaining reliability and resilience.

This increasing complexity of modern power systems is also putting pressure on control room operations. Traditional decision-making tools and static models are not effective for real-time situational awareness, requiring advancements in digital twins, AI-driven forecasting, and automation to enhance grid stability and resilience. Using these advancements to aid decision support will enable operators to anticipate and respond to grid events more effectively.

Challenge Objectives

The **Enhanced System Visibility and Control** challenge seeks to:

- Enable real-time system monitoring and adaptive grid control through digital automation, AI-driven analytics, and advanced decision-support tools.
- Enhance grid visibility by deploying advanced sensing, predictive modelling, and data-driven analytics to improve situational awareness and operational decision-making.
- Strengthen grid resilience by integrating automated response mechanisms, self-healing capabilities, and improved management of inverter-based resources.
- Improve control room capabilities and coordination between grid operators, generators, and consumers by implementing dynamic, real-time operational tools.

Scope of Projects

Project proposals must focus on at least one of the following priority areas:

1. **Advanced monitoring and automated grid control**
   - Enhance real-time visibility, fault detection, and automated grid control through advanced sensing, predictive analytics, and AI-driven diagnostics to support dynamic grid management and self-healing capabilities.
2. **Enhancing control room operations**
   - Advance control room digitalisation and automation through AI-driven tools, digital twins, and scenario-based decision support to improve operator situational awareness and streamline decision-making in complex grid conditions.

Cross-Cutting Themes

All projects must address the following themes:

- **Customer focussed –** The SIF is funded via customer bills so all projects must ensure the solution is inclusive and accessible to diverse customer and consumer segments through relevant partnerships with third parties, stakeholder engagement and user centric design principles. With the aim of saving customers money.
- **Scalability and Replicability** – Developing solutions that can be deployed across multiple regions and scaled to meet future grid needs.
- **Data and digitalisation** - Harness digitalisation and implement Energy Data Best Practice across all areas.
- **Shared learning** – not all innovation projects will lead to deployment, the learning and how it is shared openly across the energy sector and wider is critical.
- **Skills and capability –** Consider throughout the project where upskilling and new capability development is needed and signalling those needs to relevant third parties like academics, training institutes and key supply chain partners.
- **Supply chains** – Assess the deliverability and scalability of the solution across the GB network from a supply chain perspective including maturity of supply chains, potential vulnerabilities such as labour requirements, logistical and environmental risks.
- **Resilience** – Strengthening the adaptability and security of energy networks to withstand extreme weather events, cyber threats, and fluctuations in energy demand.

Project Partner Requirements

Project Scope	Discovery Project Partner Requirements	Alpha Project Partner Requirements
Advanced monitoring and automated grid control	A research institution, technology provider, or grid analytics specialist with expertise in real-time monitoring, AI-driven diagnostics, and grid automation.	No additional partner requirements
Enhancing control room operations	A research institution, control room specialist, or automation solution provider with expertise in digital twins and operator decision-support tools for complex environments	No additional partner requirements

Relevant Projects and Programmes

Projects applying to this challenge should align with and build upon existing UK and international initiatives in digital grid operations, automation, and monitoring. Applicants should consider how their innovations complement prior research and industry developments:

1. **UK Power Networks' Advanced Network Management (ANM) Programme**: Over five years, the ANM programme has been enhancing both technological and organisational capabilities to support smarter grid operations.
2. **National Grid's Digital System Operations Programme** – Enhancing digital tools for grid monitoring and control.
3. **Innovate UK's AI for Energy Systems Programme** – Advancing AI-driven solutions for predictive grid management.
4. **Flexibility Innovation Programmes (Ofgem and DESNZ)** – Supporting automation and digital solutions for real-time energy balancing.
5. **Energy Networks Association (ENA) Open Networks Project** – Enabling smarter grid operations and digitalised system visibility.
6. **International Case Studies on Advanced Grid Automation** – Learning from global best practices in AI-driven grid monitoring and automation.
7. **Energy Digitalisation Strategy**: Published in 2021, this strategy outlines the UK's vision for harnessing data and digitalisation to achieve net-zero emissions.[14]

By addressing these priority areas and leveraging existing expertise, this challenge will accelerate the deployment of scalable digital automation solutions,

[14] Digitalising our energy system for net zero: strategy and action plan. Available at: https://www.gov.uk/government/publications/digitalising-our-energy-system-for-net-zero-strategy-and-action-plan

ensuring the UK’s electricity networks can operate with enhanced visibility, stability, and control in the face of rapid energy transitions.

Innovation Challenge 6:

Green Gas: How can we integrate low-carbon gases such as biomethane and Bio-SNG in a cost-effective way, enabling networks to efficiently manage their injection while ensuring system stability and reliability?

