Ofgem Strategic Innovation Fund

Round 4 Innovation Challenges: final decision

Background and context

The Strategic Innovation Fund (SIF) is a major opportunity for businesses, academia, and other innovative organisations to work with energy networks on game-changing projects that will deliver benefits to consumers and transform the way our energy system operates. Paid for by consumers through their energy bills, it is there to help energy networks and the electricity system operator:

- save consumers money
- reduce CO2
- improve access to energy markets
- develop new products, processes, or services.

In addition, the vision is also to accelerate the net zero transition and make the UK the best place for energy businesses to grow and scale and be positioned as a global hub for energy innovation.

SIF operates via a sector wide collaboration model termed the 'Giant Leap Together' (GLT), a model to identify and develop ideas, forge partnerships, and exchange the knowledge needed to innovate and commercialise at pace in the energy network sector. This innovation operating model is detailed further towards the end of this section.

Ofgem is the decision-maker in relation to the SIF. However, to support the SIF's operation, Ofgem is partnered with Innovate UK, part of UK Research and Innovation (UKRI). Innovate UK's role is to deliver the SIF in line with the SIF Governance Document - administering the funding programme, monitoring the delivery of Projects, making recommendations to Ofgem on operational matters, forging partnerships of third-party innovators and networks, and supporting successful Projects to become business as usual activities.

The SIF is funded through the RIIO-2 network price control. It is currently open to the Electricity System Operator, and the electricity transmission, gas transmission, gas distribution, and electricity distribution licensees.

Innovation Challenges summary

Ofgem sets Innovation Challenges, with support from Innovate UK, which will help meet the strategic objectives of the sector. The approach to challenge setting is described in the SIF Governance Document[1]. Challenge setting is part of a four-stage innovation process delivered by Innovate UK. See 'the innovation operating model' below for more details on this process.

The Innovation Challenges for Round 1 of the SIF, which opened August 2021, were identified as: whole system integration, data and digitalisation, heat, and zero emission transport.

These broad areas remain the focus of the SIF. However, the SIF Challenges are refined and developed on an annual basis to respond to sector needs and address outstanding innovation gaps. Round 2 and 3 Challenges are described in full within publications that can be found on the Ofgem SIF webpage. For Round 4 the SIF will further focus on specified areas that are key to achieving key sectoral targets over the next decade, such as successful operation of a net zero power system by 2035.

These Round 4 Innovation Challenges are as follows:

1. Faster network development
2. Greater heat flexibility
3. Embedding resilience
4. Accelerating towards net zero energy networks

The full scope and detail of the Round 4 Innovation Challenges is covered further in this document.

Collaboration and consultation

These Innovation Challenges have been developed with collaboration and engagement with a wide range of stakeholders and interested bodies, including energy network companies, other innovators and entrepreneurs, government, and academia.

[1] https://www.ofgem.gov.uk/publications/updated-sif-governance-document

The key underlying principles established to secure consensus and to prioritise these challenges have been:

- **Strategic:** innovations are required to meet national and devolved net zero targets effectively.
- **Network relevant:** innovation needs and solutions that can be taken forward or materially supported by energy networks.
- **Timeliness:** the challenge should focus on problem areas where solutions can be scaled up to meet the requisite net zero targets and commitments. 2035 was used as a target year for identifying challenges for Round 4.
- **Scope:** the scope of Innovation Challenge is complementary, and non-duplicative, to other UK innovation programmes or sector initiatives (including other network innovation funding mechanisms).

SIF market engagement: From January 2024 to Feb 2024, over 50 representatives from across the energy sector gave their input to Innovate UK on potential strategic Challenges that could be considered.

The challenges were continuously iterated with Ofgem's Innovation Hub team in coordination with Ofgem policy teams and subject matter experts. The final decision on the four Round 4 Innovation Challenges was taken by Ofgem's Policy Committee.

Strategic evolution of Round 4 Innovation Challenges

The challenges from Round 1 through to Round 3 demonstrate a narrowing of focus in each new Round. Round 4 focus is targeted on areas of potential opportunity that are not likely to have been addressed by in-flight innovation projects, or ongoing policy and regulation activities. This is illustrated in the Figure 1.

The Round 4 Challenges have been framed to deliver targeted outcomes that meet the strategic objectives of the SIF and to achieve the objectives and priorities of Ofgem's strategic change programmes[2] and Innovation Vision[3].

While Round 4's challenges are based on many ideas and developments, they also represent a greater focus from some challenges more than others. Figure 1 below maps rounds 1-3 across rows and columns to illustrate the linkages and how they map across into the Round 4 Challenges. The three different colour coding in the cells each represent the three previous SIF rounds, and are also summarised here as follows:

Round 4, Challenge 1: Faster Network Deployment represents a greater focus from:

[2] https://www.ofgem.gov.uk/publications/forward-work-programme-202122
[3] https://www.ofgem.gov.uk/publications/ofgem-innovation-vision-2021-2025

