Networks reimagined: Designed to deliver for customers and growth

Energy Network Innovation Taskforce

Chaired by Laura Sandys CBE

An independent report sponsored by

ofgem Innovate UK

CATAPULT Energy Systems

Acknowledgements

The Innovation Challenges set out in this report reflect the contributions from a very wide range of individuals from across the sector who generously gave their time and expertise to contribute to shaping future energy network innovation. The Taskforce is indebted to the members of the Steering Group, the Expert Group and the five Working Groups; please see Annexe 8 for a full list of participants in the Taskforce. The members of the Steering Group were:

Chris Burchell, *Scottish and Southern Electricity Networks Distribution*
Jon Butterworth, *National Gas*
Nicola Connelly, *SP Energy Networks*
Will Drury, *PNDC*
Laura Fleming, *Hitachi Energy UK*
Steve Fraser, *Cadent*
Jodie Giles, *Innovate UK*
Ben Golding, *Department for Energy Security and Net Zero*
Aaron Gould, *Association for Decentralised Energy*
Cordi O'Hara, *National Grid Electricity Distribution*
Phil Jones, *Northern Powergrid*
Akshay Kaul, *Ofgem*
Jonathan Kini, *Twist Broadband; Ofwat & Ofgem Non-Executive Director*
Julian Leslie, *National Energy System Operator*
Tamsin Lishman, *SSE Energy Solutions*
Guy Newey, *Energy Systems Catapult*
Basil Scarsella, *UK Power Networks*
Anusha Shah, *Plan for Earth*
Nick Winser, *National Infrastructure Commission*

Report contributors: Laura Sandys CBE, Jodie Giles, Richard Halsey, Marzia Zafar, David Richardson, Laura Glover, Luke Ames Blackaby, Sam Walker, David Wyatt, Huw Thomas, Tian Coulsting, Eilidh Lockhart, Killian Condell and Nick Geddes.

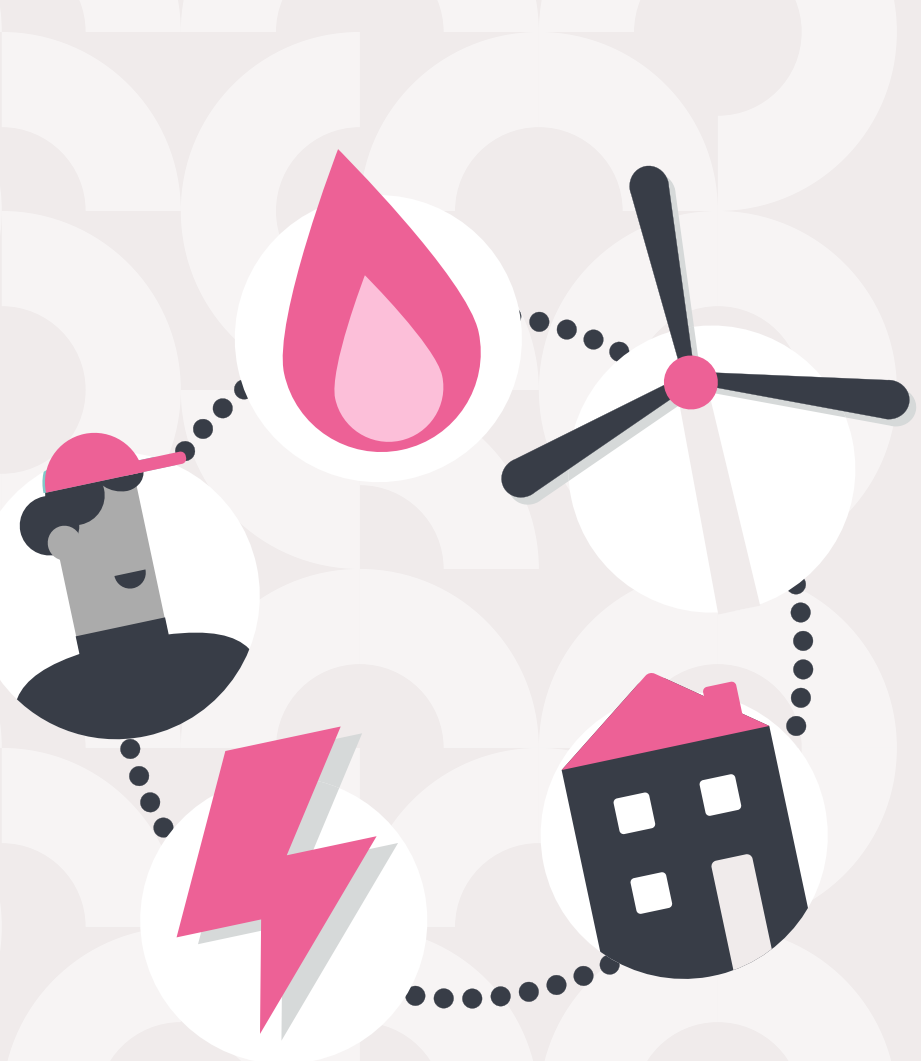
ofgem

Marzia Zafar

Deputy Director of Digitalisation, Innovation and Decentralisation

Senior Responsible Officer for the Strategic Innovation Fund

Ofgem welcomes this excellent report from Laura, her Taskforce team, and everyone who worked on it. **I am delighted to confirm that Ofgem endorses these Innovation Challenges,** which balance the need for urgency and widespread transformation, with clear, ambitious targets. Meeting these Innovation Challenges will improve consumers' lives and move us closer to a Net Zero energy system with genuine growth potential – in short, it will help us drive towards an energy infrastructure that is fit for the future.



Contents

Annexes to this report may be found in a separate document.

The five Innovation Challenges

The Energy Network Innovation Taskforce has brought together over 150 organisations to develop five Innovation Challenges for energy networks, to be addressed through the Strategic Innovation Fund for the RIIO-3 price control period. The Challenges define aspirational customer outcomes, and the associated dates represent timelines for the innovation to become business as usual across all networks.

Innovation Challenge 1

Industrial and business connection acceleration

Major new strategic industrial sites can be energised and operational within six months by 2033

Innovation Challenge 2

Faster build and maintenance

50% faster, 20% cheaper network build and maintenance by 2035

Innovation Challenge 3

Instant use domestic energy devices

Enable instant, plug-and-play connections of domestic energy devices and appliances by 2032

Innovation Challenge 4

Eliminating energy outages

Near-zero interruptions via autonomous reconfiguring and islanding of any section of the network by 2038

Innovation Challenge 5

Decentralised system balancing

Deliver products and services to prove the viability of autonomous local balancing and optimisation of networks at every level by 2034

Forewords

Laura Sandys

Taskforce Chair

I am very pleased to present five highly ambitious Innovation Challenges that have been co-designed by over 150 organisations. These mark a fundamental step-change in how we shape innovation across the energy sector: designed in the interests of our customers, driving economic growth and accelerating decarbonisation. Our Challenges have been guided by a mission-led approach to redefine our energy networks, recognising that they must do far more than simply keep the lights on, and must be informed and shaped by the needs of our customers and the wider economy.

The five Innovation Challenges we have developed represent a joint commitment across the networks to deliver a frictionless, customer-centric energy future that empowers consumers, unlocks economic growth, and ensures our energy system serves as the engine for a thriving decarbonised society.

The appetite for transformational change has been evident throughout the work of this Taskforce, and we very much look forward to seeing the realisation and most importantly deployment of the outcomes from these challenges. This has been a uniquely collaborative taskforce forging new links with unusual partners, and we want to thank all of them for their insights, input and commitment to delivering these challenges.

I want to pay a particular thanks to David Richardson and the team at Energy Systems Catapult who have designed and steered this Taskforce.

Akshay Kaul

Director General for Infrastructure, Ofgem

At Ofgem, our priority is to promote innovation across the energy system that helps deliver secure, affordable and clean energy to all consumers. The Taskforce's Innovation Challenges provide a vital and ambitious roadmap for the sector. By focusing on accelerating connections and driving down the whole-life costs of network build and maintenance, we can unlock billions in savings and support the rapid deployment of clean energy. Agile regulation and bold innovation must go hand-in-hand to protect customers whilst enabling this essential, capital-intensive transition.

Guy Newey

Chief Executive Officer, Energy Systems Catapult

This is about innovators. It's about connecting the amazing engines of creativity and resourcefulness that we have in the UK, with the biggest problems that the energy sector faces – so that radically different organisations can work together to build a better system. Energy Systems Catapult are honoured to have supported the delivery of the Taskforce, and to have contributed our perspectives to the development of these Innovation Challenges. We're impatient to see how the sector will pick these up and run with them.

Energy Networks Innovation Taskforce Steering Group

We are proud to share these five Innovation Challenges as ambitious destinations for our energy networks innovation programmes going forward. Shaped by the collective expertise of over 150 organisations, they set high, aspirational targets to drive transformative innovation across the entire energy system. As the Energy Networks Innovation Taskforce Steering Group, we support these ambitions and will champion the collective action required to deliver them.

Executive summary

There is a real opportunity to transform Great Britain's energy networks from traditional infrastructure into a dynamic, intelligent, and fiercely resilient platform that guarantees the nation's thriving, sustainable, and prosperous future. Innovating how energy network services are delivered can unlock hundreds of billions of pounds in pent up renewable generation, provision of housing and industrial expansion. The contribution the networks make is at the heart of economic growth, energy system decarbonisation and the everyday lives of tens of millions of people.

Ofgem and Innovate UK established the Energy Network Innovation Taskforce, with Laura Sandys as Chair, to set ambitious, long-term Innovation Challenges for Great Britain's Strategic Innovation Fund (SIF). Over the coming five-year RIIO-3 price control period, the SIF will make £500m available to regulated network companies to drive modernisation of the energy networks. The Taskforce's Innovation Challenges, if successfully addressed, will reduce costs, unlock economic growth, and deliver a Net Zero energy system that meets the real needs of its users.

The Taskforce's recommended Innovation Challenges, and Ofgem and Innovate UK's delivery mechanisms, support a mission-led, outcome focussed approach to energy network innovation, demanding that the country's energy infrastructure does more than simply carry on with the status quo. Instead, the sector must collectively strive to deliver the affordable future energy system that Great Britain's people and businesses need.

The 2040 future we need to plan for [1]

Up to **25%** of homes could be equipped with air conditioning, resulting in a potential load of **over 7 GW**

Connected offshore renewable generation capacity could **increase almost sixfold**, and connected renewables under 1 MW could **triple** in capacity

Biomethane could make up 25% of the total gas supply

14% of cars could be highly autonomous, **charging at centralised infrastructure**

Data centre annual electricity demand might rise to **over 54 TWh/yr**

Industrial electricity demand could **increase by 70%**

Residential heat pump uptake could increase 25-fold

A 1-in-20 winter could see an **increase of 11 GW to peak demand**

Why this approach is different

The Taskforce process represents a significant evolution of the SIF mechanism. Through richer engagement with leaders in the sector, and greater focus on delivery of outcomes for network customers, it seeks to enable energy networks – working with their customers, innovators and solution owners across energy and other sectors – to develop a portfolio of innovation projects addressing specific Innovation Challenges with clear intended impacts. Coordinating innovation activity in this way also enables continuity of knowledge across and between projects, and provides opportunities for sector participants to champion and support ambitious outcomes.

To enable this, the Taskforce's Chair and team led a process to develop future network Innovation Challenges that are highly ambitious, transformational to energy network customers, and integrated into the sector's thinking. The Taskforce undertook a radically open co-design activity, comprehensively engaging with energy network companies, their customers, and the wider sector. This approach supported participants to plan from the future and focus on strategic ambitions for the sector that can materially address four overarching objectives:

1. Drive down energy network costs

2. Serve network customer needs

3. Stimulate economic growth

4. Unlock decarbonisation

The Innovation Challenges

To unite the sector behind a vision for a future energy system that truly serves the needs of its customers, the Energy Network Innovation Taskforce has developed the following five Innovation Challenges to be overcome in networks' business-as-usual activities by the target dates – requiring accelerated innovation over the next five years to test and deploy new approaches and technologies.

