National Grid response to NIC Second National Infrastructure Assessment: Baseline Report

February 2022

Executive Summary

National Grid sits at the heart of Britain's energy system, connecting millions of people and businesses to the energy they use every day. We understand our responsibilities[1] to the environment and future generations, so we are working to develop solutions that enable an effective and secure transition to a clean energy system, in which nobody is left behind.

National Grid is supporting the UK's economic recovery through investing and innovating across strategic infrastructure solutions which support key decarbonisation technologies, such as offshore wind connections, hydrogen, electric vehicles and Carbon Capture, Usage and Storage (CCUS). In combination, these solutions will position the UK as a net zero leader globally, whilst delivering clear benefits locally.

We welcome the opportunity to respond to this call for evidence on the National Infrastructure Commission's (NIC) Second National Infrastructure Assessment (NIA) Baseline Report.

Long-term infrastructure policy and strategic investment at sufficient pace and volume can help address major future challenges such as reaching net zero, adapting to climate change, reducing environmental impacts, and levelling up across regions. Addressing these challenges in a timely, secure, affordable, and fair way will not only maximise environmental benefits from climate change mitigation but will also position the UK as a clean technology leader globally through increased export opportunities and deliver clear benefits locally through inward investment, employment, and supply chain potential.

The transition of our energy system towards net zero will be a critical part of this vast transformation. While progress has already been made, tangible steps need to be taken to stimulate and support the significant levels of infrastructure investment required to achieve economy-wide emissions reduction at the lowest cost to consumers, whilst retaining security of supply and climate change resilience both in transition and at net zero.

In summary, our submission to this inquiry sets out that:

- **We support the strategic themes and challenges identified by the NIC and feel that they broadly represent the most pressing challenges the UK economy will face in the next 30 years.** It is also essential that the challenges cover both the desired end state and the significant period of transition where the need for continuity and security of supply is essential. Furthermore, we have identified a number of cross-cutting issues between the identified challenges which need addressing such as affordability, resources and skills, and data exchange and cyber security.
- **Reaching net zero by 2050 will mean decarbonising the UK's infrastructure. To achieve this, investment at pace is required to bring nascent technologies to market, requiring clear policy decisions and detail.** Specifically**,** clarity on business models is required as soon as possible to enable cost effective private capital investment and therefore rapid at-scale deployment of key low-carbon technologies, including hydrogen, Carbon Capture Usage and Storage (CCUS) and Multi-Purpose Interconnectors. We welcome the recent updates and consultations from Government which broadly support steady progression of these technologies, however, we are now entering a critical phase where speed and coherency are essential for their successful deployment across the UK by mid-2020s.
- **Delivering net zero requires a step change in how industry plans, consents, consults on and constructs infrastructure. But without considerable refresh, current planning policy has the potential to act as a barrier to infrastructure investment at pace.** The draft revised National Policy Statements (NPS) fail to enable delivery of the scale and pace of energy Nationally Significant Infrastructure Projects (NSIPs) required to meet Government's net zero target. For example, whilst the draft NPS does call out the urgent need for new energy

[1] National Grid Responsible Business Charter 2020: https://www.nationalgrid.com/document/134426/download

generating capacity such as offshore wind they should also spell out the critical urgency of enhancing, reinforcing and extending the onshore transmission network to connect this new offshore generation.

- **We need to look at the strategic underpinning issues such as reform of governance and regulation that can set us up for success in delivering net zero infrastructure.** Effective net zero governance with clear roles, responsibilities and accountabilities is essential to stimulate and support the significant levels of infrastructure investment required to achieve decarbonisation at the lowest cost to consumers, whilst retaining security of supply both in transition and at net zero. Making net zero a central priority of the regulatory framework will also ensure the energy transition is delivered in the best interests of consumers and the wider environment.
- **Climate adaptation and energy network investment is critical to ensure the resilience and reliability of all strategic infrastructure across the UK**. By way of example, increases in pluvial flooding, storm events, temperature and water scarcity will all impact the operation of existing energy networks and associated assets. Without sufficient investment to maintain flexibility, availability and resilience, the aging energy network infrastructure may be more likely to fail under the stresses of weather and supply/demand pattern related risks.

The rest of this response provides detailed views on each of the selected questions included in the call for evidence, which are of most relevance to National Grid.