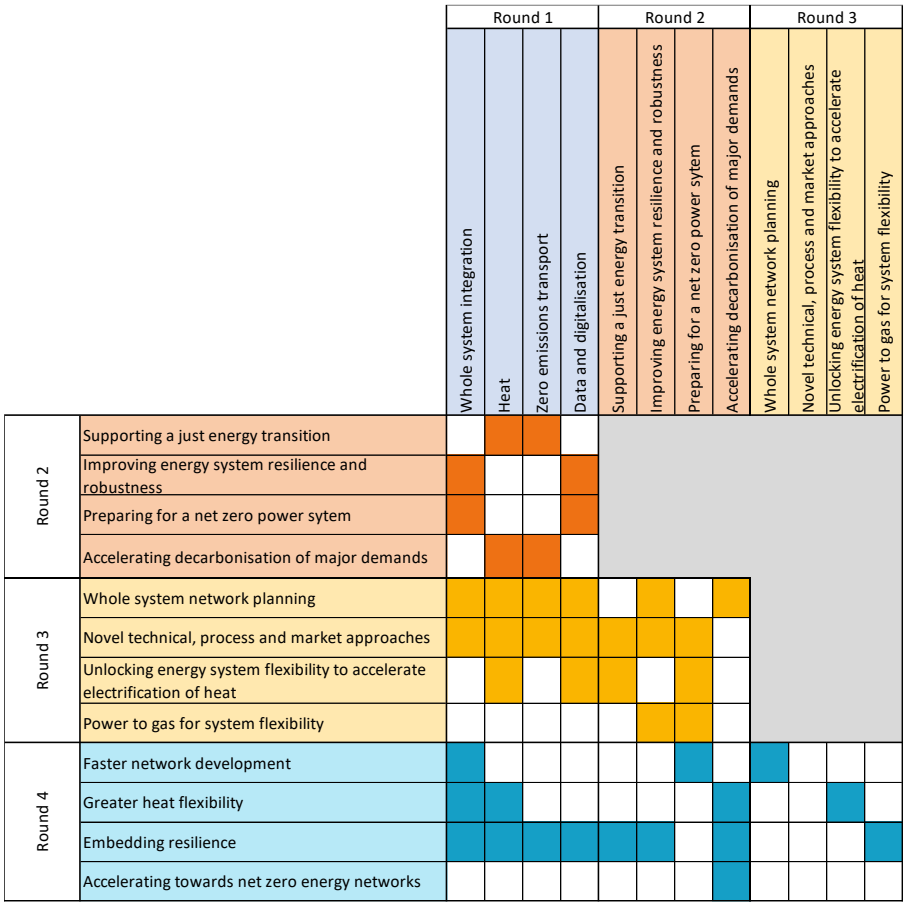
- Whole System Integration (from Round 1, Challenge 1)
- Preparing for a Net Zero Power System (from Round 2, Challenge 3)
- Whole System Network Planning (from Round 3, Challenge 1)

Round 4, Challenge 2: Greater heat flexibility represents a greater focus from:
- Whole System Integration, Heat (from Round 1, Challenges 1 and 2)
- Accelerating Decarbonisation of major demands (from Round 2, Challenge 3)
- Unlocking Energy system flexibility to accelerate electrification of heat (from Round 3, Challenge 3)

Round 4, Challenge 3: Embedding resilience represents a greater focus from:
- All Challenges from Round 1
- Three of the four challenges from Round 2 (excluding Preparing for a net zero power system)
- Power to Gas for system flexibility (from Round 3, Challenge 4)

Round 4, Challenge 4: Accelerating towards net zero energy networks, represents a greater focus from:
- Accelerating Decarbonisation of major demands (from Round 2, Challenge 3)

Figure 1 Relationship of areas of focus between the different rounds of the SIF.



The Innovation Challenges have also been defined to provide aims for energy networks and third-party stakeholders to work towards, with action-oriented target outcomes aligned to net zero. Several areas have been highlighted as essential areas to be built into all project applications and embedded in the innovation process. These are:

- Inclusive design of products and services taking into account diverse consumer needs to best ensure a just and equitable energy transition.
- Evaluation of long-term supply chains risks against solution option selection and development.
- Consideration of future skills and capability development across the supply chain needed to commercialise and roll out the innovation at scale.
- Harnessing digitalisation and implementing Energy Data Best Practice across all areas.

We will continue to work with government and industry to identify and refine future priorities for innovation, to maximise the opportunity to deliver value for consumers. We welcome any input into priority areas for future consideration.

The SIF innovation operating model

The identification of Innovation Challenges is the first stage of a cycle of activities to build ideas, create partnerships, and develop excellent project proposals. Innovate UK describe this activity with the heading 'Giant Leap Together'. Giant Leap Together describes the process of setting strategic Challenges, generating the best ideas to address those challenges, and then forming delivery partnerships to achieve impact.

This operating model has four stages:

Phase	Timeline	Objectives
Challenges: Identifying the most important energy network innovation challenges, based on problems that users and consumers are facing.	Dec - March	• Engage with a wide range of stakeholders to gather innovation challenges relating to SIF • Co-development of challenges with Ofgem subject matter experts and senior teams • Achieve broad consensus on the priority innovation challenges for the round • Develop and publish the Innovation Challenge document along with partnership requirements for the sector to develop ideas against. • Events: 7th March – Challenges Launch Webinar; March-April – Innovation Surgeries to support

		innovators to align ideas with SIF Challenges
Ideation: generating new ideas for projects/products and services that will target these challenges.	March-Aug	• Engage with wide range of energy and non-energy sector innovators on the SIF Challenges, help innovators understand network needs and gaps in knowledge and support their idea development • Provide a streamlined process for the innovators to submit ideas and receive feedback • Events: April-May - ideation workshops for innovators and energy networks to get a more informed view as to what the SIF can investigate, work up ideas and engage with other energy experts to input some proposals to the SIF (topics to be announced)
Incubation: helping energy networks and innovators form effective partnerships which can develop the ideas into powerful innovation projects/products and services.	Aug-Sep	• Direct the best and most relevant ideas from innovators to the appropriate networks for consideration • Support development of impactful consortia via match making in line with the outlined partner requirements in this document • Reduce time and effort required for energy networks to find the best ideas and develop partnerships. • Events: September – Pitching sessions for selected third parties to present to energy networks
Acceleration: selecting and funding the most promising ideas, sharing insights, solving problems, helping businesses secure investment**,** and developing the very best ideas into 'business as usual.'	Sep-Nov	• Disseminate and learn from other UK energy sector innovation projects and activities • Support energy networks and partners to develop and submit high quality applications on time to SIF. • Events: 29 – 30th October- The Summit

Next steps

With the Round 4 Innovation Challenges identified, the ideation and incubation period runs between March and August 2024. This will include Innovate UK communicating

the aims and objectives of each challenge, issuing an *Expression of Interest* for third parties to signal interest in participating in and delivering focussed workshops on select priority problem areas, and in delivering a webinar series to inform third parties of the role energy networks play in the energy system.