Each Innovation Challenge articulates an ambitious customer outcome to be delivered through network innovation. Innovation funding must not replicate or support measures that should already be undertaken and implemented by energy networks through normal operations and price control mechanisms; it must solely stimulate activity that could not otherwise occur.

These Innovation Challenges represent the very highest priorities from over 250 stakeholders across 150 organisations. They cover all customer types; all energy vectors; and all services that energy networks provide, to enable them to play their part in the energy transition. Delivering these Innovation Challenges through the SIF mechanism in the RIIO-3 price control will require new ways of thinking about the energy system, building evidence to inform future policy and regulatory frameworks, redefining roles, and forging strong collaborative partnerships with innovators beyond the energy sector.

Challenge	Title	Innovation Challenge statement
Challenge 1	Industrial and business connection acceleration	Major new strategic industrial sites can be energised and operational within six months by 2033
Challenge 2	Faster build and maintenance	50% faster, 20% cheaper network build and maintenance by 2035
Challenge 3	Instant use domestic energy devices	Enable instant, plug-and-play connections of domestic energy devices and appliances by 2032
Challenge 4	Eliminating energy outages	Near-zero interruptions via autonomous reconfiguring and islanding of any section of the network by 2038
Challenge 5	Decentralised system balancing	Deliver products and services to prove the viability of autonomous local balancing and optimisation of networks at every level by 2034

Taking innovation from Challenge to delivery

Defining the Innovation Challenges is not the end of the story. The delivery model for SIF in RIIO-3 is anchored in the creation of Innovation Delivery Groups (IDGs), convening energy networks, decision-makers and subject-matter experts from across the sector to coordinate portfolios of projects against each Innovation Challenge and focus the sector's efforts to achieve transformational outcomes.

To maximise the impact of this delivery model the Taskforce has, additionally to developing the Innovation Challenges, identified a set of wider strategic opportunities to improve the effectiveness of the innovation ecosystem in RIIO-3 and beyond.

These strategic opportunities were identified throughout the Taskforce engagement and by learning from within and beyond the energy sector. They are described more fully starting from page 36.

1. Enabling agile regulation: Evolution of network incentives
2. Market making: Procurement as an innovation engine
3. Reimagining roles and responsibilities: Innovate beyond current remits
4. Collaborative innovation ventures: Forging lasting partnerships
5. Beyond energy systems: Unlocking wider societal value
6. Higher velocity innovation: Harnessing modern tools and techniques
7. Streamlining the innovation journey: Enabling innovator participation

Harnessing these opportunities will require brave leadership and the collective efforts of energy networks, regulators, Government and innovators. The sector now needs leadership to take on and own the Innovation Challenges set out by the Taskforce; and energy networks, solution providers, innovators, regulators and customers need to collaborate around the opportunity for transformational change that the Innovation Challenges represent.

The Innovation Challenge portfolio

The primary contribution of the Energy Network Innovation Taskforce has been to develop a set of Innovation Challenges that will coordinate innovation activities by regulated energy networks in the Strategic Innovation Fund (SIF) in the RIIO-3 price control period. Formed as specific and measurable outcomes with associated dates for business-as-usual deployment, they represent concrete ambitions for delivery of real change into networks' operations.

The next pages present each Innovation Challenge in context, explaining for each:

- The **key energy system needs** that it addresses, and the prize that can be realised through successful innovative solutions to those needs.
- The concrete **ambition of each Innovation Challenge;** why it is **vital, extremely challenging and ambitious, but also achievable;** and how **success could be demonstrated.**
- The **key relationships** needed in delivery of each Innovation Challenge.
- Finally, and without wanting to predetermine the activities of the innovators who will take on the Innovation Challenges, non-exhaustive lists of **specific potential innovation opportunities** in each case that may provide the kernel of future system change.

This portfolio is not exhaustive; in particular, near-term and incremental opportunities can be supported via private venture, other network innovation mechanisms, and other funds and government initiatives (see page 34). Crucially, change, pivot and adaptation are at the heart of a truly innovative system, so on-going refinement, adaptation and technology evolution may redefine the outcomes, priorities and possibilities. Although the SIF mechanism allows for the creation of new Innovation Challenges during the price control period if the need arises, these Innovation Challenges will persist and represent the focal point for RIIO-3 SIF activity.

Innovation Challenge 1:

Industrial and business connection acceleration

Major new strategic industrial sites can be energised and operational within six months by 2033

Overview

Rapid demand for new and expanding industrial sites, including data centres, offers fundamental opportunities for industrial and economic growth. However, delays in connecting to electricity networks can undermine many potential opportunities. For new data centres or expanding manufacturers, the time spent in the grid connection queue can be as long as 8-10 years on average in Great Britain, compared with just two years in Norway [2], which leads to disconnects in the timeline between the economic need for these sites and their actual operation.

This Challenge will dramatically reduce the time needed to start supplying energy to a new industrial site, facilitating the rapid expansion of essential industries, attracting further investment into Great Britain and enabling economic growth. A particular focus of this Challenge is in cross-vector collaboration to ensure all operational requirements of the site are met, while optimising energy network connections through cross-vector solutions and giving consideration to the circularity of other vectors including water and wastewater usage. Tradeoffs in cross-vector solutions should be considered to ensure the benefits afforded by speed do not lead to unintended adverse impacts. Maximising use of local energy resources will also enhance demand for clean power generation, accelerating renewables deployment. This Challenge primarily targets new, strategically significant demand sites for energisation within the six-month timeframe. However, the innovations and learnings will provide spillover benefits to a wide range of business and industrial customers, including both demand and generation. All network customers will see improved service from dramatic accelerations of connection applications, optioneering, and consenting processes, providing a smooth and seamless customer experience.

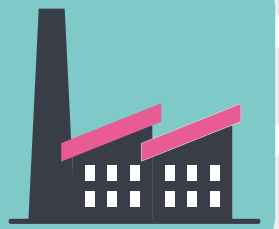
Potential prize

Massive opportunity to unlock growth and jobs in future industries across the economy

Attraction of international investment

Strategic fast-tracking of sites to align to critical demands

Acceleration of speed-to-energy for customers integrating cross-vector energy services to provide an energy solution which can evolve over time



Equipping Great Britain to be more responsive to geopolitical or technological shocks

Challenge ambition

Speed-to-energy: The average elapsed time of networks' responsible actions between receipt of an energy network connection request and connection energisation should be six months or less. An extremely stretching target, but Taskforce engagement and international evidence demonstrates that this timescale would have value for demand customers.

Strategically significant demand sites: Following the approach developed by the Department for Energy Security and Net Zero (DESNZ) for the Connections Accelerator Service [3], submitted connection application projects would be assessed against either economic or social criteria combined with national security and/or public interest considerations. This Challenge references industrial sites, and so an additional criterion would be needed to assess the alignment of a connection application with this Challenge in the context of the evolving technology and economic landscape.

Delivery year: A seven-year full deployment timescale to 2033 for the wide-ranging innovation areas of this Challenge creates impetus for meaningful change across the energy sector. Cross-sector data sharing, expected to be delivered in 2030, would be instrumental for delivery.

Necessary partnerships

System operator: For facilitating a cross-vector and whole-system optimised connections process.

Networks: Electricity and gas distribution network operators to collaborate on possible connection options to speed up the energisation process. This may also include transmission network operators depending on the scale of the industrial site.

Industrial customers: For this Challenge the customers are critical participants in co-creating the connection terms to trade off their needs against energy system possibilities and in kickstarting new business models that mobilise capital to rapidly deliver assets.

Developers: Partnerships with key industry players, site developers and local authorities are crucial in delivering suitable connections within the timeframe.

Supply chain: Close engagement with connection asset suppliers will enhance deliverability of physical works.

Technology partners: Those with new tools to automate connection services, extending to solutions based on Artificial Intelligence (AI), will give customers more control and visibility.

Innovation opportunities

- Strong co-creation of solutions with customers
- Industrial heat decarbonisation, and use of waste heat locally
- Circularity of water/wastewater or other vectors
- Connection of high density loads with generation
- Cross-vector connections & solutions – both interim and enduring
- System wide optioneering and anticipatory planning, including transmission–distribution coordination
- Regulatory and legislative arrangements for balancing customer rights and strategic national interests, under differentiated energy system access rights

Case study: A skyscraper in a day

In 2021, BROAD Sustainable Building constructed the 11 storey Holon Building Garden A1 in just 29 hours. Situated in Changsha, Hunan province, China, the building was completed with all essential utilities such as water, electricity, air conditioning and ventilation with energy recovery. Fifty-six shipping-container-sized modules, made from stainless steel, were manufactured offsite in 15 days in a factory with an annual production capacity of 2.7 million m^2. As well as China, Holon Buildings have been constructed in the USA, the United Arab Emirates and South Korea. Not only is the construction cheaper, and five times faster, but the predicted lifespan is 20 times that of a traditional build – with greater earthquake resistance too.

11 storey Holon Building Garden A1 in just 29 hours

Innovation Challenge 2:

Faster build and maintenance

50% faster, 20% cheaper network build and maintenance by 2035

Overview

This Challenge will bring about a reduction in end-to-end delivery time and whole-life costs across all network infrastructure – new build, reinforcement, and maintenance of both electricity and gas networks.

The Transmission Acceleration Action Plan [4] already targets halving transmission build times from existing timelines of 12-14 years by circa 2027. But this challenge goes further, extending the same ambition to gas networks & electricity distribution – and to encompass reinforcement and maintenance; and setting a hard 2035 deadline. With £90 billion of network investment planned over the RIIO-3 period [5], a 20% cost reduction represents billions in potential savings that can be passed on to consumers, while giving network operators the tools to support the influx of low-carbon energy sources, storage assets and demand across both electricity and gas.

Meeting both targets simultaneously will require radical change at every stage of the network build project lifecycle. Innovations such as robotics, modular construction, and cost-efficient undergrounding methods could significantly reduce the complexity and cost of physical works. Digitalisation of assets and streamlined planning and consenting processes have the potential to remove some of the longest delays. Radical changes to the way utility works are planned and conducted, from the smallest to the largest scale, will minimise disruption to customers. Closer linkages between planning of long-term transmission infrastructure pathways and delivery of transmission upgrades will support efficient project outcomes.

On the commercial side, modifications to procurement approaches to support closer supply chain engagement (including standardisation with international supply chains) could unlock significant capacity and reduce lead times. Expanding the roles of Independent Distribution Network Operators (IDNOs) and Independent Gas Transporters (IGTs) to deliver more contestable work, and further resolving the roles of independent operators of transmission assets [6], are further options to accelerate delivery and drive down costs across both electricity and gas networks.

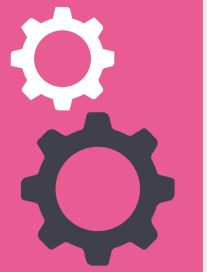
Potential prize

Accelerated end-to-end delivery of network infrastructure

Cost reduction through greater automation across build and maintenance of networks

Economic value of on-shoring more of the construction and manufacturing of network assets

Reduced total cost of ownership through expanding nonstandard modes of delivery such as Independent Network Operators



Reduced disruption to customers and the environment

Developing and implementing world leading technology

Challenge ambition

End-to-end delivery time: The Transmission Acceleration Action Plan demonstrated concrete steps to halve the delivery duration of electricity transmission infrastructure. Broadening the ambition to all network build, reinforcement or maintenance projects will maximise the benefits as the energy transition gathers pace.

Project cost: Cutting the average real-terms unit cost of network reinforcement, build or maintenance by 20% will have tangible benefits for all network customers.

Delivery year: The 2025 Future Energy Scenarios from the National Energy System Operator (NESO) [7] project peak electricity demand to double by 2050, with 50% of this increase taking place between 2035 and 2040. This means innovations in network deployment must be delivered well before 2035 so that they can be used in the intensive preparation of infrastructure for this rapid increase in demand. Rapid deployment will be anchored in coordinated network plans, which will be based on the Strategic Spatial Energy Plan (SSEP), Regional Energy Strategic Plans (RESP) and Centralised Strategic Network Plan (CSNP) to be delivered in 2028.