About National Grid

National Grid Group's operations in the UK include: National Grid Electricity Transmission (NGET), which owns the high voltage transmission system in England and Wales; Western Power Distribution (WPD), which owns and operates electricity distribution networks in the Midlands, the South West and Wales; National Grid Gas (NGG), which owns and operates the high pressure gas transmission system in England, Scotland and Wales; National Grid Ventures (NGV), which owns and operates energy businesses in competitive markets, including electricity interconnectors and the Grain LNG storage terminal; and National Grid Electricity System Operator (NGESO), a legally separate business within National Grid Group which balances the supply and demand of electricity in real time across Great Britain.

This consultation response represents the view of the majority of National Grid Group. National Grid Electricity System Operator (NGESO) will be submitting a separate response.

Responses to call for evidence questions

Question 1: Do the nine challenges identified by the Commission cover the most pressing issues that economic infrastructure will face over the next 30 years? If not, what other challenges should the Commission consider?

The nine challenges identified by the NIC are clearly important issues in economic infrastructure development that need to be addressed. In particular, we agree that new networks will be needed for hydrogen and CCS, there is a need for the electricity system to decarbonise at pace to support the Government's ambitious targets, that asset management is critical across sectors and that data and digital have a critical role in delivering net zero.

There are a range of cross-cutting issues that are not addressed explicitly in the challenges. We believe the NIC needs to consider these further given they are likely to be critical to the effective and economic implementation of infrastructure policy:

- **Affordability**: While we recognise that an assessment of affordability is noted in the baseline report, having this as a separate challenge (or at least including it more explicitly in the challenges) is important given the scale of the issues faced and associated cost implications.
- **Local support**: Community benefits should be considered as a means of ensuring that we garner support for new infrastructure from the communities impacted by it. It will be important to understand local needs and work with local authorities to ensure both bottom-up and top-down approaches to infrastructure are utilised.
- **Resources and Skills**: The UK needs to have investment in training/upskilling and be able to attract and retain skilled and capable people as well as supply chain availability (e.g., cable manufacturing and High-Voltage Direct Current (HVDC) equipment), in an increasingly competitive market.
- **Cross-sector optimisation**: There is a need for reform of institutional governance to be considered to enable optimisation to take place between sectors to minimise overall infrastructure requirements. Considering synergies between electricity, methane, heat, hydrogen/CCS, and transport will be important to effectively shape and minimise requirements to manage affordability.
- **Data Exchange and Cyber**: In considering the role of digital, the need for effective data exchange between platforms, data privacy, cyber security impacts etc. must all be considered.

Question 2: What changes to funding policy help address the Commission's nine challenges and what evidence is there to support this?

There is need for clarity on business models to enable and attract timely investment in UK infrastructure required to reach net zero such as hydrogen networks, CCUS transport and storage, multi-purpose interconnectors (MPIs) and Electric Vehicle (EV) charging infrastructure.

Networks for Hydrogen

While the publication of the Government's Hydrogen Strategy was an important signal to the local and international investment community of the UK's commitment to developing a low carbon hydrogen economy, there remains a lack of regulatory and funding models for larger scale hydrogen transport and storage. We need effective business models at the earliest opportunity to unlock private capital for investment in hydrogen to ensure that networks can catalyse the market and be ready for the increase in hydrogen demand. This will support early demonstration of hydrogen across the value chain, which could unlock further innovation and cost reductions – both vital to enabling rapid at-scale deployment of hydrogen.

There is an opportunity with the emerging hydrogen market to think strategically from day one and take forward network and storage activities in a coordinated and integrated manner. This approach, with principles established up front, will drive cost efficiencies, reduce disruption, minimise the risk that early assets are inefficiently sized and allow whole energy system optimisation. This will act as an enabler for the emerging hydrogen economy today whilst allowing optionality to be built out for whatever pathway for hydrogen emerges. See response to Question 11 for more detail.

Transport and Storage for CCUS

CCUS will play a critical role in decarbonising the economy, protecting and creating thousands of skilled jobs, and breathing new life into industrial heartlands. National Grid is an active developer in CCUS and is working with a broad range of energy and industrial companies to develop the world's first net zero industrial cluster through the East Coast Cluster (ECC), which comprises the Zero Carbon Humber and the Net Zero Teesside projects. Now selected in the first two clusters to be taken forward by the Government, the ECC will ensure the UK's leadership in the energy transition and the emerging global low-carbon and hydrogen market and play a major role in levelling up across the country. The cluster will decarbonise almost half of the UK's industrial emissions, whilst delivering more than 25,000 jobs per year by 2050 with an average Gross Value Added (GVA) of £2bn up to 2050.