The incubation period then follows. This will include a call for project proposal ideas, and brokering partnerships between energy networks and organisations with complementary capabilities and aims. This is the period when innovators and other potential project partners will work directly with the energy network companies to develop their ideas together.

During the acceleration stage between September and November we will invite energy networks to submit their applications for funding - led by the energy network companies but supported by their project partners – for Round 4 'Discovery' projects, which will address these Innovation Challenges.

More information

Details on how to engage and participate in the Ideation and Incubation stages will be shared during our Innovation Challenges briefing events which are on 7th and 15th March 2024. You can sign up here.

To be kept informed on future SIF activities, sign up to the SIF newsletter.

Ofgem recognises the valuable input given by many organisations to the development of these Innovation Challenges. Alongside Innovate UK, we look forward to working with the sector to realise the benefits of innovation for consumers and to support continued progress towards net zero.

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Innovation Challenge 1:
Faster network development

Accelerating the pace of network development to meet net zero

Context: the background to the problem we are trying to address

As per The Climate Change Committee's (CCC) sixth carbon budget and the UK Government's Energy Security Strategy[4], the capacities of low carbon generation such as onshore wind, offshore wind and solar need to increase 2, 4 and 5 times the current levels respectively, by 2035.

This increase in intermittent low carbon generation also requires tens of GWs of flexibility assets such as storage, electrolysers and gas Carbon Capture and Storage (CCS) plants up and running by 2035 to support the system[5]. Meeting these targets requires a rapid ramp up of plan, build and connection rates for these assets in the mid-2020s and early 2030s.

While there are other barriers foreseen (supply chain, regulation, markets etc), the planning process, network constraints and securing timely connection to the grid have been raised as constituting key delivery risks[6] to achieving the government's 2035 renewables targets.

The CCC's network modelling suggests that an average doubling of transmission network boundaries is needed between 2025 and 2035 to facilitate decarbonisation. Specific targets, such as the 50GW of offshore wind by 2030, might require transmission network operators to deliver five times the amount of transmission network capacity in England and Wales by 2030, compared to what has been built in the last 30 years[7]. Electricity network modelling undertaken by the Department for Energy Security and Net Zero (DESNZ) indicates that the net zero driven electricity demand increase could also trigger large-scale reinforcements in the electricity

[4] https://www.theccc.org.uk/publication/delivering-a-reliable-decarbonised-power-system/
[5] https://www.theccc.org.uk/publication/net-zero-power-and-hydrogen-capacity-requirements-for-flexibility-afry/
[6] https://committees.parliament.uk/publications/39325/documents/193081/default/
[7] https://www.nationalgrid.com/electricity-transmission/were-engaging-our-early-plans-transform-our-network-net-zero

distribution network as early as 2030[8]. Industry analysis agrees with the scale of these challenges[9], estimating a 49% increase in distribution network cables, which might be needed by 2035 to meet the increased demand from electrification. This highlights the scale and urgency of the network capacity challenge to allow low carbon power to be integrated and transmitted across the UK.

This network capacity challenge can most rapidly be addressed though identifying novel ways to improve the capacity and utilisation of our existing asset base and reduce the extent of reinforcement required[10]. Solutions such as grid-forming technologies or dynamic rating to increase capacity of existing infrastructure are all under development. In addition, there are significant developments and opportunities in balancing supply and demand at local and regional levels in the system. These approaches consider the regional needs of energy users and site developers to integrate generation, storage, transport, heating and efficiency in a smart manner using software and digital platforms. These more decentralised approaches offer a novel and effective way to accelerate delivery of net zero at lower costs. Research based on real-world trials from the Prospering from the Energy Revolution programme shows that smart and local energy system approaches can save £1.7bn in network investments and upgrades by 2040.

Deployment of these solutions could be accelerated and enhanced through innovation to improve data on real-time network conditions across all voltage levels and leveraging faster computational capacity and artificial intelligence to improve forecasting and more dynamic operational decision making. Additionally, challenges on network processes and regulatory issues are inhibiting commercialisation of these solutions and need to be addressed.

The Innovation Challenge of 'Faster network development' aims to:

- Promote greater real-time awareness and operation of power networks
- Increase net zero aligned supply and demand assets' hosting capacity of energy networks

[8]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1096248/electricity-networks-strategic-framework-appendix-1-electricity-networks-modelling.pdf
[9] https://www.beama.org.uk/services/net-zero/netzero-publications/growing-the-supply-chain-for-net-zero.html
[10] Electricity Networks Commissioner: companion report findings and recommendations (publishing.service.gov.uk)

- Demonstrate greater use of machine learning, artificial intelligence and quantum computing to improve real-time monitoring and optimisation of energy networks
- Deliver replicable regional energy system models that can support energy networks and wider system in terms of supply-demand balancing
- Increased confidence of energy networks, regulator and other actors in the energy sector on the effectiveness of regional energy models

Innovation Challenge-specific requirements

In addition to meeting the requirements within the SIF Governance document and licence condition, projects applying to the "Faster network development" Innovation Challenge must meet the below requirements.