Context: Enabling the Transition to Low-Carbon Gas Networks

The UK has significant potential to produce and use low-carbon gases such as biomethane and Bio-SNG (synthetic natural gas), with projections estimating up to 108 TWh of renewable gas production per year by 2050, depending on feedstock availability and policy support. These gases provide a crucial opportunity to reduce emissions while enhancing energy security, particularly in hard-to-decarbonise sectors such as heat, industry, and transport.

However, the scale up of green gas production and use is constrained by the capacity and flexibility of the existing gas network. Infrastructure originally designed for natural gas must now adapt to accommodate increasing volumes of distributed, lower-pressure gas injections. Without improvements in grid capacity management, injection strategies, and system balancing, bottlenecks may limit the ability to integrate and scale green gas supply effectively.

Innovative solutions are required to optimise grid utilisation, enable dynamic injection management, and ensure stable and efficient gas network operation. Advanced forecasting, real-time system monitoring, and digital automation, alongside innovations in compression, storage, and pressure management, could enable more flexible and dynamic injection of green gases, helping networks accommodate a diverse gas supply while maintaining reliability and cost-effectiveness.

Addressing these challenges will be essential for unlocking the full potential of biomethane and Bio-SNG, supporting the UK's net-zero ambitions, and maximising its abundant domestic green gas resources.

Challenge Objectives

The **Green Gas Integration** challenge seeks to:

- Develop cost-effective solutions for injecting biomethane and Bio-SNG into existing gas networks while maintaining system stability and reliability.
- Increase ability to accommodate fluctuating green gas production though improved network planning, forecasting, and flexibility.
- Streamline injection planning through enhanced coordination between gas network operators, renewable gas producers, and energy suppliers.
- Enable more effective gas injection and distribution by advancing innovations in gas storage, injection management, and pressure management technologies.

Scope of Projects

Project proposals must focus on at least one of the following priority areas:

1. **Network integration and infrastructure readiness**
    - Enhancing blending techniques, pressure management, and infrastructure upgrades to maintain system stability and ensure seamless integration of green gases with existing gas networks.
2. **System flexibility and balancing**
    - Advancing real-time forecasting, dynamic injection control, and grid-balancing solutions to manage fluctuating green gas production while maintaining operational reliability
3. **Storage and injection management**
    - Advanced compression, storage, and pressure management technologies, enabling greater network flexibility and optimised green gas utilisation.

Cross-Cutting Themes

All projects must address the following themes:

- **Customer focussed –** The SIF is funded via customer bills so all projects must ensure the solution is inclusive and accessible to diverse customer and consumer segments through relevant partnerships with third parties, stakeholder engagement and user centric design principles. With the ultimate aim of saving customers money.
- **Scalability and Replicability** – Developing solutions that can be deployed across multiple regions and scaled to meet future grid needs.
- **Data and digitalisation** - Harness digitalisation and implement Energy Data Best Practice across all areas.
- **Shared learning** – not all innovation projects will lead to deployment, the learning and how it is shared openly across the energy sector and wider is critical.
- **Skills and capability –** Consider throughout the project where upskilling and new capability development is needed and signalling those needs to relevant third parties like academics, training institutes and key supply chain partners.
- **Supply chains** – Assess the deliverability and scalability of the solution across the GB network from a supply chain perspective including maturity of supply chains, potential vulnerabilities such as labour requirements, logistical and environmental risks.
- **Resilience** – Strengthening the adaptability and security of energy networks to withstand extreme weather events, cyber threats, and fluctuations in energy demand.

Project Partner Requirements

Project Scope	Discovery Project Partner Requirements	Alpha Project Partner Requirements
Network integration and infrastructure readiness	A research institution, technology provider, or infrastructure specialist with expertise in gas blending, pressure management, and grid adaptation.	A biomethane/Bio-SNG developer to validate and test solutions.
System Flexibility and Balancing	A research institution, flexibility solutions expert, or control system developer specialising in real-time forecasting, injection control, and balancing strategies.	A biomethane/Bio-SNG developer to validate and test solutions.
Storage and Injection Management	A research organisation or technology developer with expertise in gas compression, storage, and injection management.	A biomethane/ Bio-SNG developer to validate and test solutions.

