Ofgem Strategic Innovation Fund

Round 3 Innovation Challenges: final decision

Background and context

The Strategic Innovation Fund (SIF) is a major opportunity for innovative businesses and academics to work with energy networks on innovative projects that will deliver benefits to consumers. 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 position Great Britain into as the Silicon Valley of energy and 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 partnering 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[1] - administering the funding programme, monitoring the delivery of projects, making recommendations to Ofgem on operational matters, supporting third-party innovators and, where possible, supporting successful projects to become business as usual activities.

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

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 our decision on the SIF Governance Document[2]. 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: whole system integration, data and digitalisation, heat, and zero emission transport.

These broad areas remain the focus of the SIF. For Round 2, a refined set of Innovation Challenges was developed. These were: supporting a just energy transition, preparing for a net zero power system, improving energy system resilience and robustness, and accelerating decarbonisation of major energy demands.

For Round 3 the SIF will further focus on specified areas that are key to achieving key sectoral targets over the next decade, such as delivering a net zero power system by 2035.

These Round 3 Innovation Challenges are as follows:

1. Whole system network planning and utilisation to facilitate faster and cheaper network transformation and asset rollout
2. Novel technical, process and market approaches to deliver an equitable and secure net zero power system
3. Unlocking energy system flexibility to accelerate electrification of heat.
4. Enabling power-to-gas (P2G) to provide system flexibility and energy network optimisation.

The full scope and detail of the Round 3 Innovation Challenges is covered further in this document.

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

Collaboration and consultation

These Innovation Challenges have been developed through extensive collaboration and consultation with a wide range of stakeholders and interested bodies, including energy network companies, other innovators and entrepreneurs, government, and academia. The stakeholder engagement was carried out via three approaches – SIF market engagement, Basecamp and Consultation. These are detailed further in this section below.

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.
- **Timely:** 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 3.
- **Scope:** the scope of Innovation Challenge is complementary, and non-duplicative, to other UK innovation programmes (including other network innovation funding mechanisms).

Basecamp: Input to the Challenges was taken from the Energy Innovation Basecamp, an event in which Innovate UK participated. At this event the Energy Networks Association (ENA) and energy networks, with over 300 attendees covering industry bodies, innovators and academics, discussed and disseminated 63 granular problem statements[3] that relate to real-world energy network problems.

SIF market engagement: From January 2023 to April 2023, around 120 representatives from across the energy and other sectors gave their input to Innovate UK on potential strategic challenges that could be considered.

To further develop input from Basecamp and prioritise strategic challenges, a direct engagement approach was taken. This ensured that a range of organisations who may not usually have the resources to respond to a written consultation could contribute

[3] Energy Innovation Basecamp - Problem Statements | ENA Innovation Portal (energynetworks.org)

and enabled more qualitative discussions on the nature of strategic priorities, as well as the target outcomes of Innovation Challenges.

Through this process over 100 different areas of potential focus were offered. These were then refined, through workshops with key industry stakeholder groups, to 9 priority challenge areas. An Innovation Challenge Group, consisting of industry experts, was also convened to provide ongoing input and feedback on the process and outcomes.

These options were then refined and prioritised through concentrated focus groups and workshops held with a range of organisations from areas including:

- Energy networks
- Investors
- Energy technology providers
- Consumer representative groups
- Non-energy sector technology companies
- Devolved and local governments
- UK government
- Ofgem
- Small businesses
- Academics
- Trade associations

Consultation: An open consultation was issued by Ofgem which included information-gathering on Round 3 Innovation Challenges[4]. As part of the consultation, Innovate UK invited stakeholders to identify any open innovation challenges and also consider how to best achieve impact. Feedback indicated that challenges should be framed in an outcome-orientated way that offers opportunities for a wide-range of novel and innovative ideas, whilst also supporting the achievement of key national and sub-national policy commitments and targets. This gives space for creative ideas and innovation, while also working towards common objectives. Feedback from energy networks[5] supported a number of the priority areas identified through the direct engagement process with other stakeholder groups.