We welcome the recent updates and consultations from Government which support steady progression of the transport and storage framework. However, we are now entering a critical phase where speed and coherency are essential for the successful deployment of CCUS technologies across the UK by mid-2020s. We are keen to work with Government to accelerate thinking towards the finalisation of agreeable business models and funding mechanisms by mid-2022.

EV charging infrastructure

The Government's commitment of £950m in the last Spending Review, to help with the cost of connecting to the electricity grid and unlock the EV charging market along the Strategic Road Network (SRN) was hugely welcome. It is positive to see progress being made on the deployment of the Rapid Charging Fund to deliver both coordinated and future-proofed electricity network connections to support the uptake of EVs, with the launch of the application website.

We welcome the intention to establish a Delivery Body which will play a pivotal role in governing the funding process, ensuring the £950m is spent efficiently and delivers future-proofed electricity network infrastructure. It is vital however that the Rapid Charging Fund is deployed and utilised to deliver coordinated and future-proofed electricity network infrastructure for all road transport (including HGVs, buses and coaches), and provides consistency in EV charging across the whole of the motorway network. This will ensure the efficient delivery of essential electricity network infrastructure for the long-term, which is crucial to achieving the Government targets and supporting the EV market.

We welcome the work that the Department for Transport is leading on the Zero Emission Road Freight trials. It will be important, however, to ensure sufficient funding is available for trial projects from 2022, when the current funding of £20 million ends, as this will further support the uptake of zero emission road vehicles.

Multi-Purpose Interconnectors (MPIs)

MPIs are subsea cables which can link up clusters of offshore wind (OSW) farms directly to two countries at once, thereby enabling offshore wind and interconnection to work together as a combined asset. By doing so MPIs will support UK and EU efforts to meet 2030 and 2050 OSW targets as well as reduce the impact on coastal communities with fewer individual connections and less construction needed.

Whilst we welcome Ofgem's recognition of the potential role of MPIs in its Decarbonisation Action Plan there is still a need for MPIs to have a route to market and regulatory regime in place to enable a new generation of interconnector to begin connecting large volumes of offshore wind by 2030.

MPIs are being considered within BEIS's Offshore Transmission Network Review (OTNR) and in Ofgem's Interconnector Policy Review. We recommend flexibility in the application of existing legislative and regulatory frameworks to enable the development and delivery of first of a kind MPIs. We are encouraged that Ofgem has indicated that it will open a pilot window for regulatory assessment of MPIs later in 2022 and would welcome certainty of long-term business models as soon as the assessment allows.

Question 3: How can better design, in line with the design principles for national infrastructure, help solve any of the Commission's nine challenges for the next Assessment and what evidence is there to support this?

Good design and application of the design principles can go some way to increasing acceptability of infrastructure proposals, but in some cases, there are blockers to applying the principles to yield the desired outcomes.

Regulatory support for incremental cost of design changes

Regulators need to appropriately consider the needs and desires of both people and places to ensure the application of the design principles yield meaningful changes for those impacted by new infrastructure development. Currently regulators can disallow design decisions which have been made in consultation with communities and used in good faith, if they result in a marginal cost increase to project delivery. This puts organisations delivering infrastructure in a challenging position and potentially leaves them unable to make good design decisions at the initial stages of a project where it could be most effective. Without addressing the regulatory tension between the absolute lowest cost vs. a marginal increased cost to help bring communities with you, it will become increasingly more difficult to deliver infrastructure projects without significant community opposition to the cumulative impacts on the landscape. In electricity infrastructure this is particularly pertinent to visual impact challenges.

A recent example of this in our electricity transmission business (NGET) was the consenting of the Hinkley – Seabank new circuit using an innovative T-Pylon design, which has a lower profile than conventional lattice towers and a smaller ground footprint. The incremental cost of developing and installing the T-Pylon design was disallowed by Ofgem because consumer value for money had not been adequately justified despite support from local councils during Ofgem's consultation on the cost assessment.