Necessary partnerships

Networks: Including transmission and distribution network operators for both electricity and gas.

Supply chain: Simplifying and increasing the robustness of supply chains through alignment with international standards and collaborative design to consider deployability and scalability of manufacturing.

Technology companies: Those who are developing strong robotic, modular and automated solutions to construction.

Construction and planning: Working with organisations across the planning and construction phases of projects to identify opportunities to speed up processes and approvals, and designing novel technologies and approaches that can deliver faster and cheaper build.

Innovation opportunities

- Robotics for detailed surveying and energy network construction
- Modular construction of network assets enabling rapid upgrading and maintenance
- Standardisation with international supply chains
- Streamlining of planning & consenting processes, including digital consenting
- Changes to regulation and procurement allowed through the price controls
- On-site manufacturing of custom network asset components to minimise logistics
- Novel cable and transmission designs, including meshed offshore high voltage direct current (HVDC) networks and high temperature superconducting cables (HTSC)
- Rapid-deployment pipeline technologies for distributed green gas injection sites
- Cost-efficient undergrounding methods
- Robust vector-shifting control schemes to deliver virtual capacity by making use of existing capacity on other networks, e.g. hybrid heating
- Modifications to procurement approaches to support closer supply chain engagement
- Expanding the roles of Independent Distribution Network Operators (IDNOs) and Independent Gas Transporters (IGTs) to deliver more contestable work, and further resolving the roles of independent operators of transmission assets
- Maintenance effort reductions to achieve ongoing cost savings
- Digitalisation of assets – digital representations of physical network infrastructure
- Collection and use of high-resolution data to support robust detailed designs at lower cost

Case study: Step-changes in transmission capacity with robot-applied coatings

AssetCool combines advanced materials science and robotics to increase the capacity and reliability of existing overhead power lines. Its core innovation is a spectrally selective coating that reduces solar heat absorption while enhancing thermal emission. This enables up to 30% more capacity on existing lines, with typical increases of 50-200 MW. Robotically applied in the field by crawler and aerial platforms during planned maintenance, or at time of manufacture, deployment timelines are weeks to months rather than years.
The technology is complementary to other solutions such as High Temperature Low Sag (HTLS) conductors & Dynamic Line Rating (DLR). Headquartered in Leeds, AssetCool has completed real-world deployments and pilots in Great Britain, the United States, Canada and more than 10 other countries.

Innovation Challenge 3:

Instant use domestic energy devices

Enable instant, plug-and-play connections of domestic energy devices and appliances by 2032

Overview

This Challenge will enable households to instantly install and connect any low-carbon technology, including demand, storage, and generation assets, and to disconnect redundant assets, without requiring prior network approval. At present this would cover solar photovoltaic (PV), hardwired electric vehicle (EV) chargers and vehicle-to-grid (V2G) connection points, heat pumps (including hybrid heat pumps), and stationary batteries, and disconnection and removal of conventional gas appliances. But the Challenge should also include emerging technologies, such as plug-in systems for microgeneration and storage [8].

At present, authorisation to connect such devices is governed by energy networks. The potential for network-related delays to connection – if reinforcement is necessary – risks undermining public confidence in low-carbon options. Conversely, removing networks from the critical path of household technology uptake has the potential to significantly increase customer satisfaction, while the resulting acceleration in asset deployment will unlock critical flexibility services to support wider system operation.

Achieving this Challenge could involve both network-side and customer-side developments. On the network side, proactive predictive analytics for demand and generation coupled with new engineering processes for both proactive and responsive works would ensure households have timely access to connection capacity at the point when they decide to install assets. On the demand side coordination of customer device operation is crucial, with a "flexibility by design" presumption that device operation will be managed in the interests of the wider system with opt-out by exception. At a local scale this could be used to ensure networks operate within safe limits while maximising services to households. At wider scales, coordinated operation could make a tangible contribution to system balancing, constraint resolution and restoration. New business models for domestic connections could reveal customers' interest in differentiated levels of service.

Solutions developed for domestic customers will likely also be applicable to small non-domestic customers with similar needs, broadening the value of the innovation. Beyond this, development of compelling and desirable customer experiences and seamless ways for customers to interact with the energy system will help build trust and desire to engage further with decarbonisation pathways.

Potential prize

Accelerated rollout of low-carbon technologies, delivering customer benefits

Cost reductions realised for all consumers through the management of in-home energy appliances to limit network impact

Automation and digitalisation delivering wider economic and customer experience benefits

Unlocking domestic decarbonisation, and growing the flexibility deployed in the system

Challenge ambition

Plug-and-play connections: No permission should be needed before appliances are installed, and the time delay between appliances requesting energy import/export and granting of authorisation to operate (if applicable) should be below 10 seconds.

Delivery year: Proactive measures in train for RIIO-ED3 [9] will prepare for this Challenge to be delivered in 2032, close to the end of the price control period. Delivery sooner than this would be challenging, due to the need for device manufacturers to update their products to align with new standards.

Necessary partnerships

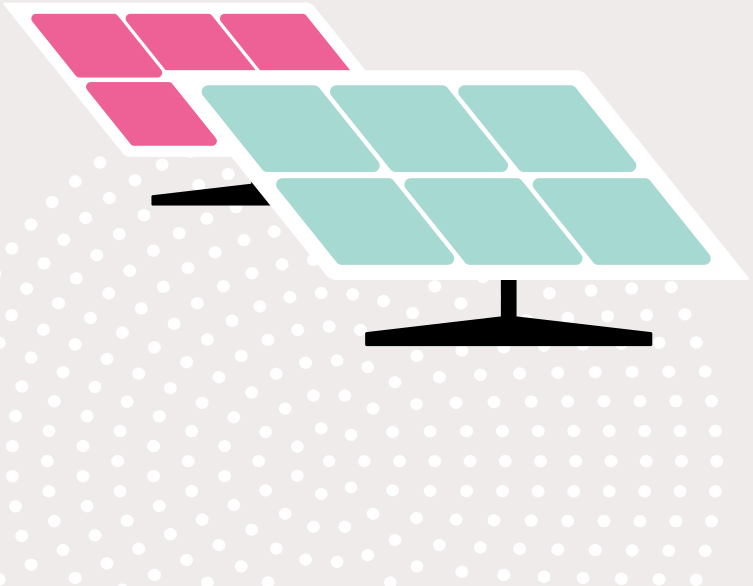
Networks: Electricity and gas distribution network/system operators will undertake both proactive measures to ready their networks for new technology uptake, and the operational management of installed devices.

Domestic energy device manufacturers: To collaborate and work with manufacturers of smart devices and white goods on standards and controls for ensuring safe network operation.

Energy providers: As owners of the customer relationship, energy suppliers, energy service companies, flexibility service providers and load controllers will create bundled propositions to interface to networks' needs.

Innovation opportunities

- Customer designed and shaped connection and disconnection regime
- AI predictions of domestic energy device uptake and resulting loads
- New business models integrating decarbonisation and flex assets into the customer proposition
- Regulatory review of customer protections and rights
- Removal of constraints on low-carbon technology connection
- Interoperable device management to comply with capacity constraints
- Vector-switching hybrid heating systems to enable load growth and meet customer needs
- Updates to connection codes to support enhanced access



Case study: Residential batteries for zero upfront cost

The Battery PowrPlan from Wondrwall allows households to obtain a high-capacity domestic battery for zero upfront cost, requiring only a fixed monthly fee over the course of a 10-year Energy Storage Agreement. Using the battery for grid services minimises the cost for the household, and Wondrwall's AI home energy management platform integrates with heat pumps, solar PV, EV chargers and other domestic energy devices. Coordinated household-level energy management across multiple appliances could allow for new demands to be accommodated seamlessly within existing network limits, while the innovative commercial arrangements will drive uptake beyond the limits of those able to pay full costs upfront.

Innovation Challenge 4:

Eliminating energy outages

Near-zero interruptions via autonomous reconfiguring and islanding of any section of the network by 2038

Overview

Great Britain's infrastructure faces a new era of risk from extreme climate events, economic shocks, and sophisticated hybrid warfare. This Challenge aspires to redefine resilience as maintaining delivery of services to customers, without the assumption that this requires protection of physical energy network integrity. When a fault, cyberattack or other bad-actor incursion occurs, the network will have the capability to autonomously detect, respond and act in the most appropriate way. This transforms energy networks from rigid, fragile structures into a dynamic platform capable of maintaining critical national infrastructure and services like water, hospitals, telecommunications, and data centres without human intervention.

Autonomous response includes the capability to operate energy system "islands", dynamically reconfiguring energy supply into self-contained zones at the level of households, streets, cities or industrial clusters, which can stay operational using their own energy storage and production resources – both grid-scale and behind-the-meter on demand sites. These islands may be electrically separate from the wider power grid, but are more likely to retain connection to the wider gas system. This allows distributed gas system assets to play a pivotal role in collaboratively protecting energy services while optimising system-level outcomes, complementing local renewable power generation and storage. The role and potential of decarbonised gases will be increasingly significant in delivering clean energy continuity. Use of these islands will be aligned to and support national Black Start processes for electricity, including the Distribution Restoration Zones introduced in the revised Electricity System Restoration Standard [10]. Notwithstanding the different characteristics of different vectors, the underlying drive to minimise interruptions is valid and valuable for all.

Benchmarks in the telecommunications sector demonstrate that replacing manual oversight with a "scalable management framework" can reduce network management operational expenditure by at least 20% while slashing service response times from 90 hours to just 90 minutes [11]. Similarly, international research into direct current (DC) microgrids has shown that autonomous "islanding" can maintain 100% reliability for critical loads even during a total failure of the wider distribution grid [12].

System resilience is also a key deterrent of bad actors aiming to disrupt the country's energy systems and economy. The quickest recovery time or least disruption can be a powerful tool in making Great Britain less attractive to attacks and ransom hunters.

Potential prize

Lower maintenance costs

Greater resilience to growing outside threats

Support innovation by providing a stable and flexible platform for new technologies, markets and customer services

Limiting impact of, and acting as a deterrent to, outside threats

Protection of critical national infrastructure, services, and vulnerable people

Less economic disruption

Challenge ambition

Near-zero interruptions: An ambitious but realistic aim, especially for rural areas where power islanding and network monitoring may be more difficult. Sub-second autonomous reconfiguration is a technical necessity for a digitalised economy to remove the "single point of failure" risks underscored by recent major infrastructure incidents.

Islanding: This approach aligns with the NESO system restoration plan. Greater deployment of distributed energy resources and their mutual visibility and coordination will enable local self-sufficiency of energy needs across broader regions of the network.

Delivery year: 2038 represents a ten-year horizon to deploy the necessary Fault Location, Isolation, and Service Restoration (FLISR) hardware and the cyber-defence AI required to handle complex, bidirectional flows, as well as the deployment of local grid-forming assets through the 2030-2040 period.

Necessary partnerships

System operation: Coordination between control rooms across all network types will be required, led by NESO to define the architecture for handovers from national to local, and from vector to vector. Support from organisations engaged in the field of transmission-level islanding.

Cross-vector collaboration: Coordinated planning at local levels between electricity and gas networks to iteratively define region boundaries and asset portfolios available to support islanded operation.

Security and resilience: Innovative partnerships with the National Cyber Security Centre (NCSC) and cross-sector utility operators (water and telecoms) to mitigate cascading failures during system stress.

Technology companies: Harnessing the full potential of deep tech solutions for predictive analysis, sensing, automation, and decision-making during islanding.