[4] https://www.ofgem.gov.uk/publications/consultation-potential-changes-default-approach-strategic-innovation-fund-round-two-or-three-innovation-challenges-and-information-gathering-round-3-challenges

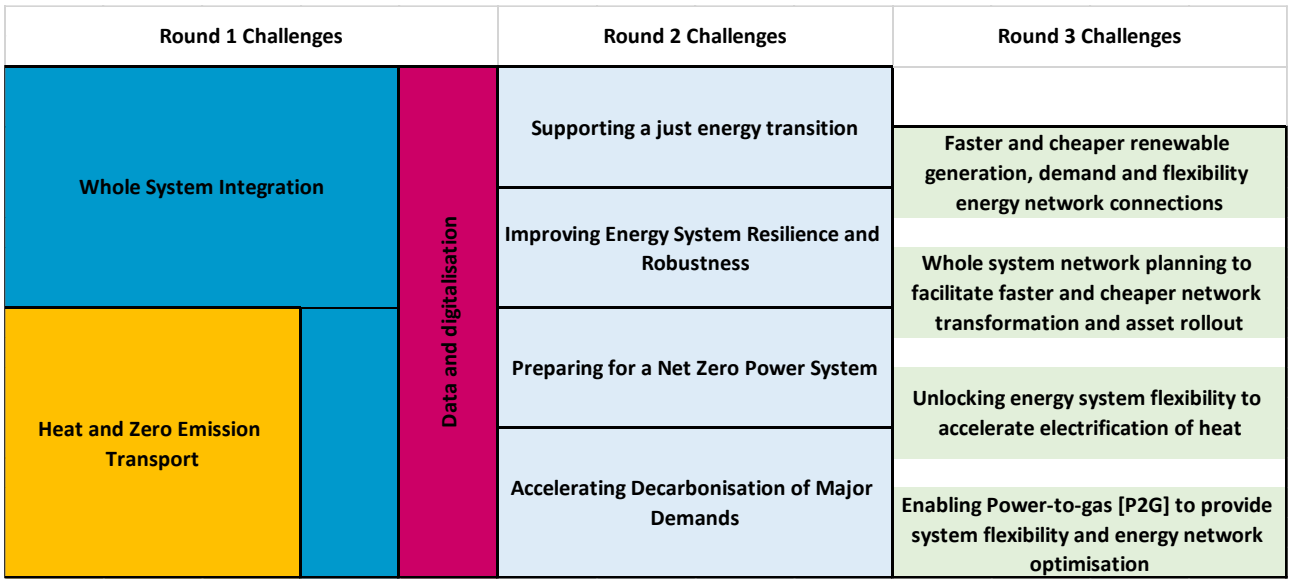
[5] https://www.ofgem.gov.uk/sites/default/files/2023-04/Direct%20Access%20-%20Issues%20Log%20%20April.xlsx

The challenges were continuously iterated with Ofgem's Innovation Hub team and the final decision on the four Round 3 Innovation Challenges was taken by Ofgem's Executive Committee.

Strategic evolution of Round 3 Innovation Challenges

This iteration of challenges and associated themes for Round 3 is more detailed on specific innovation needs. The challenges from Round 1 through to Round 3 demonstrate a narrowing of focus with close links to those previously announced, as illustrated in the Figure 1. The Round 3 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[6] and Innovation Vision[7].

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. In Round 3, the aim of delivering a just and equitable energy transition has been incorporated across all four of the Innovation Challenges, to ensure it is addressed as an essential focal point in all areas of innovation development.

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

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 planned to recur and be refined each year – 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.	Jan-May	• Engage with a wide range of stakeholders to gather innovation challenges relating to SIF • 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: 25 May – Launch Webinar; early June – individual challenge introductions webinar; mid-June online educational series
Ideation: generating new ideas for projects/products and services that will target these challenges.	May-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: July to August - 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: early September - Partnership forums to support SIF applicants in identifying and securing partners
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: 31st October-1st November - The Summit

Next steps

With the Round 3 Innovation Challenges identified, the ideation period runs between May and August 2023. This will include Innovate UK communicating the aims and objectives of each challenge, outlining the process for submitting project proposals, an 'Introduction Guide to Energy Network Innovation: What You Need to Know and How to Apply' online educational series for new innovators, and brokering partnerships between organisations with complementary capabilities and aims.