Planning and Consents

Targets for electricity sector decarbonisation have been strengthened in recent months. While the design principles talk about extensive community engagement from the very earliest stages, the need to deliver infrastructure quickly in line with these stronger decarbonisation targets must also be given careful consideration. Trade-offs may be required between (i) extensive engagement with communities at all projects phases and in all aspects of design and (ii) more targeted engagement to ensure effective consultation and make progress with limited time and resources.

Climate Adaption

Policies and funding need to support energy resilience and climate resilience for new infrastructure as it is designed and built. This is far easier than retrofitting.

Question 4: What interactions exist between addressing the Commission's nine challenges for the next Assessment and the government's target to halt biodiversity loss by 2030 and implement biodiversity net gain?

There is a need to develop significant amounts of new electricity infrastructure to support the decarbonisation of power by 2035. When developing new electricity routes community sentiment is often that visual impact considerations are paramount and should be minimised and therefore technologies that are either offshore or underground onshore deepen acceptability for our proposals. There is a however potentially a higher environmental, ecological and biodiversity impact of technologies offshore or underground onshore either on a temporary or enduring basis e.g., with regards to habitat disturbance.

Another interaction where biodiversity and net zero come into conflict is around hydrogen production. National Grid recognises the role that both blue and green hydrogen could play in a decarbonised future. Green hydrogen production, while championed for its lower carbon footprint, requires particularly large volumes of clean water which could put added pressure on existing aquatic systems where water abstraction for human use, is already at permitting limits for sustainability.

To meet the objectives of halting biodiversity loss, regulatory bodies need to accept and enshrine this objective within their regulatory price controls and policies. Infrastructure providers also need to strive to this objective through good design and construction practices. We have made net gain commitments, and great strides in this area, as evidenced in the NGET and NGG 2021 Environmental Action Plans[2][3], and the WPD Environment Strategy[4] but continually seek to improve.

Furthermore, emerging opportunities presented by new digital technologies will need to be taken by all sectors. Digital technologies, analytics and big data will help us to understand our impacts on biodiversity better and lessen them. For example, using a satellite-powered Intelligent Sustainability Management System (ICMS) our non-operational land can be monitored by remote sensing technologies, run through an algorithm and the resulting data displayed on a dashboard to enable fast decisions to promote land improvements[5].

Question 5: What are the main opportunities in terms of governance, policy, regulation and market mechanisms that may help solve any of the Commission's nine challenges for the Next Assessment? What are the main barriers?

Transforming our energy system will be a critical part of reaching net zero. While significant progress has already been made in this transition, there is much further to go with the scale of the challenge requiring a step change in innovation and investment and, consequently, a different mindset and approach from Government, its statutory bodies, regulators and industry.

Governance

Effective net zero governance is essential to stimulate and support the significant levels of infrastructure investment required to achieve decarbonisation at the lowest cost to consumers, whilst retaining security of supply both in transition and at net zero. Current governance must be reformed with clear roles, responsibilities and accountabilities established for all parties. There is a need to plan strategically across energy vectors and different sectors of the economy; across central government, devolved administrations and local government; across regulatory regimes and markets; across the skills pipeline and the supply chain and to engage with the public to improve awareness and support for an effective net zero transition and destination.

Currently, there is no single body within the energy system which has overall accountability for providing a holistic and strategic view of how markets and infrastructure should develop over the long-term to achieve Government's net zero goal in the most efficient and secure way. Provided it coordinates industry-wide inputs and views and has the right skills and capabilities, a Future System Operator could potentially fulfil this role, ensuring consistent and coordinated long-term advice and strategic planning across all energy systems, including identifying where investment ahead of need or to support a secure transition is required to deliver overall value for money for all energy consumers.

Government must also collaborate and co-ordinate across a range of actors and sectors to ensure effective alignment with regulatory frameworks and net zero delivery. We recognise that there have been recent examples of positive cross-Whitehall working including the work of the Office for Zero Emissions Vehicles (OZEV) and the OTNR. This co-ordination and collaboration between stakeholders ensure knowledge is shared, issues are identified early, proposals are developed which work across regions and sectors and are implemented quickly and effectively.

Policy

Planning Policy - National Policy Statements update

Delivering net zero requires a step change in how industry plans, consents, consults on and constructs infrastructure, therefore the commitment within the EWP to review and update the energy National Policy Statements (NPS), was most welcome. Whilst the revised draft NPSs make progress on several factors, significant further revision is needed to the current drafting to ensure timely planning, consenting and delivery of energy related Nationally Significant Infrastructure Projects (NSIPs) at the pace required to meet net zero.