Innovation opportunities

- Development of digital and AI systems to support autonomous network operation
- Combining self-sustaining islands with network re-routing/reconfiguration
- Islanding ability at home/street/local area/regional scales
- Dynamic coordination with distributed energy resources
- Cross-vector resilience strategies, including visibility and coordination post-fault
- Definitions of resilience focussing on maintenance of customer services in relation to their criticality
- Rights of energy stakeholders and consumer protections under islanded operation
- Redefinition of networks' roles to support effective delivery
- Improved bio-methane purification strategies to enable broader asset availability
- Cross-vector network architectures to enable local operation without connection to higher pressure tiers/voltage levels
- Business models for strategic energy reserve operation at national and local levels
- Innovation of assets to withstand prolonged extreme weather events

Ukraine's power grid was isolated from Russia's and synchronised with Continental Europe in 20 days, thanks to achieving 'a year's work in two weeks'

Case study: Ukraine's wartime grid adaptations

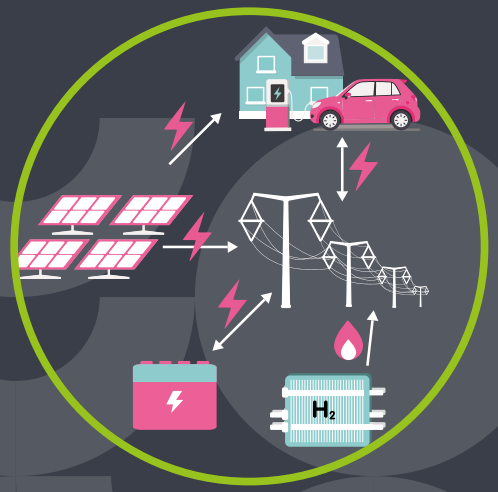
On 24 February 2022, Ukrainian grid operators happened to be conducting a planned isolation test, deliberately de-linking from the Russian power system for a trial intended to last just a few days. When Russia invaded that same day, the two grids were never reconnected. Ukraine's grid operated in isolation until 16 March 2022, when it was successfully synchronised with the Continental European grid. This synchronisation had been planned for 2023 but was expedited with 'a year's work in two weeks'.

Ukraine's response to Russian attacks on its infrastructure has been to pivot dramatically to distributed generation and localised resilience. The country has deployed additional generators to support supply to key services such as hospitals, and created 10,676 'points of invincibility' providing heat and power to citizens affected by disruption. Meanwhile, an estimated 1.5 GW of new solar capacity was added in 2025 alone, and a 200 MW/400 MWh battery storage system was delivered and remotely commissioned in six months rather than the typical two years - in the power system of a country at war.

Innovation Challenge 5:

Decentralised system balancing

Deliver products and services to prove the viability of autonomous local balancing and optimisation of networks at every level by 2034



Overview

This Challenge aspires to deliver a future where energy flows across homes, streets, businesses, and local communities are balanced and managed autonomously, using local control systems to meet local needs from local clean assets while coordinating with the wider system. Instead of a national centralised control room micromanaging millions of devices (storage sites, heat networks, biomethane injection points, electric vehicles, solar PV installations, heat pumps and more), the energy networks of 2034 will use distributed approaches to optimise operation of all assets in real time and help to unlock potential economy-wide savings of £36 billion [13] annually by 2050.

By resolving most energy imbalances and constraints locally, networks will unlock unused capacity, reduce the need for infrastructure build, enhance intelligent system visibility, and respond to real or potential faults in ways which are mathematically impossible through a centralised control system [14]. Automation and digitalisation are key enablers, delivering simplicity of outputs from the background complexity. The system will optimise across vectors, fully exploiting assets that allow constraints on one vector to be sidestepped using another. Work must consider not only how decentralised control functions in normal operation but also under stressed system conditions. This will allow network customers to more actively participate and be rewarded for ensuring reliable, affordable and abundant low-carbon energy for every UK business and household.

Evidence indicates that a bottom-up balancing hierarchy is likely to be the most cost-effective route to a decarbonised energy system. Analysis by PwC and Innovate UK found that place-based delivery has the potential to achieve net zero goals at roughly a quarter of the cost [15] of traditional top-down alternatives. This transition follows proven benchmarks in the telecommunications sector, where edge computing architectures have reduced operational expenditure by at least 20% while enabling an uplift to near-instant service responses [11]. Building on these insights, innovation should be framed as exploring the relative potential contributions from decentralised and centralised approaches, and the roles of and interactions between decentralised and centralised coordination layers.

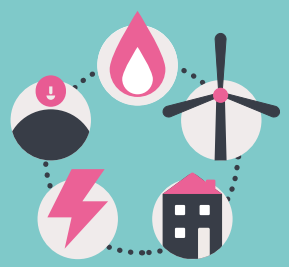
Potential prize

Rewards to customers for taking a greater role in operating the energy system

Competing investment between infrastructure, self-generation and energy efficiency

Tools for local area energy management

Systemic ability to coordinate decentralised assets



Trailblazing organisational roles and obligations in delivering local optimisation

Challenge ambition

Proving the opportunity available from decentralised local balancing: This is a fundamental change to current grid operation. There is a need to determine the most technologically-suitable and cost-effective approaches, and to develop new technologies, standards, business models and partnerships across the energy system to deploy them. In parallel, regulatory mechanisms should be developed to ensure that customers benefit from the cost avoidance they enable, allocating rewards to the actors creating the value.

Delivery year: 2034 targets initial deployment and validation during the RIIO-4 period, paving the way for full national scale-up through RIIO-5. This horizon aligns with economy-wide projections for electrification, sector-coupling interactions and the ubiquity of connected devices, edge computing, and AI.

Necessary partnerships

Networks: Distribution Network Operators (DNOs) transitioning into active System Operators (DSOs), with Gas Distribution Networks (GDNs) for cross-vector balancing operations, and electricity and gas TOs and NESO for larger-scale coordination.

Energy asset and smart appliance manufacturers: Working with them to understand their ability to perform energy services and to define mechanisms and protocols to communicate to local controllers.

Industrial and commercial organisations: They will play a crucial part in the ability to drive new forms of balancing and system management.

Technology companies: Building on solutions delivered for complex logistical and system-wide sectors.

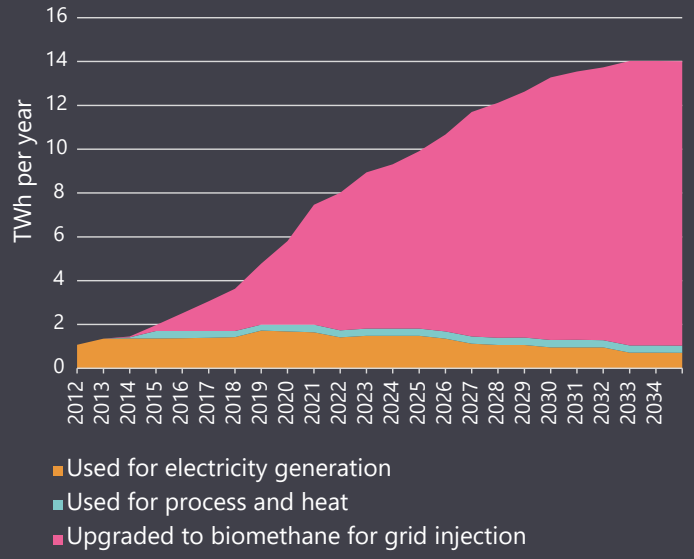
Others: Local authorities, Fintech market operators, and coordinators of energy communities.

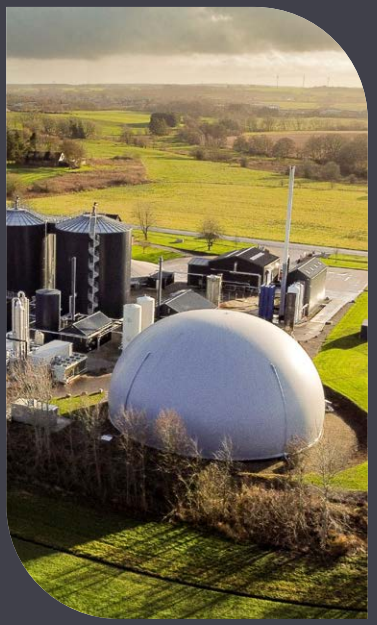
Innovation opportunities

- Management systems for orchestrating energy actions within and between system layers and across actors
- Integration of edge computing controllers to network assets, and connected devices
- New rewards for customers and actors that participate in reducing whole energy system costs
- AI and machine learning models to better predict demand, supply, faults etc. at granular levels
- User Experience paradigms and AI energy companions that help to automate consumer participation
- Coordination models between local, regional and national system actors
- Power hardware devices and configurations to enable smart and reconfigurable operations
- Smart, bidirectional and scalable gas compression solutions
- Automated low power and latency data and control system architectures

Case study: Denmark's biomethane revolution

Historical and expected future biogas production





Biogas in Denmark supplied over 40% of the country's gas consumption in 2025, compared to just 1% in Great Britain, with Denmark aiming for 100% by 2030. Biogas production in the country increased when 20-year-long subsidies were introduced in 2012, which were open for new applications until 2018. Over this time the market matured, and new production is now being encouraged through tenders.

At the time the subsidies were introduced, the vast majority of biogas was being used to produce electricity. Over time this has shifted, with ~80% now being upgraded to biomethane and injected into the grid – allowing it to contribute to the decarbonisation of sites and processes not currently suitable for electrification using existing gas infrastructure, and providing distributed sources of molecular energy to supply local demand.

A portfolio view of the Innovation Challenges

Objectives delivered by the Innovation Challenges

Though each Innovation Challenge individually represents a distinct ambition for the energy sector, the Innovation Challenges have been developed as a coherent, mutually supporting portfolio, designed to support ambitious projections for Great Britain's energy transition. The Taskforce process embedded four overarching objectives, and the resulting portfolio has the potential to contribute to each and every one:

- **Cost reduction:** Drastically reducing whole-life infrastructure costs and enhancing resilience aims to ensure affordability and unlock billions in economic savings and opportunity. New business models and service definitions will allow value to be better realised by customers.
- **Customer outcomes:** Radically simpler engagement with networks to connect assets, and significantly higher resilience, meet the needs of customers from households to major sites.
- **Economic growth:** Accelerating connections across vectors and asset scales, and minimising the disruption caused by infrastructure works, will streamline development of new energy-intensive sites, expansion of existing sites and uptake of new technology by consumers.
- **Decarbonisation:** Reshaping the architecture of system operations is a prerequisite for the rapid connection of tens of millions of smart, flexible decarbonised energy demand assets. Time- and cost-efficiency of infrastructure deployment allow the networks to support new clean energy resources to come on stream.

The table on the next page illustrates how the individual Innovation Challenges relate to selected overarching objectives (stimulating economic growth and reducing energy costs, within a context of achieving decarbonisation goals). It also gives selected examples of initiatives under way at the close of the Taskforce (2026) related to the Challenges' outcomes.