The incubation period then follows, when innovators and other potential project partners will work directly with the energy network companies to develop their ideas together.

Finally, as the acceleration stage begins in September, we will invite applications for funding - led by the energy network companies but supported by their project partners – for round three '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 event on 25 May 2023. 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.

Marzia Zafar

Deputy Director - Strategy & Decarbonisation Ofgem

Matt Hastings

Deputy Director – Ofgem Strategic Innovation Fund, Innovate UK

Innovation Challenge 1:
Whole system planning and utilisation of networks to facilitate faster and cheaper network transformation and asset rollout

Strategically improving and evolving the planning and connections process to meet net zero in a timely and cost-effective manner

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[8], 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[9]. Meeting these targets requires a significant ramp up of plan, build and connection rates for these assets in the mid-2020s and early 2030s.

While there are other bottlenecks (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[10] to achieving the government's 2035 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 networks in England and Wales by 2030, compared to what has been built in the last 30 years[11]. This highlights the scale and urgency of the network roll out challenge to allow low carbon power to be integrated and transmitted across the UK.

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

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 distribution network as early as 2030[12]. Industry analyses also concur on the scale of these challenges. The Energy System Catapult's modelling for BEAMA[13] indicates that a 49% increase in distribution network cables might be needed by 2035 to meet the increased demand from electrification[14]. This challenge is further compounded by the lower level of visibility in the secondary Low Voltage (LV) part of the networks, making the estimates of place, time and extent of reinforcements needed uncertain.

This network capacity challenge and a surge in low-carbon demand and supply connection requests have contributed to slowing down the time taken to connect to the network. For example, in some cases low-carbon generator customers have to wait 10-15 years to secure a grid connection[15]. As of February 2023, there was 257 GW in the connections queue and only 30-40% of these projects will ultimately materialise[16]. This low conversion rate from connection application to actual project development and connection delivery further increases time for viable low-carbon projects to secure connections.

To address these challenges and enable the timely build out of the energy network infrastructure needed, there is a greater need for strategic and holistic energy network planning and connections queue management; this is the key focus area of this challenge. In addition, there are significant opportunities to use the move to a smarter, digitalised and more flexible energy system to accelerate connections to the grid.

Aims of this challenge

The Innovation Challenge of 'whole system planning and utilisation of networks to facilitate faster and cheaper network transformation and asset rollout' aims to:

- Improve coordination, modelling and planning capability across networks to support holistic and timely system development

[12] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1096248/electricity-networks-strategic-framework-appendix-1-electricity-networks-modelling.pdf

[13] BEAMA is the UK trade association for manufacturers and providers of energy infrastructure technologies and systems

[14] https://www.beama.org.uk/services/net-zero/netzero-publications/growing-the-supply-chain-for-net-zero.html

[15] https://committees.parliament.uk/committee/62/environmental-audit-committee/news/195090/mps-call-for-grid-improvements-and-affordable-household-loans-so-more-can-join-the-solar-revolution/

[16] https://www.nationalgrideso.com/news/eso-leads-way-major-initiative-accelerate-connections-electricity-transmission-grid

- Accelerate connection times for renewables and/or demand sites to meet 2030 target
- Support prioritisation of flexible assets in connection queues to increase network headroom and reduce time for viable assets to secure connection
- Improve availability of information to consumers to support more cost effective and diverse decarbonisation choices

Innovation Challenge-specific requirements

In addition to meeting the requirements within the SIF Governance document and licence condition, projects applying to the "Whole system planning and utilisation of networks to facilitate faster and cheaper network transformation and asset rollout'' 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. Digital simulation and advanced modelling techniques to facilitate whole system network planning and development
2. Leveraging data, digital tools, and novel commercial arrangements to maximise existing network capacity
3. Reducing network connection times through use of demand and supply side flexibility
4. Supporting consumers in making cost-effective decarbonisation choices coordinated with wider local area or regional plans