The need case for energy NSIPs must be strengthened to reflect the urgency of the Government's decarbonisation targets, the need for new energy infrastructure and to ensure security of supply during the transition. Greater clarity and authority on the need case will ensure planning examinations focus on the impacts of infrastructure, as well as the impact of not investing in infrastructure on security of supply, rather than the principle of development. This will remove the

[2] NGET 2021 Environmental Action Plan - https://www.nationalgrid.com/uk/electricity-transmission/document/136551/download
[3] NGG 2021 Environmental Action Plan - https://www.nationalgridgas.com/document/129571/download
[4] WPD 2021 Environment Strategy - WPD - Environment Strategy Document May 2021.pdf
[5] https://sustainabilitymag.com/diversity-and-inclusion-dandi/national-grid-and-aidash-unveil-tech-meet-net-zero-goals

need for often extensive and detailed debate during the project development phase and ensure that the NSIP regime works effectively and enables timely consenting for major projects.

The NPS should be updated to ensure it is aligned with the latest policy developments. This includes the net zero Strategy, policy on CCUS and hydrogen, and emerging policy on a Holistic Network Design (HND) and co-ordinated offshore transmission from the OTNR. Clarity is needed on how these will, or should be considered by promoters, stakeholders, examining authorities and decisions makers involved in the development and delivery of NSIPs.

Development Consent Order (DCO) reform

There is also a need to reform the DCO process to support delivery of infrastructure required to enable the transition. It is critical to align the planning and regulatory approvals processes, ensuring earlier agreement between Ofgem and Government on the right schemes to achieve net zero and maintain security of supply. Most notably there is misalignment between the current process to obtain a DCO planning permission and Ofgem's Large Onshore Transmission Investments (LOTI) process which is the second step after the initial recommendations for electricity transmission network infrastructure is determined through the Network Options Assessment (NOA), performed by the Electricity System Operator. This creates uncertainty and risks delay to these projects to the detriment of consumers and net zero.

Regulation

The energy system sits at the heart of the transition to net zero, but the country's current energy system was not designed for a net zero age. This will be a time where whole system considerations will be critical to optimise decision making, power will be dominated by more variable and less predictable renewable sources, demand for electricity at a household level will rise and the market will become more fragmented and decentralised as new stakeholders, technologies and business models enter the system. At the same time, climate change will place an increasing burden on the resilience of our energy networks, requiring significant investment to adapt networks and ensure security of supply.

Key to this will be ensuring the regulatory regime enables efficient investment and innovation in net zero technologies at pace. Regulatory support is therefore needed to provide early certainty to the supply chain to allow for innovation and efficiency in technology and delivery. A prime example is the effort to coordinate offshore wind connections in the North Sea to the East Coast, where regulatory clarity is vital to support innovation and delivery of the vast volumes of cable technology required to support the net zero infrastructure in the region.

Appropriate independent economic regulation, which is clear, stable and forward-looking will also be vital to achieving the UK's net zero target, as well as ensuring that the UK is seen as a positive destination for inward investment. Ofgem has an important role in supporting decarbonisation throughout the energy supply chain, from production, to transportation (via existing and new networks) through to end use by consumers in homes and businesses. Ofgem's role, responsibilities and duties will need to evolve to reflect this. To improve alignment between policy outcomes set out by Government, we support the recommendation by the NIC for the strengthening of Ofgem's statutory duties to explicitly support the delivery of the legally binding net zero target. This clarification of statutory duties, alongside the proposed Strategy and Policy Statement (SPS), as set out in the Energy White Paper (EWP), would help ensure that Ofgem has due consideration of the need to serve consumers through supporting efficient, timely delivery of investment to help meet decarbonisation targets through a fair and just transition whilst maintaining security of supply.

Beyond this, further reform of the regulatory framework is needed to:

- Refresh the licensing regime to enable, and not form a barrier to entry for, new technologies and business models that will be central to achieving net zero, for example, storage, hydrogen and CCS, whilst maintaining appropriate levels of checks and balances.
- Shape the evolution of the energy market mechanisms – holistically across retail, wholesale, balancing markets and the Capacity Market / Contract for Difference – so they are fit for purpose and encourage and support the transition to net zero in a fair and just way (see further 'Market Mechanisms' below).