Relevant Projects and Programmes

Projects applying to this challenge should align with and build upon existing UK and international initiatives in green gas integration and network flexibility. Applicants should consider how their innovations complement prior research and industry developments:

1. **Green Gas Support Scheme (GGSS)** – A UK government initiative supporting biomethane production and injection into gas networks.
2. **Future Grid Programme (National Gas Transmission)** – Exploring network readiness for hydrogen and low-carbon gas integration.
3. **Ofgem's Innovation Link** – Providing regulatory support for green gas projects seeking market entry.
4. **Flexible Gas Networks (Ofgem's Strategic Innovation Fund)** – Driving innovation in gas network management for enhanced flexibility.
5. **Biomethane Study (NIA_NGN_337)** - Identifying areas for potential growth in biomethane production by reviewing feedstock potential and gas grid capacity, aiming to convert underperforming Anaerobic Digestion (AD) facilities from Combined Heat and Power (CHP) to biomethane injection for maximum economic, environmental, and social benefit.[15]
6. **Assessing the Gas Network Decarbonisation Pathway (NIA_SGN0144) -** Evaluating the decarbonisation pathway set out by the gas networks, including the level of decarbonised gas delivered,

[15] Northern Gas Networks (2022) 'Biomethane Study'. Available at: https://smarter.energynetworks.org/projects/nia_ngn_337/

system cost implications, security of supply, safety and risk management, economic benefits, and emissions savings potential at different stages.[16]

7. **Intelligent Gas Grid - Beta (SIF Beta - Round 1)** - Implementing automated pressure management software, utilizing near real-time data and machine-learning techniques to enhance network coordination, planning, and optimization. This project also aims to increase biomethane and future hydrogen injection into networks, contributing to net-zero goals and facilitating the decarbonization of heat.[17]
8. **GasNetNew54** (EPSRC project; 22-25): The aim of this project is to undertake a major review of the role of the gas network in future. This project explores the different possible uses for parts of the gas network not being converted to hydrogen, including use for district heating networks or as compressed air energy storage systems.

By addressing these priority areas and leveraging existing expertise, this challenge will accelerate the deployment of scalable green gas integration solutions, ensuring the UK's gas networks can support the transition to a low-carbon future.

[16] SGN (2020) 'Assessing the Gas Network Decarbonisation Pathway'. Available at: https://smarter.energynetworks.org/projects/nia_sgn0144/

[17] SGN (2023) 'Intelligent Gas Grid - Beta'. Available at: https://smarter.energynetworks.org/projects/10063754/

Innovation Challenge 7:

Whole System Optimisation: How can whole system approaches enable gas and multi-vector decarbonisation?

Context: Advancing Whole System Planning for a Decarbonised Energy Future

As GB transitions towards a net-zero energy system, an integrated, multi-vector approach across electricity, gas, heat, and transport is essential to optimise system-wide decarbonisation. The growing interdependencies between these vectors require advanced optimisation frameworks that provide a holistic view of energy flows, enhance system resilience, and support coordinated infrastructure investment. By integrating multiple energy carriers, multi-vector systems can improve energy efficiency, reduce system costs, and unlock innovative decarbonisation pathways that would not be feasible under siloed approaches.

Gas remains a critical component of the GB energy system, offering significant advantages in storage capacity, infrastructure costs, and energy delivery at peak demand. Gas is a storable energy resource, whereas electricity is an instantaneous energy vector. Local gas networks alone provide twenty times more flexibility in a day in comparison to that provided by pumped hydro for the electricity system[18]. On a winter's day, gas networks transport up to four times more energy than electricity networks[19]. These factors highlight the vital role of a multi-vector optimisation approach in improving coordination between gas and electricity systems.

Current energy system planning methods often focus on individual vectors in isolation, limiting the ability to leverage synergies between electricity, green gases (including green hydrogen) and heat networks. Without a whole system perspective, infrastructure investments may be suboptimal, and opportunities for flexibility and cost savings across vectors may be missed. This approach is also important to address the future configuration and operation of the gas network.

A multi-vector optimisation approach enables improved coordination between sectors, enhances system flexibility, and ensures a cost-effective, reliable, and resilient decarbonisation strategy at both regional and national levels. Addressing these challenges requires innovative system modelling, and investment strategies that reflect the full value of multi-vector integration in the future energy system.

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[18] Wilson, G., Rowley, P., and Argent, S. (2018) *Flexibility in Great Britain's gas networks: analysis of linepack and linepack flexibility using hourly data*. UK Energy Research Centre. Available at: https://d2e1qxpsswcpgz.cloudfront.net/uploads/2019/05/UKERC_BN_Linepack_flexibility_DOI_update.pdf

[19] Institution of Gas Engineers & Managers (IGEM) (2021) *Written evidence submitted by the Institution of Gas Engineers & Managers (IGEM) (ESI0029)*. UK Parliament. Available at: https://committees.parliament.uk/writtenevidence/50036/html/

Challenge Objectives

The **Whole System Optimisation** challenge seeks to:

- Improve coordination between electricity and gas networks to enable efficient system transitions by developing advanced modelling tools with regional granularity.
- Enhance investment decision-making across multiple energy vectors through whole system insights that inform cost-effective, integrated planning.
- Facilitate better policy development by providing a robust, data-driven foundation for future energy network evolution.
- Support the integration of low-carbon fuels and technologies while maintaining system stability and resilience through improved network modelling and forecasting.
- Develop evidence for future gas network configurations that deliver overall system benefit by assessing long-term system needs and optimisation strategies.