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. Digital simulation and advanced modelling techniques to facilitate whole system network planning and development	1. Organisations with capability in whole systems modelling and analysis.	1. Energy network licensee in addition to the project lead. The partner network must hold a different category of network licence than the licensee leading the project.
2. Leveraging data, digital tools, and novel commercial arrangements to maximise existing network capacity	1. Organisations with capability in digital tools and techniques.	1. Customers with existing or proposed demand and/or supply connections.
3. Reducing network connection times through use of demand and supply side flexibility		1. Flexibility aggregators **and** 2. Customers with existing or proposed demand and/or supply connections.

4. Supporting consumers to make cost effective decarbonisation choices co-ordinated with wider local area or regional plans	1. Consumer representative group or relevant charities.	1. Relevant local government entity.

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[17]: 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. Access and Forward-Looking Charges Significant Code Review (Access SCR)[18]: This review and subsequent decision focused on ensuring the efficiency and flexible use of electricity networks including defining users' access rights to the distribution network.
3. RIIO price control Incentive on Connections Engagement (ICE)[19]: This is an incentive as part of the RIIO price controls aimed at encouraging DNOs to provide a better service for connecting customers.
4. Diversified Flexible Queue Management (SIF project)[20]: This is a SIF project exploring use of data to understand actual customer characteristics to manage network capacity.

17 https://www.nationalgrideso.com/document/262676/download

18 https://www.ofgem.gov.uk/sites/default/files/2022-05/Access%20SCR%20-%20Final%20Decision.pdf

19 https://www.ofgem.gov.uk/sites/default/files/docs/2015/03/ice_guidance_doc_010415_0.pdf

20 https://www.youtube.com/watch?v=fXYm8km9R6c&list=PLrMOhOrmeR6ldr-EVoT8ABGhTCxgvBKqs&index=10

Innovation Challenge 2:
Novel technical, process and market approaches to deliver an equitable and secure net zero power system

Development and scaling of technologies, processes and markets which will deliver an equitable and fair net zero electrical system at all levels

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

This Innovation Challenge builds upon the Round 2 SIF Challenge of 'Preparing for a Net Zero Power System'. The Round 3 Challenge has an increased focus upon developing ground-breaking digital technologies, novel hardware for power network operation, and flexibility provision from long duration storage; all technologies that are expected to be needed to deliver a net zero power system. Developing and leveraging market innovations alongside these technological developments is required to ensure an equitable distribution of energy network costs, and to create opportunities for all consumers to engage with and use low carbon technologies with cheap, clean electricity.

A key policy commitment within the UK Government's net zero strategy is to fully decarbonise the power system by 2035, subject to security of supply considerations[21]. Over the last two decades Great Britain has delivered the fastest-decarbonising power system of all major economies globally[22]. As of 2020, around 40% of installed capacity and 30% of generation output came from fossil fuels; these may need to be replaced by renewables, nuclear and other low carbon sources prior to 2030. Particularly, significant increases in deployment of offshore wind (supported by a policy commitment of 50 GW by 2030[23]), onshore wind, and solar PV (five-fold increase by 2035) are expected.

With the objective to deliver a fully Net Zero Power System by 2035, increasing attention has been given to resolving how to provide clean electricity during the most challenging periods when demand might be high and renewable generation is low. Parliamentary research findings[24] supported by the energy networks and industry have highlighted that long-duration energy storage is likely to be required to play a

[21] https://www.gov.uk/government/publications/net-zero-strategy

[22] https://www.drax.com/press_release/uk-tops-global-decarbonisation-league-amid-renewable-revolution/

[23] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1067835/british-energy-security-strategy-web.pdf

[24] https://post.parliament.uk/research-briefings/post-pn-0688/

greater role in resolving this challenge. This is with acknowledgement that further research and innovation is required to understand the roles of thermal storage, batteries, mechanical storage, and hydrogen in providing services to the energy system.