Market mechanisms

Existing market mechanisms (e.g. Contract for Differences) have proved highly successful in securing investment in renewable technologies since they were introduced, but as the energy system increases its reliance on renewable technologies, consideration should be given as to whether those existing mechanisms remain fit for purpose, or if changes need to be considered that better serve the next phase of the transition. Energy markets must be designed to encourage investment in further innovation and in immature technologies that will facilitate the transition. Any review must be done holistically, taking into account all parts of the energy markets (i.e. wholesale, retail and balancing).

Question 8: What are the greatest risks to security of supply in a decarbonised power system that meets government ambition for 2035 and what solutions exist to mitigate these risks?

As indicated by the NIC's "*Anticipate, React, Recover – Resilient Infrastructure Systems*" report, resilience is a growing concern for a modern society which is reliant on technology and energy. If we are to maintain an acceptable level of resilience and ensure any societal disruption is mitigated, even for exceptional events, it will be important for both regulatory frameworks and government policy to align on the need and funding requirements to ensure sufficient resilience is built into the increasingly complex infrastructure systems which rely on communications and energy to work.

Our transmission networks are extremely resilient and reliable. Robust design and operation standards help ensure security of supply while strategies are in place to adapt to climate change risks on infrastructure assets. However, the criticality of electricity to society out to 2050, where over 30% of UK citizens will likely have electricity as their only source of energy, will mean that any loss of electricity supply will have a much greater impact[6]. This shift in criticality, together with climate adaption means we need to closely examine the resilience of our electricity system and not assume that current engineering and characteristics of the network will be fit for purpose between now and 2050.

As such, we are alert to the potential risks associated with the transition to a decarbonised power system and subsequent challenges for future supply security and network resilience. We have identified a non-exhaustive list of potential risks and solutions:

Risks to Security of Supply

Network infrastructure update and transition

- The transition to net zero is expected to generate an unprecedented volume of work for the energy sector. This will impact operation and maintenance of networks as infrastructure improvement and enhancement works take place e.g., with circuits or parts of substations out of service to connect new assets, asset health delivery to ensure reliability of rotating machinery etc. System access will need to be managed carefully so as not to deplete the network and impact security of supply, whilst still meeting the needs of ambitious construction and maintenance programmes.
- A growth in skills and capability in the industry and supply chain will be needed to maintain standards of engineering design, project management and operation. Capability will need to evolve to recognise and respond to the energy transition, the repurposing of assets and impact of climate change.
- As the transmission network grows and becomes more reliant on computer systems for its operation, the risk of terrorism and malicious attack through cyber-attack also becomes an increasing threat and therefore increased investment is required to maintain a secure and resilient network.

Climate adaptation

- As we decarbonise our energy system, electricity generation will continue to rely on gas as a key component (abated from 2035) of the GB generation mix. It is therefore paramount that the reliance on gas-fired generation and mitigation of impacts of climatic change on the Gas transmission system are equally considered on the transition to net zero.
- External analysis shows a threefold increase in significant events between 1980 and 2019. An increase in fluvial and pluvial flooding and storm events will increase the risk to loss of supply by damaging energy assets and affecting above and below ground infrastructure.
- Gradual climate changes such as increases in temperature and water scarcity, will impact operational ratings of electrical circuits, operational risks to gas compressors, renewable generation patterns, solar production and the requirement for nuclear and gas generators during the transition. An example would be that vegetation will grow faster in a warmer and wetter climate and strategies will need to evolve to avoid overhead line clearance or above and below ground infrastructure infringement and obscuration of gas pipeline marker posts which increases the likelihood of third-party infringement.
- Without sufficient investment to maintain and enhance resilience, aging energy network infrastructure may be more prone to higher levels of failure under the stresses of weather-related risk.

System interdependencies

- As electricity demand grows through adoption of technology such as EVs and heat pumps, the whole energy system will grow in complexity and interdependency.
- To ensure resilient networks we will need to improve how we collaborate across the whole energy system and understand interdependencies better, including with other sectors such as telecoms.
- There will be more touchpoints and stakeholders to consider when managing security of supply. Incidents and interdependencies will need to be well defined to ensure network/asset resilience.