Innovation Challenge	Cost saving potential	Economic growth potential	Relevant current initiatives
1. Major new strategic industrial sites can be energised and operational within six months by 2033	Reduces costs associated with navigating complex bureaucracy, and lowers barriers to investment.	Unlocks huge economic value creation from strategic future and existing industries (data centres, tech foundries, biotech, space ports, manufacturing etc.).	• Connections Action Plan (CAP), Ofgem and DESNZ. • NESO Queue Management (TMO4+): Shifting the connections queue from "first-come, first-served" to "first-ready, first-connected". • Consultation on Accelerating electricity network connections for strategic demand.
2. 50% faster, 20% cheaper network build and maintenance by 2035	Significant potential for lowering labour, financing, delivery, and whole-life operation & maintenance costs of infrastructure.	Allows networks to cost-effectively adapt to changing energy flow patterns at the rate of the transition. It should also provide opportunities for onshoring of manufacturing and assembly.	• Transmission Acceleration Action Plan (TAAP): Government target to halve the end-to-end build time of new transmission infrastructure. • ASTI Framework: Ofgem's Accelerated Strategic Transmission Investment mechanism to fast-track large-scale onshore network projects.
3. Enable instant, plug-and-play connections of domestic energy devices and appliances by 2032	Removes manual engineering assessment costs for DNOs. Reduces costs of red tape and navigating complexity for the customer. Enables households to more easily benefit from microgeneration and off-peak power.	Enables domestic low-carbon technology rollout, creating value in supply chain. Reinforcement-free options for domestic connections would allow network capacity upgrades to be targeted to other users with growth needs.	• Market-wide Half Hourly Settlement (MHHS): Industry-wide transition to incentivise dynamic, time-of-use tariffs. • Smart Secure Electricity Systems (SSES): Government framework regulating Energy Smart Appliances (ESAs) to ensure grid interoperability and cybersecurity. • Warm Homes Plan: Ambition to streamline connections process for domestic heat pumps and other devices.
4. Near-zero interruptions via autonomous reconfiguring and islanding of any section of the network by 2038	Delivers significant avoided economic costs of a shock to the system that takes days to recover, or that cases cascade failures. There will be energy system cost savings from avoided costly restoration measures.	Speed to recovery from any technical or bad actor shock will deliver greater whole economy resilience. Existing and new industries will be more confident from system reliability and power quality. Remote areas will see step-change service improvements, enabling new economic activity.	• RIIO Network Resilience Allowances: Dedicated funding streams within the RIIO-ED2 and upcoming RIIO-T3 price controls for climate adaptation and cyber resilience. • Energy Resilience Strategy: DESNZ upcoming action plan to protect the sector from environmental and adversarial threats.
5. Deliver products and services to prove the viability of autonomous local balancing and optimisation of networks at every level by 2034	Avoids expensive national balancing and constraint payments and supports the transition to consistently modelled lowest system cost energy pathways.	Enables connection of low-carbon generation and demand. UK is well positioned to develop exportable expertise in this sector, particularly around energy system digitalisation and novel services.	• Regional Energy Strategic Plans (RESPs): NESO-led implementation of regional planners to coordinate local network planning and flexibility. • Open Balancing Platform (OBP): NESO's ongoing dispatch platform upgrades to better integrate smaller, distributed balancing mechanism units.

The Innovation Challenges in the context of the energy transition

The portfolio of Challenges aids the wider decarbonisation agenda by aligning with ongoing and projected developments across the energy sector and beyond:

Accelerating transformation of physical infrastructure

Challenges 1 (Industrial connection acceleration by 2033) and 2 (Faster build and maintenance by 2035) lay the physical and commercial foundations for system transformation. With the Clean Power Action Plan expecting clean electricity to match total annual consumption [16], and biomethane potentially able to meet 8.3% of gas demand by 2030 [17], frictionless grid connections are vital. The UK targets a 78% emissions reduction by 2035 (Sixth Carbon Budget [18]), while the Net Zero Strategy [19] aims to replace 50 TWh/yr of fossil fuels by 2035. Slashing delivery times and infrastructure costs will help macro-infrastructure scale ahead of demand to support immense industrial decarbonisation, reindustrialising regional clusters and growth of frontier clean energy technologies, as well as widespread new connections.

Unlocking the energy system edge

Challenges 3 (Instant use domestic devices by 2032) and 5 (Decentralised system balancing by 2034) focus on the system edge to eliminate customer friction. With NESO's 2025 FES6 projecting 50% EV uptake by 2035 (driven by the 2035 phase-out of new petrol and diesel vehicles) and a 50% heat pump adoption by 2040, these challenges must seamlessly integrate millions of low-carbon technologies. Unlocking autonomous, local flexibility will help to balance intermittent renewables, creating a highly efficient system that relieves pressure on macro-infrastructure.

Delivering for energy users

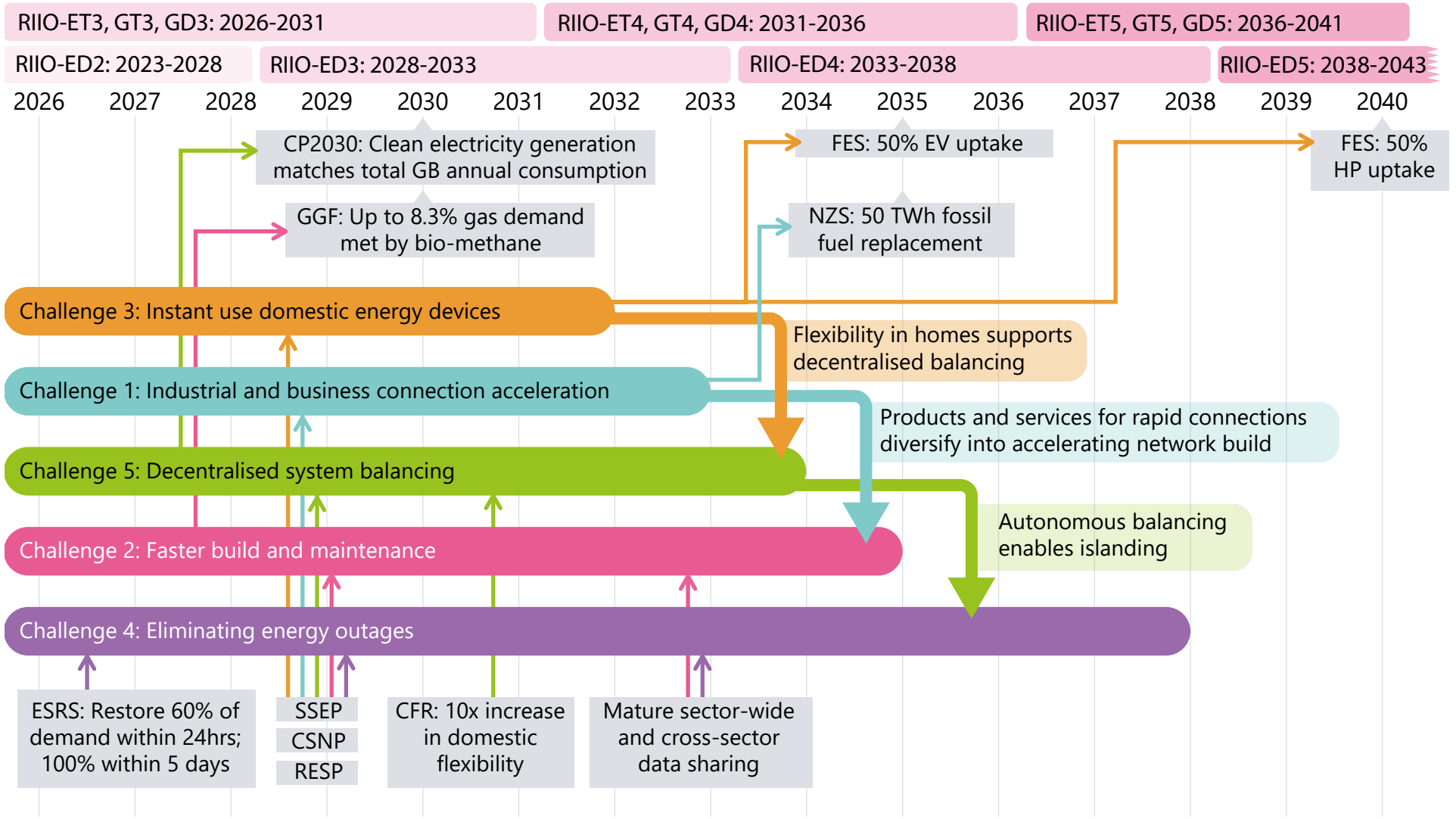
The Industrial Strategy [20] emphasises the crucial importance of large-scale energy users both obtaining connections in feasible timescales – delivered by Challenge 1 – and accessing electricity at competitive prices – enabled both directly through cost reductions in Challenge 2, and through the accelerated availability of zero-carbon power resulting from all Challenges. At the other end of the scale, Challenge 3 empowers households to choose their own route to lower costs and lower carbon.

Securing the whole energy system

Challenge 4 (Eliminating energy outages) ensures whole energy system resilience against adversarial action, shifting demand, and climate change impacts. Crucially, this system-wide resilience is unlocked by the edge innovations in Challenges 3 and 5. Intelligently orchestrating local energy use and building customer trust creates the dynamic flexibility needed for networks that autonomously reconfigure themselves to route around faults. Through deep digitalisation, the grid can operate as self-sufficient energy islands, guaranteeing uninterrupted service and safeguarding critical infrastructure.

The diagram on the next page shows a timeline of the Innovation Challenges, with linkages between Challenges and developments in the wider sector. The dates reflect the timescales for improved outcomes to be embedded into networks' business-as-usual practices.

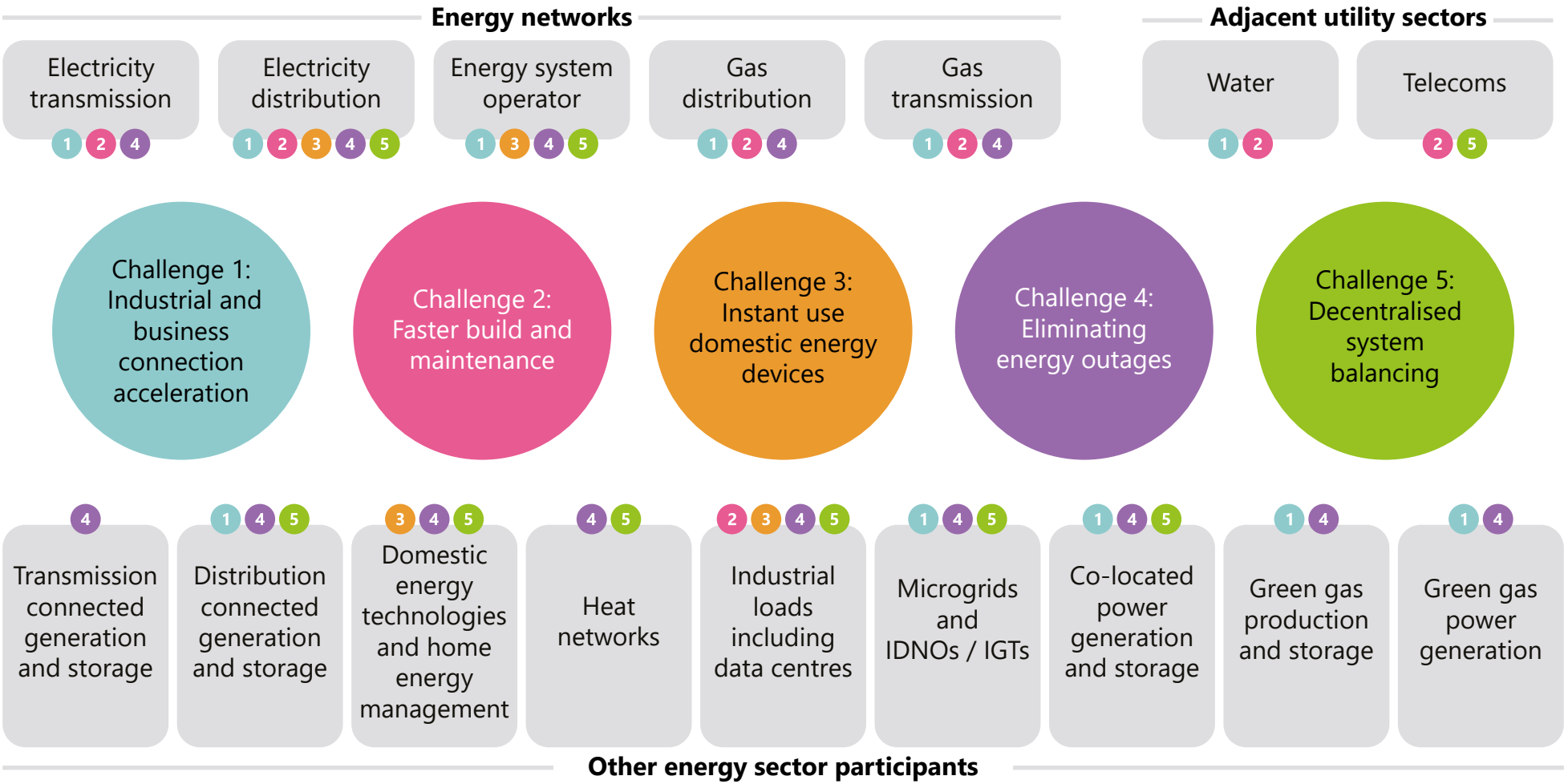
Timeline and interaction between Innovation Challenges



Abbreviations and sources: CSNP: Centralised Strategic Network Plan [21]; SSEP: Strategic Spatial Energy Plan [22]; RESP: Regional Energy Strategic Plan [23]; ESRS: Energy System Restoration Standard [10] ; CFR: Clean Flexibility Roadmap [24]; GGF: A Green Gas Future [17]; FES: NESO Future Energy Scenarios [7]; NZS: Net Zero Strategy [19]; CP2030: Clean Power Action Plan 2030 [16]

System elements that enable Challenge delivery

This map shows the energy system elements key to delivering each Innovation Challenge. It illustrates the cross-vector and cross-sector nature of the Challenge portfolio, the strong reliance on collaboration between actors across the sector, and the complementarity between Innovation Challenges in identifying the key stakeholder groups to support the energy transition.