The Department for Energy Security and Net Zero (DESNZ) is currently undertaking a Review of Electricity Market Arrangements (REMA)[25], acknowledging that future reforms to energy markets in the power sector may be necessary to accelerate renewable generation integration and low carbon technology deployment.

Operating a power system safely and securely with high levels of renewables will bring novel challenges and require new approaches. As noted in the Operability of High Renewable Electricity Systems Report by the National Infrastructure Commission (NIC) and the System Operability Framework by the Electricity System Operator (ESO)[26], aspects including inertia, short circuit level, voltage control, system restoration, loss of mains protection and fault ride through will need to be met to operate a safe and secure system.

Unlocking these opportunities will require innovation across technology (including control systems), processes, markets and standards and must take place in the wider context of local energy systems, cyber security, Distribution System Operator (DSO) transition[27], and new challenges to energy security.

Aims of this challenge

The Innovation Challenge of 'novel technical, process and market approaches to deliver an equitable and secure net zero power system' aims to:

- Reduce at GWh scale the amount of renewable energy curtailed annually, at a cost lower than current constraint payments
- Demonstrate greater use of machine learning, artificial intelligence and quantum computing to increase responsiveness, system visibility, and resilience
- Use innovation to improve processes needed for managing and operating a Net Zero power system
- Reduce the whole system cost of intermittent renewable integration

[25] https://www.gov.uk/government/consultations/review-of-electricity-market-arrangements
[26] https://nic.org.uk/studies-reports/operability-highly-renewable-electricity-systems/
[27] https://www.energynetworks.org/creating-tomorrows-networks/open-networks/distribution-system-operation-transition

- Reduce use of fossil fuel plants to provide system flexibility and balancing services
- Increase the number of consumers across segments (regional, spatial, income, and other key socio-demographic indicators) participating in markets and reducing their unit cost of energy

Innovation Challenge-specific requirements

In addition to meeting the requirements within the SIF Governance Document and licence condition, projects applying to the 'Novel technical, process and market approaches to deliver an equitable and secure net zero power system' 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 market and technical approaches to cost effectively minimise renewable energy curtailment
2. Leveraging disruptive computing technologies for improving system visibility, performance, and cyber-security
3. Effectively managing peak demand and stability through increased flexibility including over longer time periods (multi-day and seasonal)
4. Enabling disadvantaged consumer segments to participate in flexibility markets and benefit from novel low carbon technologies

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. Novel market and technical approaches to cost effectively minimise renewable energy curtailment.	1. An organisation with specialist expertise in energy market economics **or** A technology provider or developer of energy system assets (both hardware and software).	1. A technology provider or developer with potential to leverage market arrangements or signals under investigation in the project proposal. **and** 2. A renewable generator, renewable project developer, or operator.
2. Leveraging disruptive computing technologies for improving system visibility, performance, and cyber-security.	1. A technology developer or research organisation with primary focus of developing computing and digital technologies.	1. A technology developer or research organisation with primary focus of developing computing and digital technologies. **and** 2. A renewable generator.
3. Effectively managing peak demand and stability through increased flexibility including over longer time periods [multi-day and seasonal].		1. At least one flexibility service provider (including storage providers) with a direct customer or consumer interaction. **and** 3. A technology provider, developer, installer, or significant operator of assets that can provision flexibility.

4. Enabling disadvantaged consumer segments to participate in flexibility markets and benefit from novel low carbon technologies, to make more cost-effective choices for low carbon technologies.	1. A consumer representative group **or** 2. Relevant local government entity.	1. A consumer representative group **or** Relevant local government entity **and** 2. An energy service provider with a direct consumer relationship.