Network evolution

[6] National Grid ESO – July 2021 Future Energy Scenarios: https://www.nationalgrideso.com/document/199871/download

The journey towards net zero will transform the characteristics of the energy system, including:

- Changes to new generator technologies such as invertor-based generation resources and high penetration of renewables will impact system inertia which is fundamental to power system balancing.
- Changing energy demand will increase current in our overhead power lines, which presents an indirect risk to other energy infrastructure. For example, buried steel transmission pipelines are at risk of induced AC corrosion where they traverse overhead power lines, which accelerates the deterioration of the pipeline.
- More volatility in the requirement for natural gas as the level of renewable generation increases the need for gas fired generation to support intermittency as will the resulting response requirement from gas infrastructure assets.
- In the transition the interaction between the gas and electricity systems will likely grow and place greater load on the available, but aging, assets that will be required to respond more quickly to peak load and drops in renewable output.
- Complexity in system operation will increase with distributed energy resources, such as community energy schemes, reducing visibility and control.
- There will be a need for more electrical storage, including inter-seasonal energy storage at scale.
- Changes to protection, due to lower short circuit infeed and the quality of electricity (e.g., network harmonics created by complex control systems) will need to be considered.
- Repurposing the gas network to a hydrogen network
- Changing gas flows, with the forecast reduction in gas flows from UKCS needing to balance with increased supply from other entry points into the GB market (LNG importation terminals and EU interconnectors). This will require timely investment to transport the flows to centres of demand without creating entry constraints. Security of supply will also need to be ensured by maintaining secure pressures and appropriate levels of capability of the National Transmission System (NTS).

Geo-political instability

- Whilst not unique to a decarbonised network the impacts of fuel interruption, pan-European demand and critical network failure points could create significant risk for networks.
- The move to less indigenous gas supply and more reliance on LNG and EU interconnector flows means that the GB market will be even more linked to the global gas market, therefore requiring more engagement across EU and the world to ensure security of supply during the transition including the potential for additional investment in GB- based long duration/strategic storage.

Solutions for ensuring security of supply.

Beyond the robust design and operation standards which maintain the resilience and reliability of the transmission networks, further action to address the risks associated with a decarbonising power system are:

Network infrastructure update and transition **- Regulation and investment:** Energy networks will need significant investment and regulation change to allow the whole energy system to respond to the challenges set by government for 2035 and out to 2050. Security of supply standards and design will be reviewed to ensure they meet the needs of the future consumer. Regulation needs to recognise the whole energy system implications of decarbonising the power system as it is only through this recognition that resilience will be maintained.

Climate adaptation - **Long term forecasting:** National Grid has developed tools to understand the impact of climate change and uses this information to help inform an asset management strategy. As our modelling capability improves, we can embed climate change adaptation in our asset management strategies so that climate-risk is a key consideration in asset health investment decisions. Long term planning, understanding of future topologies and whole system network modelling allows for timely investment to ensure the networks remain robust and investment is well-targeted.

System interdependencies - **Resilience strategies:** National Grid is developing and adopting organisation-wide resilience framework to ensure the capability is in place to retain high levels of resilience. The framework allows the business to plan, respond and recover and adapt from unusual events and prevent future scenarios by ensuring the right level of forward planning and investment. Cross sector collaboration is important as part of this work, to ensure a whole system and end to end approach protects consumers from loss of supply.

Network evolution - **Technology and innovation:** The changing nature of the energy system requires new and innovative technology. As an example, synthetic inertia (designed to replace the effect of CCGT motive force from turbines) is being developed to manage low inertia on the network and overhead line conductors are being developed with double the current carrying capacity of those currently in use. This will ultimately allow more demand to be transported around the network. The development of digital twin technology will allow a digital replica to stress test the whole energy system and will better enable us to protect security of supply impact through thoughtful and informed investment and mitigation measures. Hydrogen also presents a future option for meeting the UK's inter-seasonal energy storage needs at scale, with a hydrogen network being a key enabler to this.

Q9: What evidence do you have on the barriers to converting the existing gas grid to hydrogen, installing heat pumps in different types of properties, or rolling out low carbon heat networks? What are the potential solutions to these barriers?

With regards to converting the existing gas grid to hydrogen, research to date both in the UK and abroad[7][8] suggests that converting existing natural gas transmission infrastructure to hydrogen is possible. National Grid Gas is now running a full technical study to explore the capability of converting the NTS to transport hydrogen and devising how to deliver hydrogen networks most efficiently and overcome any barriers (see Question 11 below). The most cost-efficient way to deliver a hydrogen backbone is through the phased repurposing of existing natural gas assets rather than building new, dedicated hydrogen pipes[9]. Efficient sequencing of the transition of this backbone is critical to allowing parts of the natural gas infrastructure to be freed up for the transportation of hydrogen whilst maintaining security of natural gas supply.