Taskforce to delivery: Implementation & next steps

To find out more about the SIF, how to apply and how to get involved, click here

Delivering solutions to Challenges through the Strategic Innovation Fund in RIIO-3

Ofgem is adopting all Innovation Challenges proposed by the Taskforce to drive outcome-oriented network innovation throughout the RIIO-3 price control.

Funding for projects under the Innovation Challenges will primarily be available via the Strategic Innovation Fund (SIF) [25], delivered by Innovate UK. Established in 2021 as part of the RIIO-2 price control framework, the SIF facilitates partnerships between energy network companies and innovators to deliver transformational projects that benefit consumers and revolutionise the energy system.

Extended into RIIO-3 with a further £500m available to be allocated, the SIF will provide networks and their project partners a route to designing and delivering portfolios of innovation projects to tackle the ambitions set out in the Innovation Challenges. A £50m deployment fund has been added to the SIF for RIIO-3 to ensure innovation projects are deployed at scale across networks.

Innovation Delivery Groups in RIIO-3

Compared to RIIO-2, the Innovation Challenges set out by the Taskforce are bigger, more ambitious and will require higher levels of coordination across the energy sector to achieve them. For that reason, Innovate UK are introducing an Innovation Delivery Group (IDG) for each Innovation Challenge. Chaired by senior representatives in the energy networks, these groups bring together decision-makers and subject-matter experts from across the energy supply chain, third-party innovators, regulators, policy makers and other key stakeholders. IDGs are an ongoing forum to collaborate and share information and learnings to collectively progress projects, with the ultimate goal of transforming solutions developed through innovation into scalable, business-as-usual practices across the energy sector unlocking Innovation Challenge outcomes.

An initial output of each IDG will be a publicly available Innovation Charter. The core purpose of this document is to build on the outputs of the Taskforce Working Groups to:

- Further define potential pathways to achieving the Innovation Challenge, breaking down the areas where targeted innovation is needed across technology, business models, regulatory and market development
- Lay out an approach to prioritising and sequencing this work
- Further refine KPIs and methods for tracking progress against outcomes

Additional details on Innovation Charters can be found in the SIF Governance Document [26], with further guidance to be issued to networks in Spring 2026.

Over the RIIO-3 period, IDGs will refine the plans set out in their Charters based on the outcomes and learnings from the innovation projects in their portfolios and wider initiatives, homing in on effective solutions to progress into deployment. Networks' senior leadership will report on progress against all Innovation Challenges each year at the Annual Innovation Meeting (AIM). All networks have agreed to report clearly on their progress, impact, and outcomes, and work collaboratively to deliver against the Challenges. This includes celebrating successes and progress made, and engaging constructively with government and the regulator to identify and address any barriers, ensuring continued focus on achieving the intended outcomes.

Innovation Delivery Groups are an ongoing forum to collaborate and share information and learnings to collectively progress projects

Wider funding and initiatives

Where appropriate, funding routes outside of the SIF may be better suited to targeting the barriers identified by the IDG to the delivery of the Innovation Challenge and ensuring smooth rollout of solutions into widespread delivery. A subset is included in the table below with further details of selected funding routes available from Ofgem [27].

Funding route or initiative	Description
Network Innovation Allowance [28,29]	Lower-TRL research and evidence generation focused on vulnerable customers or near-term challenges created by the energy transition. These projects typically focus on near-term opportunities that work within existing business m odels, cost reduction of new solutions and/or on problems facing individual networks that do not require cross-network or sector collaboration.
Research and Development Missions Accelerator Programme - Clean Energy Superpower Mission [30]	2 GW peak time flexibility research and innovation challenge: Collaboration with industry and investors to develop and scale-up digital and data-driven solutions that improve flexibility and resilience across the energy system, to achieve an additional 2 GW of customer led flexibility on the system by 2030.
DESNZ Cleantech Innovation Challenges	Announced in the Carbon Budget and Growth Delivery Plan, DESNZ will launch a set of challenges, co-developed with industry, targeting the most pressing innovation needs to deliver carbon budgets and the industrial strategy. These challenges will set ambitious and measurable goals for innovation that will be used to engage and inspire innovators and investors. Focused on technologies that may in future connect to the energy networks, these Challenges will be complementary to the SIF Innovation Challenges.
Network Use It Or Lose It funding	Specific funding to encourage fast-tracking of critical infrastructure projects by providing upfront funding without the need for detailed regulatory assessments. Any funding not spent is returned to customers.
RIIO-3 Reopeners	Funding routes to support rollout of successful solutions in specific areas set out in RIIO-3 Final Determinations
Network Totex spend	Embedding innovation into core planning and delivery where it will result in operational efficiency savings

Opportunities for involvement

Delivering solutions to these Innovation Challenges will require input and ideas from across the energy sector, as well as transfer of innovations from sectors beyond energy such as telecommunications, water or banking. IDGs will be forming over the coming months and refined during the development of the Innovation Charters.

If you have expertise relevant to a Challenge and are keen to share your knowledge, please get in touch.

The Innovation Charters will provide an ongoing steer to innovators on problem areas to focus on. Following publication of the Innovation Charters in Autumn/Winter 26, Innovate UK's ideation process will help build ideas, create partnerships, and develop high-impact project proposals. The aim is to support the most transformational project ideas and facilitate the right partnerships, to deliver high quality breakthrough innovation projects that achieve real-world impact. Details on how to engage and participate in the ideation process will be shared via the SIF newsletter. In the transitional period through to establishment of the IDGs, the SIF Round 5 Innovation Challenges [31] remain open for idea submission until the end of September 2026 through the existing Expression of Interest process [32].

Annual updates will be given by the IDGs to share key learnings from projects and progress against Innovation Challenge outcomes. This will be supported by project-led Show and Tell sessions and Innovation Challenge-level dissemination events and webinars facilitated by Innovate UK.

For more information, sign up to the SIF newsletter

Strategic opportunities for developing the innovation ecosystem

Alongside the Innovation Challenges developed with industry through the Taskforce, the discussions have elicited wide-ranging feedback on how the sector could operate differently to support the emergence of more transformational innovation ideas, and to accelerate the best ideas into business as usual more quickly.

The Taskforce encourages network stakeholders, Ofgem, DESNZ, and third-party partners to consider and work together to resolve some of these issues and capture the huge opportunities for accelerating innovation, improving collaborative working, and unlocking business value for UK supply chains and innovative businesses.

The strategic opportunities that the Energy Network Innovation Taskforce has identified are:

1. Enabling agile regulation: Evolution of network incentives
2. Market making: Procurement as an innovation engine
3. Reimagining roles and responsibilities: Innovate beyond current remits
4. Collaborative innovation ventures: Forging lasting partnerships
5. Beyond energy systems: Unlocking wider societal value
6. Higher velocity innovation: Harnessing modern tools and techniques
7. Streamlining the innovation journey: Enabling innovator participation

1. Enabling agile regulation: Evolution of network incentives

To ensure transformational ideas transition rapidly into business as usual, the evolution of regulatory incentives must urgently keep pace with market innovation. Currently, energy networks are frequently restricted from pursuing optimal, whole energy system solutions simply because such activities sit outside their strict historical remits. As the energy system integrates far greater numbers of connected, distributed, and intermittent assets, optimal whole energy system solutions will require evolution of the regulated incentive regime and the roles and responsibilities of networks and other stakeholders.

For instance, siloed regulations can hinder proactive investment that would address cross-vector outcomes. Examples of this include coordinating heat decarbonisation in almost half a million multi-occupancy buildings across the country. The energy networks have no responsibility for the wiring within the multi-occupancy building, but uncoordinated or patchwork upgrades may have a significant and costly impact on both the enduring distribution network and the occupants. Another example is the regulatory barrier preventing networks from offering differentiated one-off and/or operational costs based on varying resilience needs – whereas for some customers, on-site generation or behind-the-meter storage may provide a more cost-effective whole systems approach to service reliability, compared to a high-reliability network connection that might require physical grid reinforcement or fault management.

Networks and their partners must be granted the regulatory freedom to explore and test solutions beyond these traditional boundaries. Crucially, new regulatory frameworks must be innovated in parallel with these operational trials. By co-developing agile incentives alongside technological advancements, future price control frameworks can be constructed to actively incentivise, reward, and embed novel approaches into everyday network practice. This could be achieved through more ambitious digital and physical sandboxes, temporarily adapting licences, granting derogations, and exploring novel incentive structures as part of projects.

2. Market making: Procurement as an engine for innovation

The GB energy sector must mobilise its procurement mechanisms to pull through innovations that can scale at pace to deliver impact. By moving away from rigid technical specifications towards long term outcome specified procurements, networks can give innovators the precise operational direction needed to commercialise and scale transformational solutions. The sector must develop novel commercial approaches and use existing frameworks like the Competitive Flexible Procedure outlined in the Procurement Act [33], to buy research and development as a service. This shifts the sector from merely funding trials to acting as an aggressive early adopter of new technology.

Furthermore, the sector could consider implementation of guaranteed contracts and milestone driven innovation prizes, such as in the Innovate UK Contracts for Innovation model [34]. This will provide the ultimate commercial signal, ensuring that suppliers of all sizes are fiercely incentivised to solve the sector's most critical system challenges.

The sector must recognise the reality that the Great Britain energy network market is relatively small for global supply chain participants. Currently, networks frequently demand bespoke asset specifications and impose divergent procurement or market processes, forcing suppliers to expend time and resources on niche modifications. These inefficiencies add direct costs that are ultimately borne by consumers.

To rectify this, energy networks in Great Britain should better collaborate to standardise processes and technical specifications across all network types. Crucially, this must involve strategic alignment with European infrastructure partners. By harmonising requirements internationally, the sector can achieve vital economies of scale, position the wider European network ecosystem as a global leader rather than a follower, and increase the viability of domestic manufacturing, thereby crucially reinforcing Great Britain's long-term supply chain resilience.

3. Reimagining roles and responsibilities: Innovating beyond current remits

Recent years have seen substantial change in the makeup of the GB energy sector: the advent of DSOs, NESO's changing role in the energy system, the rapid growth of IDNOs and heat networks, the emergence of flexibility service providers as well as energy service intermediaries, and ongoing development of the role of community energy groups. This presents huge opportunities for the sector to reimagine traditional boundaries of responsibilities, affording infrastructure owners, energy suppliers, and service providers the regulatory space to explore new commercial models, test, fail, and ultimately flourish.