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. Project TRANSITION[28]: TRANSITION aims to design, develop, and demonstrate a Distribution System Operator (DSO) market platform to fully utilise flexibility services whilst realising the physical, locational, and economic constraints of the networks on which these services will be transacted.
2. Project FUSION[29]: FUSION develops an innovative demand-side response approach to minimise curtailment by integrating flexibility services from industrial, commercial, and residential users.
3. Socially Green[30]: Socially Green aims to understand how we can continue to serve the needs of customers from all backgrounds and support those in vulnerable circumstances as we transition to a net zero carbon emissions future energy system.
4. The ESO's Impact of Long-duration Energy Storage Systems on GB Transmission Planning[31] project and the BEIS Longer Duration Energy Storage (LODES)[32] innovation programme.

[28] SSEN Transition (ssen-transition.com)

Innovation Challenge 3:
Unlocking energy system flexibility to accelerate electrification of heat

Coordination and visibility of electric heat demand to enable effective network planning and flexibility for a greener and more affordable future energy system

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 deploy at least 600,000 heat pump systems per annum by 2026 (potentially scaling to 1.7m per annum by mid-2030s), phase out fossil fuel heating systems in off-gas-grid homes, make strategic decisions on the role of hydrogen in heating by 2026, and ensure that all heating systems are net-zero compatible by 2035[33] Some regions in the UK have more ambitious policies for cutting emissions from heating[3435].

It is suggested that heat pumps alone could add up to 14TWh of electricity demand to the power system in 2030[36], and this is expected to increase peak demand by 50% by 2035, doubling again by 2050[37]. Flexibility will be needed to support shifting or reducing heat demand at times of system stress or high carbon intensity. Technology solutions like thermal energy storage (TES) and long-duration storage can help to decouple electricity demand and supply, to minimise system costs and maximise renewable consumption. However, these technologies are relatively unused and further analysis is needed to understand the value to the energy system[38].

To support these challenges, and enable timely heat decarbonisation, better coordination and visibility are needed for local heat requirements against network constraints. This will better inform network planning activities alongside increasing

[29] FUSION | ENA Innovation Portal (energynetworks.org)
[30] Socially Green | ENA Innovation Portal (energynetworks.org)
[31] Impact of Long-duration Energy Storage Systems on GB Transmission Planning | ENA Innovation Portal (energynetworks.org)
[32] Longer Duration Energy Storage Demonstration (LODES) competition (closed to applications) - GOV.UK (www.gov.uk)
[33] Heat and buildings strategy - GOV.UK (www.gov.uk)
[34] https://www.gov.scot/publications/heat-buildings-strategy-achieving-net-zero-emissions-scotlands-buildings/
[35] https://www.gov.wales/low-carbon-delivery-plan
[36] Bloomberg New Energy Finance – Heating Could Add 5% to UK Energy Demand in 2030 – 2021 - https://about.bnef.com/blog/heating-could-add-5-to-u-k-electricity-demand-in-2030/
[37] The energy consumer | ESO (nationalgrideso.com)
[38] BEIS and Ofgem Policy Paper - Transitioning to a net zero energy system: smart systems and flexibility plan 2021 – 2021 - https://www.gov.uk/government/publications/transitioning-to-a-net-zero-energy-system-smart-systems-and-flexibility-plan-2021

accessibility of flexibility solutions and markets to support peak demand, whilst meeting the needs of all consumers, especially the fuel-poor and vulnerable.

In addition, where flexibility options have been exhausted and reinforcement must be pursued, further action is required to ensure the fair and equitable circulation of reinforcement costs to avoid households and businesses which may adopt technologies later being disadvantaged due to factors such as socio-economic status, poor housing stock, and/or network status.