Scope of projects

Project leads are encouraged to consider all the below points within their project development, but as a minimum your proposal must directly address at least one as a primary focus of the proposed project.

1. Novel methods to increase electrical capacity from existing assets or support faster and more efficient connection methods including using digital innovations
2. Regional balancing approaches to accelerate low carbon technology deployment

Any proposed project against the points above must also consider contributing to four key cross-cutting areas:

- Inclusive development – Ensuring the solution is applicable and accessible to diverse customer and consumer groups through relevant stakeholder engagement and user centric design principles
- Skills and capability – Consider throughout the project where upskilling and new capability development is needed and signalling those needs to relevant third parties like academics, training institutes and key supply chain partners
- Supply chains – Assess the deliverability and scalability of the solution across the GB network from a supply chain perspective including maturity of supply chains, potential vulnerabilities such as labour requirements, logistical and environmental risks.
- Data and digitalisation - Harness digitalisation and implement Energy Data Best Practice across all areas.

Partner requirements

The table below outlines Project Partner requirements for each of the specific areas of scope within this Innovation Challenge. Please note that the Project Partner requirements may differ for Project Phases within each scope of the Innovation Challenge and, where set out, they are only applicable for that specific Project Phase. Where there are multiple partnership requirements indicated, these can be met by a single organisation.

The Beta phase partnership requirements are not outlined in this document as the guidance will be provided on a project-by-project basis prior to application.

Project scope	Discovery project partner requirements	Alpha project partner requirements
1. Novel methods to increase capacity from existing assets or support faster and efficient connection methods including using digital innovations	No specific partner requirements	No specific partner requirements
2. Regional balancing approaches to accelerate low carbon technology deployment	1. Organisations with proven experience in developing and trialling regional energy models.	1. Organisations who represent regional consumer energy and or economic interests.

Relevant projects and programmes

The projects applying into this challenge should familiarise themselves with the projects, policies and programmes outlined here. Any proposal addressing this challenge area should consider the following and propose complementary and/or additional pieces of work.

1. NG ESO's Pathway to 2030 Holistic Network Design[11]: This is an integrated and strategic design document setting out the network policy, capacities and interfaces to help integrate up to 50GW of offshore wind in the UK.
2. Department of Energy Security and Net Zero's Transmission Acceleration Action Plan[12]: the Government's Action Plan to halve the end-to-end build time of electricity transmission network infrastructure, from 14 to 7 years. It includes recommended actions on strategic spatial planning, design standards, regulatory approvals, planning approval, supply chain and skills, communities and engagement, outage planning and end-to-end processes.
3. Prospering from the Energy Revolution programme[13]: The Prospering from the Energy Revolution programme invested in three large-scale demonstrator projects, and ten detailed designs of smart local energy systems around the UK. With substantial funding, they aimed to show how integrated intelligent local/regional systems can deliver power, heat and mobility to users in new and better ways.
4. Net Zero Living - Pathfinder Places[14]OBJ: +30 location-specific projects with £60m funding, focused on developing innovative solutions to maximise the opportunities associated with taking a systems-based approach to planning and implementation of net-zero solutions. By considering multiple systems and their interdependencies, benefits can be delivered not only in terms of net zero but also to reduce energy usage and cost, provide cleaner and safer transport systems and protect the natural environment through improved resource management.

[11] The Pathway to 2030 Holistic Network Design | ESO (nationalgrideso.com)
[12] Electricity networks: transmission acceleration action plan - GOV.UK (www.gov.uk)
[13] Net Zero Living - Thriving Places: 'Pathfinder Places' or 'Fast Followers', how to be involved? - Innovate UK Business Connect (ktn-uk.org)
[14] Net Zero Living - Thriving Places: 'Pathfinder Places' or 'Fast Followers', how to be involved? - Innovate UK Business Connect (ktn-uk.org)

5. Regional Energy Strategic Planning[15]: In 2023, Ofgem announced the creation of 13 Regional Energy Strategic Planers (RESPs) across Great Britain, who will work with organisations at a local level including local government and gas and electricity networks, to improve understanding of the infrastructure needed in different parts of the country and attract investment for projects. The RESPs will be part of the National Energy System Operator (NESO), allowing greater coordination with the new Central Strategic Network Plan[16] the NESO is responsible for developing.

[15] Decision on future of local energy institutions and governance | Ofgem
[16] Decision on the framework for the Future System Operator's Centralised Strategic Network Plan | Ofgem

Innovation Challenge 2:

Greater heat flexibility

Increasing development and use of heat flexibility for network and system benefit

Context: the background to the problem we are trying to address

Heating buildings contributes to almost a quarter of all UK carbon emissions. The UK Government has set targets to make strategic decisions on the role of hydrogen in heating by 2026, deploy at least 600,000 heat pump systems per year by 2028 (potentially scaling to 1.7m per year by mid-2030s) and phase out fossil fuel heating systems in off-gas-grid homes by 2035[17] [18]. Some regions in the UK have more ambitious policies and proposals for cutting emissions from heating[19] [20].

It is suggested that heat pumps alone could add up to 14TWh of electricity demand to the power system in 2030[21], and this is expected to increase peak demand by 50% by 2035, doubling again by 2050[22]. This predicted increase in peak demand is likely to be exacerbated by extreme weather events becoming more frequent[23], with potential for longer periods of extreme cold temperatures leading to increased pressure on generation capacity and network infrastructure. This forecasted growth in peak demand and hence network reinforcement needed is a critical barrier to the delivery of heat decarbonisation targets on time and at reasonable cost, with large scale deployments of heat pumps being delayed or associated with large connection costs.