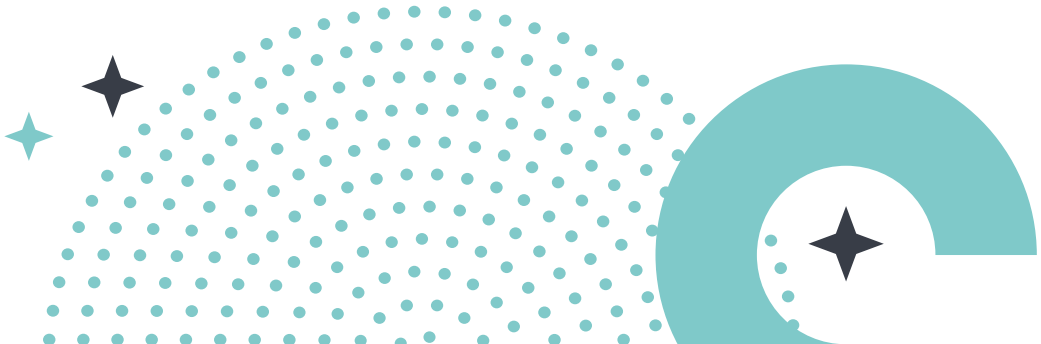
International markets provide inspirational results of reimagining roles and commercial paradigms. For instance, when regulators allowed the telecommunications provider Safaricom to venture into Kenya's highly regulated banking space, it birthed M-Pesa [35]. This unprecedented blurring of lines between communications infrastructure and financial services safely disrupted traditional banking, delivering massive consumer benefits through widespread financial inclusion. By similarly empowering energy networks in Great Britain to innovate beyond their historic remits, there is a potential to unlock transformational value and entirely new service paradigms benefitting customers. Incumbents should become more comfortable relinquishing control over existing regulated responsibilities and exploring new future roles for themselves and other stakeholders; failing to do so risks stifling the pace of beneficial system evolution.

4. Collaborative innovation ventures: Forging lasting partnerships

Energy networks should pivot to become active clients and customers of innovation. Networks should help innovators to understand the complex challenges they have and jointly develop practical solutions. Achieving deeply integrated partnerships can help narrow the asymmetry of expectations between networks and innovators. Furthermore, they enable a sustained focus on large long-term challenges. Ultimately, this collaborative approach helps to build robust domestic commercial offerings.

This strategy applies across the board. Emerging startups require time and structured guidance to enter the energy sector successfully. Meanwhile, large corporates from other industries can apply their existing technology to strategic infrastructure challenges.

Incumbents in other sectors already demonstrate this value. For example, Transport for London partnered with Cubic Transportation Systems and Barclaycard to pioneer contactless transit [36]. This joint effort revolutionised urban mobility and created massive commercial growth opportunities for the technology providers. Similarly, the Port of Rotterdam partnered with robotics firms like Rocsys and Embotech to integrate automated logistics. These collaborations drive immense economic expansion for both the infrastructure owners and their innovation partners. By adopting a similar model, energy networks can unlock unprecedented value and deliver tangible real-world impact.

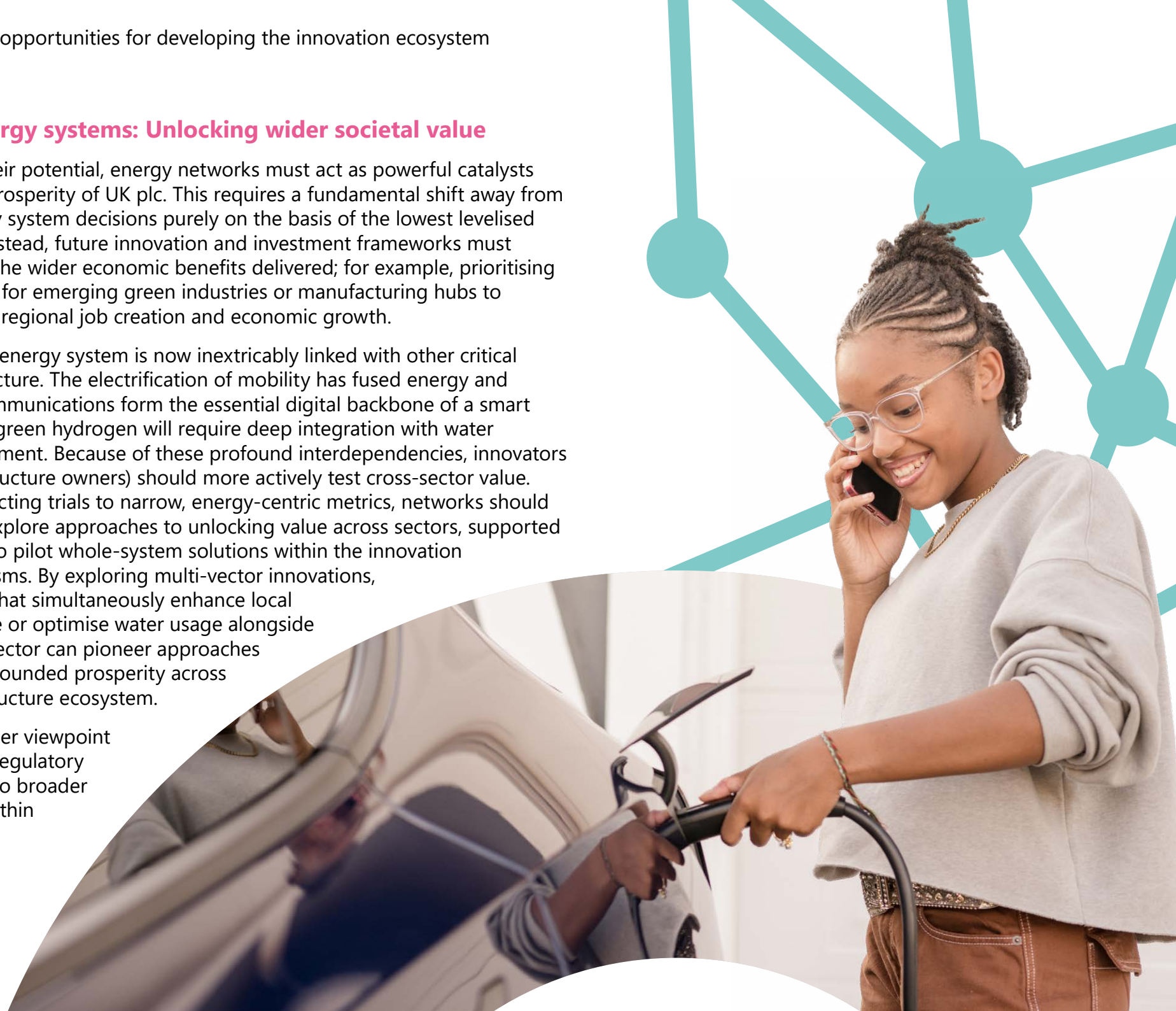


5. Beyond energy systems: Unlocking wider societal value

To fully realise their potential, energy networks must act as powerful catalysts for the broader prosperity of UK plc. This requires a fundamental shift away from evaluating energy system decisions purely on the basis of the lowest levelised cost of energy. Instead, future innovation and investment frameworks must holistically value the wider economic benefits delivered; for example, prioritising faster grid access for emerging green industries or manufacturing hubs to directly stimulate regional job creation and economic growth.

Furthermore, the energy system is now inextricably linked with other critical national infrastructure. The electrification of mobility has fused energy and transport; telecommunications form the essential digital backbone of a smart grid; and scaling green hydrogen will require deep integration with water resource management. Because of these profound interdependencies, innovators (including infrastructure owners) should more actively test cross-sector value. Rather than restricting trials to narrow, energy-centric metrics, networks should enthusiastically explore approaches to unlocking value across sectors, supported by the mandate to pilot whole-system solutions within the innovation funding mechanisms. By exploring multi-vector innovations, such as projects that simultaneously enhance local telecom resilience or optimise water usage alongside electrolysis, the sector can pioneer approaches that deliver compounded prosperity across the entire infrastructure ecosystem.

Adopting this wider viewpoint requires specific regulatory reframing, but also broader culture change within the energy sector itself.



6. Higher velocity innovation: Harnessing modern tools and techniques

The sector must collaborate more effectively on system-scale problems. This means moving beyond conventional and manual means of collaboration and innovation, to exploit new frameworks, tools and processes. Harnessing novel tools like AI, rapid prototyping and shared workspaces can bridge organisational divides. Together, these enable high velocity collaboration within networks and the broader innovation community. The sector should quickly adopt a unified working approach that facilitates knowledge exchange and matches complex real problems with innovative solution providers with unprecedented agility.

To truly enable this high-velocity approach, the sector must also urgently act on the cultural imperatives highlighted in the Innovate UK *Culture of Innovation* report [37]. While networks have made initial strides, accelerating progress requires a fundamental shift in mindsets and behaviours across the board, including adopting a *'try things, and fail fast'* mindset. Crucially, organisations must lean into the paradox of fostering agile innovation within an environment traditionally focused on strict operational excellence. This means cultivating psychologically safe spaces where teams can actively experiment, confidently challenge the status quo, and openly learn from "intelligent failure" without fear of penalty. Furthermore, leaders should work together to reinforce this culture through concrete actions and tangible incentives. The sector must ensure that innovation is not simply left to siloed teams, but becomes an empowered, everyday responsibility for the entire workforce.

7. Streamlining the innovation journey: Enabling innovator participation

For emerging technologies to transition swiftly into business as usual, the overarching innovation ecosystem must become fundamentally easier to navigate from idea through to scale deployment. By harmonising engagement points, communicating clearly as a collective sector, and reducing administrative friction across the entire landscape (including protracted contracting with networks and reporting across multiple actors), the sector can ensure that innovators spend the vast majority of their time actually delivering transformational solutions.

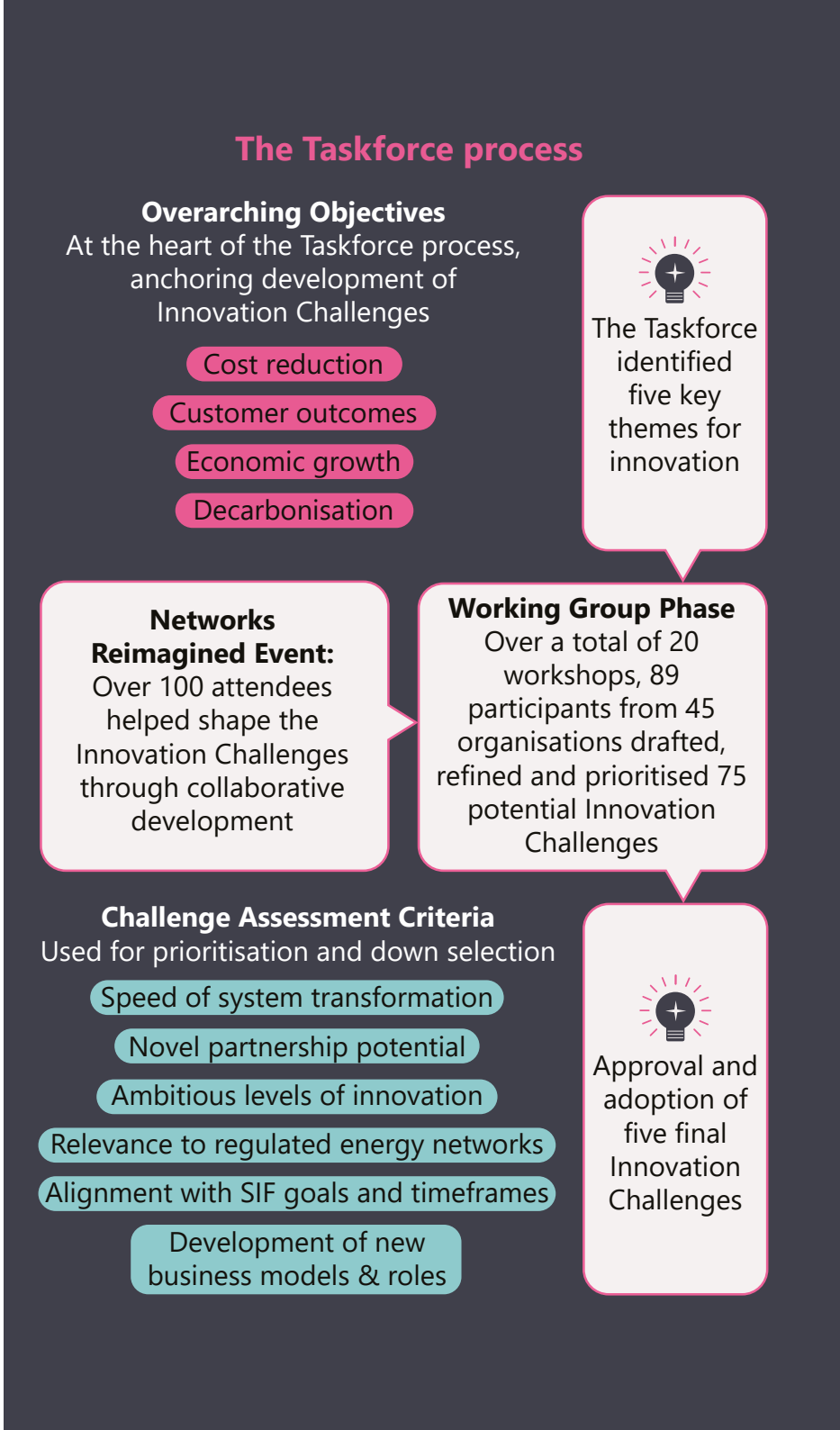
The Taskforce approach: Co-designing disruptive Innovation Challenges