Aims of this challenge

The Innovation Challenge 'unlocking energy system flexibility to accelerate electrification of heat' aims to:

1. Increase participation of thermal flexibility in DSO and ESO markets
2. Reduce time to integrate heat decarbonisation in network planning
3. Reduce heat led peak demand through flexibility
4. Increase use of renewable power for electrified heat through flexibility
5. Deliver evidence to support policy and charging mechanisms to enable more equitable sharing of reinforcement costs

Innovation Challenge-specific requirements

In addition to meeting the requirements within the SIF Governance Document and licence condition, projects applying to the 'unlocking energy system flexibility to accelerate electrification of heat 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. Improving local heat supply and demand analysis and coordination to support energy network planning
2. Improving the value and capture of system benefits from heat flexibility
3. Effectively managing peak demand and stability through increased flexibility including over longer periods (multi-day and seasonal)

4. Equitable approaches to reinforcements costs driven by heat electrification including via improving visibility of constraints

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. Improving local heat supply and demand analysis and coordination to support energy network planning	1. Relevant local government entity **and** 2. Organisation with their primary expertise focused on data modelling, machine learning, or advanced statistical approaches **and** 3. a Large Business Consumer of Energy **or** Community Energy Groups – that can provide local energy generation or storage facilities.	1. A third party with skills or capabilities which can supply low carbon heat to multiple buildings.
2. Improving the value and capture of system benefits from heat flexibility		1. Flexibility aggregator.

3. Effectively managing peak demand and stability through increased flexibility including over longer periods [multi-day and seasonal]	1. Organisation with capability in developing and operating thermal storage **or** Community Energy Groups – that can provide local energy generation or storage facilities.	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 **and** 2. Energy Supplier **or** Flexibility aggregator.
4. Equitable approaches to reinforcement costs driven by heat electrification including via improving visibility of constraints	1. A consumer representative group.	1. A third party with skills or capabilities which can supply low-carbon heat to multiple buildings.

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. Research into sustainable energy and relieving fuel poverty in Multi Storey Buildings (MSB)[39]: This is an Network Innovation Allowance (NIA) project that aims to shifting approaches to supplying energy to MSBs and researching alternative approaches to managing fuel poverty, alternative heating and power and managing resident needs and expectations.
2. Heat Pump Ready Programme[40]: Department for Energy Security and Net Zero's programme that aims to develop solutions for high-density domestic heat pump deployment.
3. Project EQUINOX (Equitable Novel Flexibility Exchange)[41]: A Network Innovation Competition project that aims to develop novel commercial arrangements and supporting technologies that unlock flexibility from residential low carbon heating.
4. Heat Balance[42]: A SIF project which examined the commercial and technical feasibility of network flexibility from large-scale thermal energy storage (TES) over multiple timescales.

[39] Research into sustainable energy and relieving fuel poverty in Multi Storey Buildings | ENA Innovation Portal (energynetworks.org)
[40] Heat Pump Ready Programme - GOV.UK (www.gov.uk)
[41] https://www.nationalgrid.co.uk/projects/equinox-equitable-novel-flexibility-exchange
[42] HEAT BALANCE | ENA Innovation Portal (energynetworks.org)

Innovation Challenge 4:
Enabling power-to-gas (P2G) to provide system flexibility and energy network optimisation

Unlocking system benefits and long duration storage potential of Power-to-gas

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

The UK has set an ambitious target of 10GW of low-carbon hydrogen production by 2030[43]. This is ambition is underpinned with programmes of support including the Low Carbon Hydrogen Supply Competition[44] and Net Zero Hydrogen Fund[45]. The Hydrogen Business Model Support Framework[46] has kicked off development on the production and demand side.

The deployment of hydrogen production technologies, such as electrolysers (a power-to-gas technology) also has the potential to offer important system flexibility by acting as a point of controllable demand[47]. Flexibility services are currently provided by gas turbines and batteries, but electrolysers can also be added to this portfolio in the future, given their ability to ramp up quickly in response to control signals. It has been shown that electrolysers can technically fulfil the necessary conditions for grid service by ramping up and down in seconds, with potential to shift load from 10% to 100%[48]. This is important as the UK energy system transitions and integrates more intermittent renewable in line with Net Zero targets.

National Grid ESO's work on the UK's energy system in 2035[49] highlights this critical future role of electrolysers in providing a balancing demand load to use renewables effectively. The system modelling[50] shows that out of a total of 16.8GW of demand reduction across the system during the period of lowest renewable output, electrolysers contribute 9.8GW (c.60%). This highlights the large potential flexibility value that could be delivered by electrolysers to manage a system with high penetration of renewable generation.