Novel thermal energy storage (TES) and long-duration storage solutions[24] could mitigate these reinforcement requirements, through decoupling electricity consumption and heat supplied from intermittent generation. However, many of these technologies still require demonstration at scale, across a wide customer base.

[17] https://www.gov.uk/government/publications/heat-and-buildings-strategy
[18] Households off the gas-grid and prices for alternative fuels - House of Commons Library (parliament.uk)
[19] https://www.gov.scot/publications/heat-buildings-strategy-achieving-net-zero-emissions-scotlands-buildings/
[20] Heat strategy for Wales | GOV.WALES
[21] https://about.bnef.com/blog/heating-could-add-5-to-u-k-electricity-demand-in-2030/
[22] https://www.nationalgrideso.com/future-energy/future-energy-scenarios-fes/energy-consumer#:~:text=Electrification%20of%20heat%20could%20lead,network%20capacity%20to%20support%20this
[23] Mapped: How climate change affects extreme weather around the world (carbonbrief.org)
[24] Longer Duration Energy Storage Demonstration Programme, Stream 2 Phase 2: details of successful projects - GOV.UK (www.gov.uk)

Additionally, network planning, connection processes and DSO service parameters require updating to incentivise their uptake and reflect the value they can provide [25].

Outside of extreme cold weather periods, demand side flexibility from heat pumps and other direct electric heating technologies alone, including from district heating, can play a valuable role in managing grid constraints and balancing supply and demand[26]. Systems modelling shows that flexibility from electrified heat-effective forms of flexibility available to the system[27],[28]. In recent years, the evidence base demonstrating their capabilities has been growing. However, participation of heat assets in ESO and DSO services on a commercial basis remains very limited, indicating that these propositions are not yet commercially available at scale.

Ofgem's 2023 Call for Input on Engaging domestic consumers in energy flexibility raised risks on achieving the widespread adoption of flexibility required to save consumers billions of pounds in system costs, flagging barriers on complex customer journeys, a lack of coordination between stakeholders and a lack of propositions tailored for each customer group that still needs to be addressed[29]. Industry research agrees with this conclusion, flagging concerns that interoperability of assets and customer perceptions of automation in different stakeholder groups are issues that need to be addressed[30].

[25] Watt Heat | ENA Innovation Portal (energynetworks.org)
[26] Flexibility in Great Britain | The Carbon Trust
[27] Flexibility in Great Britain | The Carbon Trust
[28] Modelling flexibility requirements in deep decarbonisation scenarios: The role of conventional flexibility and sector coupling options in the European 2050 energy system - ScienceDirect
[29] Engaging domestic consumers in energy flexibility | Ofgem
[30] Automating heat pump flexibility: results from a pilot (nesta.org.uk)

The Innovation Challenge of 'greater heat flexibility' aims to:

- Increase participation of thermal flexibility in DSO and ESO markets
- Reduce time to integrate heat decarbonisation in network planning
- Reduce heat led peak demand through flexibility
- Increase use of renewable power for electrified heat through flexibility

Innovation Challenge-specific requirements

In addition to meeting the requirements within the SIF Governance Document and licence condition, projects applying to the 'greater flexibility' Innovation Challenge must meet the below requirements.

Scope of projects

Project leads are encouraged to consider all the below points within their project development, but as a minimum your proposal must directly address at least one as a primary focus of the proposed project.

1. Flexibility solutions to reduce peak electricity demand from heat decarbonisation

Any proposed project against the point above must also consider contributing to four key cross-cutting areas:

- Inclusive development – Ensuring the solution is applicable and accessible to diverse customer and consumer segments through relevant stakeholder engagement and user centric design principles
- Skills and capability – Consider throughout the project where upskilling and new capability development is needed and signalling those needs to relevant third parties like academics, training institutes and key supply chain partners
- Supply chains – Assess the deliverability and scalability of the solution across the GB network from a supply chain perspective including maturity of supply chains, potential vulnerabilities such as labour requirements, logistical and environmental risks.
- Data and digitalisation - Harness digitalisation and implement Energy Data Best Practice across all areas.

Partner requirements

The table below outlines Project Partner requirements for each of the specific areas of scope within this Innovation Challenge. Please note that the Project Partner requirements may differ for Project Phases within each scope of the Innovation Challenge and, where set out, they are only applicable for that specific Project Phase. In the case where there are multiple partnership requirements indicated, these can be met by a single organisation.

The Beta phase partnership requirements are not outlined in this document as the guidance will be provided on a project-by-project basis prior to application.

Project scope	Discovery project partner requirements	Alpha project partner requirements
1. Flexibility solutions to reduce peak demand from heat decarbonisation	No specific partner requirements	1. A heat technology, service, or infrastructure provider. For example, this could include, but is not limited to: - heat network providers - heat pump designers and installers - thermal storage developers **and** 2. an Energy Supplier **or** a Flexibility aggregator.

Relevant projects and programmes

The projects applying into this challenge should familiarise themselves with the projects and programmes outlined here. Any proposal addressing this challenge area should consider the following and propose complementary and/or additional pieces of work.