The Energy Network Innovation Taskforce developed the Innovation Challenges and wider strategic opportunities presented in earlier sections between September 2025 and May 2026. The Taskforce originated from Ofgem's RIIO-3 Determinations [38, 39], that referenced a Taskforce to set long-term Innovation Challenges for SIF, aiming for:

- **Increased focus on critical challenges, with greater certainty of direction**
- **Greater leadership and accountability for delivery of outcomes**
- **Greater ambition**
- **Stronger focus on carrying innovations through to business-as-usual**
- **An open cross-sector engagement process**

The Taskforce process is outlined in the diagram to the right (see Annexe 1 for further details). Five thematic Working Groups led Innovation Challenge development. They were overseen by a Steering Group and an Expert Group, with an engagement event in January 2026 providing wider feedback from the sector. Annexe 7 acknowledges the contributions of the approximately 250 individuals from 150 organisations who participated. Setting 5-year Innovation Challenges spanning the full RIIO-3 period is a critical part of achieving the Taskforce's aims, but Ofgem and Innovate UK have the ongoing opportunity to modify, retire and/or create new Innovation Challenges to respond to the changing energy landscape.

Alongside the Innovation Challenges, the Taskforce has built unusual partnerships, brought together previously disconnected groups, and stimulated joint working on innovations – making the process the start of changing aspirations, creating new solutions and deepening collaboration across a wider ecosystem of innovators.



The Taskforce stimulated participants to break out of current assumptions about the energy system, and to strive for greater ambition by imagining an idealised 2040 world. Below is a composite description from all participants, painting a picture of a system transformed.

A customer-centric system

Infrastructure has helped reduce energy bills, improved living standards nationally, and the customer experience is seamless. Opaque, disjointed interactions are gone. Even after the massive shift in demand represented by the transition to low-carbon heating and transport, and the nascent reindustrialisation of the economy, customers receive energy when they need it as an invisible service.

Demand and generation now connect in months, not years, through a simple end-to-end experience, reflecting customer requirements. Optimisation engines model network conditions and market signals to ensure every new connection can be delivered robustly and adds value to the grid and wider society. The connections process is streamlined for domestic technologies and for non-domestic customers from small retail outlets to major industrial sites. Automated connection optioneering integrates data layers to derive best-fit solutions, working across vectors to meet customers' expressed preferences. The energy system allows customers to get the most from their own assets, earning money supporting the grid while meeting their own needs.

Customers can access reliable, easy-to-understand decarbonisation guidance tailored to their needs, building trust and empowering them to make better choices. Secure data sharing, integrated digital systems, and personal AI energy agents ensure no one is left behind. Everyone can effortlessly play a role in the energy system and share the benefits.

Decentralisation and cross-vector delivery

Energy system optimisation starts at the home and street level, with system operation now largely decentralised to manage and optimise millions of smart energy assets. Local areas work together through autonomous intelligence to balance the system from the bottom up – coordinating with national scale actions to respond to macro-scale system behaviours.

Network operators have a new role. They orchestrate system operation by coordinating local and regional energy actions. Integrated, cross-vector thinking – across electricity, hydrogen, biomethane and heat networks – provides resilience during outages and minimises the cost and disruption of new infrastructure. Planning and operation are coordinated across energy and adjacent sectors – primarily water and telecoms. Hybrid demand and reverse-flow gas systems are standard, connecting up carbon-negative biomethane producers and seasonal storage in salt caverns.

Unified, cross-sector digital frameworks form the backbone of the energy system and interface it to operators of other infrastructure. They support system planning, approvals for new infrastructure build, fault prediction, integrated markets, customer experience and asset operation. This makes it simple to coordinate local and national actions and deliver new consumer value. Automated monitoring pre-empts faults and delivers swift resolutions. The system adapts to maintain energy flow using flexibility and local energy resources, automatically reconfiguring, isolating, or switching to cross-vector alternatives as needed.

Building differently

Construction is fast, fair, and safe. Modular design delivers low-cost substations and energy corridors like Lego bricks - precise, interoperable, and fast to deploy. Mobile low-carbon factories produce components on-site, cutting transport miles and reducing logistical delays, ready for robot-supported construction. On-shored manufacturing delivers more jobs and investment into the UK. Injury rates have been slashed and productivity boosted. AI platforms plan work for minimum disruption and maximum optionality, forward-planning multi-vector infrastructure into every project. Every decision balances biodiversity and social impact transparently through streamlined engagement and evaluation tools.

Driving growth and innovation

This transformation – in how customers experience energy, how the system is operated, and how infrastructure is built – has become a powerful engine of economic growth. By 2040, a reimagined energy system has opened new markets, supported new industries, and established the UK as a world leader in energy technology:

- Faster connections and lower energy costs make the UK a prime target for industrial investment.
- Simplified regulation and governance boost productivity and growth.
- Higher asset utilisation has driven productivity gains across the energy sector and the industries that interface with it.
- Aligning network infrastructure with international supply chains makes the UK a more attractive market. It improves component access and helps British manufacturers expand globally.
- A faster, digitally enabled training pipeline has built a workforce of multidisciplinary energy experts — giving the UK a skills advantage in the global energy transition.
- Networks now act as platforms for innovation. Standardised modular assets and rich, accessible data and digital systems make it easy for new entrants to join the market, fostering novel propositions and improving consumer value.

The annexes to this report include additional material:

Annexe 1: Further details on the approach and process for Taskforce delivery

Annexe 2: Areas of focus for each of the thematic Working Groups developing Innovation Challenges

Annexe 3: Descriptions of idealised future energy systems developed by Working Groups for each key theme

Annexe 4: Innovation Challenges that were shortlisted against each key theme but which were excluded from the final list

Annexe 5: Potential areas of innovation identified through Working Group discussions

Annexe 6: Case studies of cutting-edge innovation from the energy sector and beyond

Annexe 7: Glossary of terms

Annexe 8: Acknowledgements to Taskforce participants

References

[1] Where comparative increases are presented, 2025 values are used as a baseline. "FES 2025" refers to Future Energy Scenarios 2025: Pathways to Net Zero, National Energy System Operator, 2025

- 25% of homes could be equipped with air conditioning: FES 2025 Falling Behind scenario, Pathway Assumptions, linear interpolation between values for 2035 and 2050
- Biomethane makes up 25% of gas supply: Interpolated value for 2040 biomethane feedstock resource from A Green Gas Future: Outlining the Feedstock Potential for Biomethane Generation, Green Gas Taskforce, 2025, compared with FES 2025
- 54 TWh data centre electricity demand: FES 2025, Electric Engagement scenario, data table ED1
- 70% increase in industrial electricity demand: FES 2025 Electric Engagement scenario, data table ED1, GBFES Customer Demand: Total Industrial (Excluding Electrolysis)
- Connected offshore renewable capacity could increase sixfold, and renewables under 1MW could triple in capacity: FES 2025 Holistic Transition scenario, data table F.55, Networked offshore wind capacity; ibid., data table ES1, "Distributed – micro" connected generation, sum of Hydro + Onshore Wind + Solar PV
- 14% highly autonomous cars: Connected and Autonomous Mobility: The UK Economic and Market Opportunities, Society of Motor Manufacturers and Traders, Automotive Council UK, and Zenzic, 2024, table 2, Proportion of on-road vehicles in the motorparc that are SAE level 4 highly automated for Cars, taxis and private hires (including ride hailing)
- Potential air conditioning load of over 7 GW: FES 2025 Falling Behind scenario, data table ED1, Residential Air Conditioning Demand (annual consumption) divided by 200 running hours from FES 2025 Pathway Assumptions
- Residential ASHP Uptake could increase 25-fold: FES 2025 data table ED7, Holistic Transition scenario, cumulative annual stock
- Residential ASHP 1-in-20 peak demand could increase by 11GW: FES 2025 data table ED7, Electric Engagement scenario, Peak 1-in-20

[2] Grids for data centres, Ember Energy, 2025

[3] Open consultation: Accelerating electricity network connections for strategic demand, DESNZ, 2026

[4] Transmission Acceleration Action Plan, Department for Energy Security & Net Zero, 2023

[5] RIIO-3 Final Determinations Overview Document, Ofgem, 2025

[6] Onshore early competition in electricity transmission – Stakeholder update, Ofgem, 2025

[7] Future Energy Scenarios 2025: Pathways to Net Zero, National Energy System Operator, 2025

[8] The Future Homes and Buildings Standards, Ministry of Housing, Communities & Local Government, 2026

[9] ED3 Sector Specific Methodology Consultation, Ofgem, 2025

[10] Introducing a New 'Electricity System Restoration Standard', Department for Business, Energy & Industrial Strategy, 2021

[11] Intelligent Management at the Edge, Shaping the Future of IoT with Edge Intelligence, M. Mosahebfard et al., 2024

[12] Unified dispatch of grid-connected and islanded microgrids, M. R. Wodicker et al., Frontiers in Energy Research, Vol 11, 2023

[13] FES 2025 Economics Annex, National Energy System Operator, 2025

[14] Distributed control and optimization technologies in smart grid systems, F. Guo et al., CRC Press, 2017

[15] Accelerating Net Zero Delivery, Innovate UK and PwC, 2022

[16] Clean Power Action Plan, Department for Energy Security & Net Zero, 2024

[17] A Green Gas Future: Outlining the feedstock potential for biomethane generation, Green Gas Taskforce, 2025

[18] The Sixth Carbon Budget: The UK's path to Net Zero, Committee on Climate Change, 2020

[19] Net Zero Strategy: Build Back Greener, HM Government, 2021

[20] The UK's Modern Industrial Strategy, DBT, 2025

[21] Centralised Strategic Network Plan: Draft Methodology for Consultation, NESO, 2025

[22] Strategic Spatial Energy Plan: Methodology, NESO, 2025

[23] Regional Energy Strategic Planning: Draft Methodology for Consultation, NESO, 2025

[24] Clean Flexibility Roadmap, DESNZ, 2025

[25] Strategic Innovation Fund Annual Report 2025, Innovate UK and Ofgem, 2025

[26] SIF Governance Document, Ofgem, 2026

[27] Network price control 2026 to 2031 (RIIO-3) guidance, Ofgem

[28] RIIO-3 NIA Governance Document, Ofgem, 2026

[29] Network Innovation Allowance (NIA), Ofgem

[30] Clean Energy Superpower Mission areas of research interest, Department for Energy Security & Net Zero, 2025

[31] Strategic Innovation Fund: Round 5 Challenges, Ofgem, 2025

[32] SIF Round 5 Expression of Interest form, Innovate UK

[33] Section 20(2)(b), Procurement Act 2023, HM Government, 2023

[34] Innovate UK Contracts for Innovation, Innovate UK

[35] M-Pesa journey, Safaricom

[36] London Oyster & Cubic's Fare Collection Technology, Cubic Transportation Systems

[37] Innovation culture: There's no stopping you, PA Consulting, 2023 (Commissioned by UKRI)

[38] Clause 10.30, RIIO-3 Draft Determinations Overview Document, Ofgem, 2025

[39] Clause 10.28, RIIO-3 Final Determinations Overview Document, Ofgem, 2025

Energy Network Innovation Taskforce

Chaired by Laura Sandys CBE

An independent report sponsored by

ofgem Innovate UK

CATAPULT Energy Systems