[43] https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy
[44] Low Carbon Hydrogen Supply Competition (closed) - GOV.UK (www.gov.uk)
[45] Net Zero Hydrogen Fund strands 1 and 2: Round 2 open to applications - GOV.UK (www.gov.uk)
[46] Hydrogen production business model - GOV.UK (www.gov.uk)
[47] A load which can rapidly increase or decrease the consumption of electricity, known as "ramping"
[48] https://hybalance.eu/wp-content/uploads/2021/12/HyBalance-D7.5-Final-Technical-Performance-Report.pdf
[49] https://www.nationalgrideso.com/document/246851/download
[50] https://www2.nationalgrideso.com/document/277531/download

Another key and unique aspect of electrolyser flexibility is its ability to "vector shift", which is using low cost, constrained or other curtailed electricity to produce green hydrogen. This green hydrogen can then be stored over time and be used as a fuel to generate electricity back via turbines or for other end-use demands such as industry.

The critical enabler for vector shifting and flexible demand operation of the electrolysers is the ability to store the hydrogen effectively, both technically (efficiency, performance, safety etc.) and commercially (cost, viable business models etc.). Hydrogen can be stored underground in caverns over long durations and above ground in pressurised tanks or in solid-state for shorter durations.

This creates an opportunity for providing the system with long-duration (>12 hours) storage services, currently only available through pumped hydro, compressed air and some thermal storage technologies. The need for long-duration storage, and its associated value, are likely to increase as energy systems require greater seasonal balancing in a more weather-driven system[51].

There are several dependencies to unlocking these system value streams, including resolving uncertainty in hydrogen production use cases (off-grid, co-located etc), optimisation of electrolysers and storage locations, effective hydrogen transport, and need for coordination across the hydrogen value chain with energy networks and system operation. Addressing these issues to unlock the system value of green hydrogen production and storage is the key focus area for this challenge.

Aims of this challenge

The 'Enabling power-to-gas (P2G) to provide system flexibility and energy network optimisation' Innovation Challenge aims to:

1. Demonstrate electrolyser and similar technologies' capability for providing system services
2. Increase electrolyser participation in flexibility services
3. Increase consideration of system aspects such as constraints management when siting electrolysers
4. Improved understanding of business models and technical design for long duration hydrogen storage to provide system services

[51] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1095997/benefits-long-duration-electricity-storage.pdf

Innovation Challenge-specific requirements

In addition to meeting the requirements within the SIF Governance Document and licence condition, projects applying to the 'Enabling power-to-gas (P2G) to provide system flexibility and energy network optimisation' 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. Optimising electrolyser deployment and operation to unlock whole system value
2. Commercial and technical innovation to secure system benefits from hydrogen storage deployments

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. Optimising electrolyser deployment and operation to unlock whole system value	1. Operator of hydrogen electrolyser or other green power-to-gas assets connected to the energy networks. **and** 2. Organisations with capability in hydrogen production and use optimisation.	1. Energy network licensee in addition to the project lead. **and** 2. Flexibility aggregator.
2. Commercial and technical innovation to secure system benefits from hydrogen storage deployments	1. Academic partner or Research and Technology Organisation (RTO) with experience in hydrogen storage.	1. Organisation with capability in developing and operating hydrogen storage. **and** 2. Energy network licensee in addition to the project lead.

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. HyBalance[52]: EU Project that demonstrates the use of hydrogen in energy systems. The hydrogen is produced from water electrolysis, enabling the storage of cheap renewable electricity from wind turbines. It can help balance the grid, and the hydrogen is used for clean transportation and in the industrial sector.

2. Hydrogen Production for Thermal Electricity Constraints Management[53]: This is a NIA project led by National Grid ESO investigating the potential for electrolysers to provide constraint management services and suggesting the right market signals to encourage investment in the right areas.

[52] https://hybalance.eu/
[53] https://smarter.energynetworks.org/projects/nia2_ngeso036/