1. Equitable Novel Flexibility Exchange (EQUINOX, a Network Innovation Competition (NIC) funded project; 2022-25)[31]: This project tests new billing schemes to reward up to 1000 households for temporarily altering their heat pump operation in response to Distribution Network Operator (DNO) needs without compromising on comfort. It tests three commercial reward methods to demonstrate how varying risk/reward frameworks between DNOs, suppliers, aggregators and customers can influence the amount, cost, & reliability of flexibility from portfolios for varying customer groups including fuel poor and vulnerable.
2. HeatFlex UK[32]: This large-scale innovation project aims to understand how much flexibility each home with a heat pump can provide and how this can benefit a range of different stakeholders. The project aims to identify an acceptable approach to automated control of domestic heat pumps for flexibility while maintaining comfort and customer satisfaction, measure the amount of flexibility (kWh reduced during a heat flex event) delivered by the approach and examine how this impact varies by household and property characteristics.
3. Watt Heat (SIF-funded project; 2023-ongoing)[33]: investigates the flexibility potential of thermal storage technologies, individually and in combination with heat pumps, and understand how far in time these technologies can shift electrical demand relative to customer heat demands.
4. Peak Heat (Network Innovation Allowance (NIA) funded project; 2021-22)[34]: to what degree heat pumps will impact the Low Voltage (LV) networks, during the average winter day, the average winter peak as well as in a 1 in 20-year winter event. The project will also investigate the market for domestic thermal storage and the ability of thermal storage to help solve constraints on the distribution network.
5. Heat Pump Ready[35] (2022-ongoing): The Heat Pump Ready programme is a £60m UK government initiative to support the target of 600,000 heat pumps installed per year from 2028. £15m has been allocated to 37 SMEs for 24 projects across stream 2 of the programme – projects focused on reducing costs and alleviating current difficulties holding back heat pumps install. This includes projects addressing the "smart and flexible" theme.

[31] National Grid - EQUINOX (Equitable Novel Flexibility Exchange)
[32] HeatFlex UK | Nesta

6. Data Driven Decarbonisation[36] (Innovate UK Net Zero Heat project, 2023 – ongoing): Trustmark Research and Innovation (TRI) has been funded by Innovate UK for an ambitious project programme delivering data driven decarbonisation of buildings. The project will allow for connectivity of numerous UK datasets making them more substantial, delivering a national stock model and a more complete energy distribution dataset.

[33] Watt Heat | ENA Innovation Portal (energynetworks.org)
[34] Peak Heat | ENA Innovation Portal (energynetworks.org)
[35] Heat Pump Ready Programme - GOV.UK (www.gov.uk)
[36] https://iuk.ktn-uk.org/programme/net-zero-heat/

Innovation Challenge 3:
Embedding resilience

Preparing energy networks for a resilient net zero transition

Context: the background to the problem we are trying to address:

The energy transition requires widespread change across the system. However, some parts of the system are better placed to handle this change than others.

Rural areas face very specific challenges to cost-effective decarbonisation. Approximately 20% of the population are based in rural areas[37] [38] [39], with a range of interlinked challenges that lead to high energy demands in these regions. These include that 50% of these areas located off the gas grid[40] and have typically poorer levels of building fabric with 60 percent of rural homes having an Energy Performance Certificate (EPC) of D[41] or below leading[42] to high heat demands and expensive fuel bills. Additionally, these households tend to have greater reliance on cars, with longer average journey mileage than those in urban areas.

These factors have significant implications for how best to decarbonise these communities in a cost-effective manner, whilst ensuring resilience needs are met. Electrification of heat and transport can be a cost-effective option at the site level, when compared to petrol and oil alternatives. However, these technologies come at high upfront cost and additionally place significant additional load on often aging electricity infrastructure, with grid capacity continuing to be a significant barrier. Feeders in these areas tend to serve a low number of houses and businesses, leading to a high reinforcement cost per customer. This lack of network capacity also makes connection of large-scale renewable generation unviable in the medium term.

Reliance on the electricity network for meeting all energy needs also potentially decreases the resilience of the community to system outages. This aspect is becoming more important as the severity and frequency of extreme weather events increase in the UK owing to climate change.

[37] Microsoft Word - Rural_Focus_3_Final_.doc (gov.wales)
[38] Rural population and migration - GOV.UK (www.gov.uk)
[39] Urban rural classification - Registers of Scotland (ros.gov.uk)
[40] Rural Fuel Poverty Gap widens - Rural Services Network (rsnonline.org.uk)
[41] Energy Performance Certificates explained - Energy Saving Trust
[42] New report shows devastating triple blow pushes rural communities into a cost-of-living emergency - Rural Services Network (rsnonline.org.uk)

The other key area for this resilience challenge is managing an energy system with falling gas demand. As UK increases deployment of net zero technologies, gas demand is anticipated to fall significantly. In 2022, UK's natural gas demand decreased by almost 8% compared with 2021[43]. As UK transitions its energy system in line with net zero, it could further reduce gas demand between 40-60%[44] by 2035. 60% of natural gas consumption is used evenly for electricity generation and domestic uses (primarily heating) with the rest across industrial and commercial uses[45]. As natural gas currently plays a key role across the system providing power, heat and flexibility, it is important to develop alternate solutions to meet the system and consumer requirements.

From a SIF perspective, the critical aspect is understanding the role of the GB gas network in the transition and ensuring the infrastructure development and use is aligned to the net zero goals and delivering consumer value. Analysis commissioned by the National Infrastructure Commission (NIC) estimates the total capital cost of transitioning the gas network to 2050 is £46-70bn[46]. To put this in context, the total cost of net zero estimated to be £50bn/year from late 2020s[47]. This highlights the significance and importance of innovating here to support improving the overall affordability of reaching net zero.

As there continues to be active ongoing technical and commercial investigation on the repurposing potential of the gas networks for hydrogen, these are not within the scope of this SIF round.