Scope of Projects

Project proposals must focus on at least one of the following priority areas

1. **Whole-system modelling and scenario analysis**
    - Develop advanced modelling tools to optimise multi-vector energy configurations, assessing future gas grid roles, infrastructure needs, and long-term decarbonisation pathways.
2. **Development and demonstration of high-impact multi-vector configurations**
    - Design, develop, and trial scalable multi-vector energy solutions, integrating gas-electricity and other vector coordination in real-world demonstrations.

Cross-Cutting Themes

All projects must address the following themes:

- **Customer focussed –** The SIF is funded via customer bills so all projects must ensure the solution is inclusive and accessible to diverse customer and consumer segments through relevant partnerships with third parties, stakeholder engagement and user centric design principles. With the ultimate aim of saving customers money.
- **Scalability and Replicability** – Developing solutions that can be deployed across multiple regions and scaled to meet future grid needs.
- **Data and digitalisation** - Harness digitalisation and implement Energy Data Best Practice across all areas.
- **Shared learning** – not all innovation projects will lead to deployment, the learning and how it is shared openly across the energy sector and wider is critical.

- **Skills and capability –** Consider throughout the project where upskilling and new capability development is needed and signalling those needs to relevant third parties like academics, training institutes and key supply chain partners.
- **Supply chains** – Assess the deliverability and scalability of the solution across the GB network from a supply chain perspective including maturity of supply chains, potential vulnerabilities such as labour requirements, logistical and environmental risks.
- **Resilience** – Strengthening the adaptability and security of energy networks to withstand extreme weather events, cyber threats, and fluctuations in energy demand.

Project Partner Requirements

Project Scope	Discovery Project Partner Requirements	Alpha Project Partner Requirements
Whole-system modelling and scenario analysis	National Energy System Operator (NESO)	NESO **and** a gas network licensee **and** a research or industry partner with expertise in whole systems and multi vector analysis
Development and demonstration of high-impact multi-vector configurations	A technology provider **or** Research institution specialising in cross-sector energy modelling **and** NESO	NESO **and** a gas or electricity network licensee **and** relevant generation and/or demand sites spanning across all vectors being investigated.

Relevant Projects and Programmes

Projects applying to this challenge should align with and build upon existing UK and international initiatives in whole system energy planning and optimisation. Applicants should consider how their innovations complement prior research and industry developments:

1. **Whole Systems Energy Modelling Consortium (wholeSEM)** – A multi-institution initiative that developed integrated energy models to assess multi-vector transitions in the UK's energy system.[20]
2. **Infrastructure Transitions Research Consortium (ITRC)** – A programme providing modelling and data to support national infrastructure planning, focusing on interdependencies between energy, transport, and other systems.[21]

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[20] UCL Energy Institute. (n.d.). *Whole Systems Energy Modelling Consortium (wholeSEM)*. Retrieved from https://www.ucl.ac.uk/bartlett/energy/research-projects/2025/jan/whole-systems-energy-modelling-consortium
[21] Infrastructure Transitions Research Consortium (ITRC). (n.d.). *ITRC Overview*. Retrieved from: https://www.itrc.org.uk/

3. **Energy Systems Catapult – Whole System Modelling** – An initiative offering independent, technology-agnostic whole-system modelling to design future energy systems and support decarbonisation strategies.[22]
4. **NESO's Future Energy Scenarios (FES)** – A long-term modelling framework assessing whole-system decarbonisation pathways, including gas-electricity interactions and hydrogen deployment.[23]
5. **Multi-vector or whole system demonstrations projects -** Innovate UK has supported several projects including under the PfER programme.

By addressing these priority areas and leveraging existing expertise, this challenge will accelerate the development of whole system approaches, ensuring the UK's energy networks can efficiently transition to a low-carbon future while maintaining stability, reliability, and cost-effectiveness.

[22] Energy Systems Catapult. (n.d.). *Whole System Modelling*. Available at: https://es.catapult.org.uk/what-we-do/whole-system-modelling/

[23] National Electricity System Operator. (2023). *Future Energy Scenarios 2023*. Available at: https://www.nationalgrideso.com/future-energy/future-energy-scenarios