This theme is focussed on four main aspects

- Determining areas of GB network where gas infrastructure will not be needed taking into account whole system pathways to achieve net zero
- Maintaining security of supply and resilience as GB system transitions away from natural gas and parts of the gas network are decommissioned
- Assessing and developing alternative opportunities for use of the gas infrastructure to provide consumer benefits (including beyond energy)
- Developing cost effective and environmentally sustainable ways to decommission gas network assets where alternate uses are ruled out

[43] DUKES 2023 Chapter Gas (publishing.service.gov.uk)
[44] https://eciu.net/analysis/reports/2023/getting-off-gas
[45] DUKES 2023 Chapter Gas (publishing.service.gov.uk)

The Innovation Challenge 'Embedding resilience' aims to:

1. Alleviate energy network barriers to decarbonising rural communities
2. Develop novel and replicable approaches to support rural decarbonisation in a timely, resilient and cost-effective manner
3. Develop critical evidence to support clarifying role of GB gas networks in net zero transition from a whole system perspective
4. Deploy novel and cost-effective alternate uses of gas infrastructure in parts of the system
5. Improve gas network decommissioning cost estimates and develop novel solutions to reduce it

Innovation Challenge-specific requirements

In addition to meeting the requirements within the SIF Governance Document and licence condition, projects applying to the 'embedding resilience' Challenge must meet the below requirements.

Scope of projects

Project leads are encouraged to consider all the below points within their project development, but as a minimum your proposal must directly address at least one as a primary focus of the proposed project.

1. Cross vector[48] approaches to decarbonise rural communities in a resilient manner
2. Transition planning for an energy system with reducing natural gas demand

Any proposed project against the point above must also consider contributing to four key cross-cutting areas:

[46] Report (nic.org.uk)
[47] Paying for net zero | Institute for Government
[48] Cross vector refers to considering electricity, heat and transport as interdependent and linked energy vectors in the system

- Inclusive development – Ensuring the solution is applicable and accessible to diverse customer and consumer segments through relevant stakeholder engagement and user centric design principles
- Skills and capability – Consider throughout the project where upskilling and new capability development is needed and signalling those needs to relevant third parties like academics, training institutes and key supply chain partners
- Supply chains – Assess the deliverability and scalability of the solution across the GB network from a supply chain perspective including maturity of supply chains, potential vulnerabilities such as labour requirements, logistical and environmental risks.
- Data and digitalisation - Harness digitalisation and implement Energy Data Best Practice across all areas.

Partner requirements

The table below outlines Project Partner requirements for each of the specific areas of scope within this Innovation Challenge. Please note that the Project Partner requirements may differ for Project Phases within each scope of the Innovation Challenge and, where set out, they are only applicable for that specific Project Phase. In the case where there are multiple partnership requirements indicated, these can be met by a single organisation.

The Beta phase partnership requirements are not outlined in this document as the guidance will be provided on a project-by-project basis prior to application.

Project scope	Discovery project partner requirements	Alpha project partner requirements
1. Cross vector approaches to decarbonise rural communities in a resilient manner	1. A consumer representative group relevant to rural energy development	1. A technology provider or developer relevant to rural energy development

2. Transition planning for an energy system with reducing natural gas demand	No specific partner requirements	1. Energy network licensee in addition to the project lead. **And** 2. A consumer representative group

Relevant projects and programmes

The projects applying into this challenge should familiarise themselves with the projects and programmes outlined here. Any proposal addressing this challenge area should consider the following and propose complementary and, or additional pieces of work.

1. Rural Electrification 2.0[49] (NIA funded; 22-23): Understanding the impact of increasing electrification of the agricultural sector and rural communities / businesses on the distribution network allows the removal of barriers and the acceleration of the net-zero transition.
2. Supporting Off-Grid Communities[50] (NIA funded; 2023- ongoing): this project seeks to better understand the realities and practicalities of decarbonizing off-grid properties and the likely impacts on occupants. This includes identifying the policy and regulatory frameworks within which decisions about the decarbonisation of off-grid communities will be made and reviewing possible decarbonisation solutions for off-grid communities, considering technical, financial, social, cultural and geographical barriers.
3. Local area energy plans (LAEP) [51]: a new process being implemented by some local authorities, including those in rural locations, for developing a bottom-up, whole systems approach to delivering net zero in their region. The aim of LAEP is to outline the most cost-effective way for a local area to decarbonise and to set out an action plan for implementation.
4. Regional Energy Strategic Planning[52]: In 2023, Ofgem announced the creation of 13 Regional Energy Strategic Planers (RESPs) across Great Britain, who will work with organisations at a local level including local government and gas and electricity networks, to improve understanding of the infrastructure needed in different parts of the country and attract investment for projects. The RESPs will be part of the National Energy System Operator (NESO), allowing greater coordination with the new Central Strategic Network Plan[53] the NESO is responsible for developing.

[49] Rural Electrification 2.0 | ENA Innovation Portal (energynetworks.org)
[50] Supporting Off-Grid Communities | ENA Innovation Portal (energynetworks.org)
[51] Local Area Energy Planning: achieving net zero locally (parliament.uk)
[52] Decision on future of local energy institutions and governance | Ofgem
[53] Decision on the framework for the Future System Operator's Centralised Strategic Network Plan | Ofgem

5. GasNetNew[54] (EPSRC project; 22-25): The aim of this project is to undertake a major review of the role of the gas network in future. This project explores the different possible uses for parts of the gas network not being converted to hydrogen, including use for district heating networks or as compressed air energy storage systems.

[54] GasNetNew - The role of the gas network in a future decarbonised UK (ukri.org)

Innovation Challenge 4:
Accelerating towards net zero energy networks

Developing an efficient net zero energy system

Context: the background to the problem we are trying to address

Energy networks play a critical role in supporting the UK's Net Zero emissions targets, developing the critical infrastructure necessary to support the transition away from fossil-fuels. Network operators must manage this changing role alongside decarbonising their own operations, a fact that is being increasingly recognised with network operators committing to ambitions science-based targets[55, 56,57,58,59,60]. Actions to date have focused on driving forward adoption of SF6-free technologies[61,62], transitioning to electric vehicle fleets[63] and installing renewables at substations to cover the site's own loads. These actions all have material impact, but as the networks facilitate the decarbonisation of the wider system, the scale of the challenge becomes larger.

A key focus area for this challenge is reducing electricity related losses from the system. Technical losses occur as energy is lost as heat from electricity networks when power flows through equipment, effectively increasing overall demand and cost for customers. These losses could increase from 6-7% currently to over 20% in a net zero energy system[64], driven by higher network utilisation[65]. With rise in electricity demand to 550-680 TWh by 2050[66], increasing losses could lead to significant wastage of energy and cost in the future. With increasing losses, more electricity will need to be generated and consumed, which leads to increased costs across the

[55] SSEN Transmission goes greener with plans to cut emissions by a third - SSEN Transmission (ssen-transmission.co.uk)
[56] National Grid Electricity Transmission has emissions reduction targets approved by the Science Based Targets initiative | National Grid Group
[57] SBTi targets approved - SP Energy Networks
[58] Environment and Sustainability | UK Power Networks
[59] Recognition from the Carbon Trust | Cadent (cadentgas.com)
[60] Power network operator building on net zero targets (enwl.co.uk)
[61] National Grid - Sulphur Hexafluoride (SF6)
[62] 'Clean air' switchgear paves the way for a greener future | UK Power Networks
[63] SSE on the road to a fully electric fleet | SSE
[64] What can electricity networks do about technical losses? | WSP
[65] Sin título de diapositiva (energynetworks.org)
[66] Sector-summary-Electricity-generation.pdf (theccc.org.uk)

system. While it is complex to determine the exact cost of losses, it is estimated that it could already be costing a typical GB household c.£100 per year[67].

There are several strategies being used to address these issues including power factor correction, lower loss transformer use, increasing conductor sizing and improved phase balancing. While there has been continued work on better understanding and reducing losses in the GB electricity networks, this challenge is focussed on enabling a more efficient system in the context of greater digitalisation, electrification, use of flexible solutions and renewable generation. Taking a whole system and cost-effective approach to reducing losses will have an important bearing on future system design and operation.

The 'towards net zero energy networks' Innovation Challenge aims to:

1. Develop solutions to reduce efficiency loss in the GB electricity transmission and distribution system
2. Achieve greater clarity and improved evidence on reducing efficiency loss in the context of greater network utilisation and deployment of low carbon technologies

Innovation Challenge-specific requirements

In addition to meeting the requirements within the SIF Governance Document and licence condition, projects applying to the 'towards net zero networks' Innovation Challenge must meet the below requirements.

Scope of projects

Project leads are encouraged to consider all the below points within their project development, but as a minimum your proposal must directly address at least one as a primary focus of the proposed project.

1. Innovation to improve efficiency of network operations

Any proposed project against the point above must also consider contributing to four key cross-cutting areas:

[67] The cost of losses (sustainabilityfirst.org.uk)

- Inclusive development – Ensuring the solution is applicable and accessible to diverse customer and consumer segments through relevant stakeholder engagement and user centric design principles
- Skills and capability – Consider throughout the project where upskilling and new capability development is needed and signalling those needs to relevant third parties like academics, training institutes and key supply chain partners
- Supply chains – Assess the deliverability and scalability of the solution across the GB network from a supply chain perspective including maturity of supply chains, potential vulnerabilities such as labour requirements, logistical and environmental risks.
- Data and digitalisation - Harness digitalisation and implementing Energy Data Best Practice across all areas.

Partner requirements

The table below outlines Project Partner requirements for each of the specific areas of scope within this Innovation Challenge. Please note that the Project Partner requirements may differ for Project Phases within each scope of the Innovation Challenge and, where set out, they are only applicable for that specific Project Phase. In the case where there are multiple partnership requirements indicated, these can be met by a single organisation.

The Beta phase partnership requirements are not outlined in this document as the guidance will be provided on a project-by-project basis prior to application.

Project scope	Discovery project partner requirements	Alpha project partner requirements
1. Innovation to improve efficiency of network operations	No specific partner requirements	1. A technology or service provider with expertise in electrical networks efficiency improvement

Relevant projects and programmes

The projects applying into this challenge should familiarise themselves with the projects and programmes outlined here. Any proposal addressing this challenge area should consider the following and propose complementary and, or additional pieces of work.

1. New approaches to losses (NIA funded; 2023-24)[68]: This project developed a new methodology using network data from engineering assessments to improve the accuracy of apportioning them across different network users.

2. VoltXpanse (NIA funded; 2023-26)[69]: The project is examining strategic ultra-high voltage solutions (up to 765Kv AC and 800kV DC) to consider for future transmission network reinforcement to improve bulk power transfer capability and reduce losses

3. Full Circle (SIF-funded; 2023-24)[70]: This innovative project is developing a new industry-leading framework that will make it easier for heat network developers, property developers, and Energy Service Companies (ESCos) to make use of this untapped resource of waste heat from transformers, reducing the associated carbon emissions from network losses.

4. Strategies for reducing losses in distribution networks (2018)[71]: Research paper providing analysis of where losses are occurring in the low voltage network and the effectiveness of loss management strategies in mitigating these issues.

[68] New Approach to Losses | ENA Innovation Portal (energynetworks.org)
[69] VoltXpanse: Ultra high voltage onshore energy highway | ENA Innovation Portal (energynetworks.org)
[70] 10086459 | ENA Innovation Portal (energynetworks.org)
[71] strategies-for-reducing-losses-in-distribution-networks.d1b2a6f.pdf (ukpowernetworks.co.uk)