Question 11: What barriers exist to the long-term growth of the hydrogen sector beyond 2030 and how can they be overcome? Are any parts of the value chain (production, storage, transportation) more challenging than others and if so why?

As highlighted in answer to Q2 hydrogen has the potential to help the UK to become a world-leading net zero economy, exporting low-carbon energy solutions in a global market and creating UK employment and supply chain potential.

National Grid is supporting the development of a UK hydrogen economy through its innovation projects. For example, our Project Union is exploring the development of a UK hydrogen backbone which aims to join industrial clusters around the country, potentially creating a 2000km hydrogen network. This would repurpose around 25% of the current gas transmission pipelines. Furthermore, our FutureGrid project[10] will help us demonstrate the safety case and any modifications required to transport up to 100% hydrogen in the NTS.

Focus is now needed on unlocking private capital for investment in hydrogen by launching business models at the earliest opportunity to allow networks to play their role in early unlocking of the UK wide hydrogen market, promoting the confidence of early movers, to maintain the trajectory to the end state goal. The distinct lack of business models for large and 'medium' transport and storage hydrogen networks risks deployment of CCUS ahead of hydrogen and therefore could be a missed opportunity for dual development which would reduce costs for consumers.

The Government has signalled that beyond 2030, a steep ramp up in growth of a hydrogen economy is expected to meet 2050 projections. Given the long lead time associated with constructing shared network assets, and the most efficient solution being phased repurposing of existing natural gas assets, the work underway today needs to continue at pace if conversion is to begin in 2026 to ensure the potential for a backbone network to be in place by mid 2030s. An appropriate regulatory regime that allows for investment in hydrogen is therefore needed before 2030, with a clear roadmap of ongoing regulatory commitments beyond 2030. Equally the impact of repurposing towards hydrogen on the remaining natural gas network needs to be considered and where necessary efficient/economic solutions may need to be implemented to ensure the safe and secure operation of the natural gas network during the transition period.

Question 12: What are the main barriers to delivering the carbon capture and storage networks required to support the transition to a net zero economy? What are the solutions to overcoming these barriers?

As outlined in answer to Q2, we welcome the recent updates and consultations from Government but now need the finalisation of agreeable business models by mid-2022. Moreover, we have urged Government to scale up ambition and provide clarity on funding mechanisms for the timely development of CCUS transport and storage infrastructure. A further need is for suitable national planning policy statements that support "rightsizing" and anticipatory routeing of new infrastructure to facilitate connection of future emitters without need for further infrastructure investment.

Question 13: In what ways will current asset management practice need to improve to support better infrastructure resilience? Your response can cover any number of the Commission's sectors.

Our response to Q8 provides some ways in which we are supporting better infrastructure resilience of our assets. Further improvements to asset management which will be needed include:

[7] European backbone report: https://gasforclimate2050.eu/wp-content/uploads/2020/07/2020_European-Hydrogen-Backbone_Report.pdf
[8] Carbon Limits Re-stream study: https://www.carbonlimits.no/project/re-stream-reuse-of-oil-and-gas-infrastructure-to-transport-hydrogen-and-co2-in-europe/
[9] ACER Transporting Pure Hydrogen by Repurposing Existing Gas Infrastructure: Overview of existing studies and reflections on the conditions for repurposing:
[10] FutureGrid programme: https://www.nationalgrid.com/uk/gas-transmission/document/133841/download

- Resilience will need to be baked into future decision making to ensure that assets remain robust. As an example, assets will need to withstand higher temperatures in the future and be sited away from sites that may flood due to climate adaption. This may require building to a higher capability to account for resilience, as well as improved modelling to manage and mitigate asset-specific climate risk.
- Technologies will need to be sustainable and reduce carbon footprints. Harmful gas, such as sulphur hexafluoride (SF6), will need to be removed as far as possible from assets.
- Real time monitoring and use of digital twins will be needed to understand how assets are performing in real time to maximise asset availability and life.
- Engineering standards will need to be reviewed to reflect high asset utilisation and a reduction in the UK maintenance period. This is needed to protect demand as well as asset life.
- Greater dependence on electricity means consideration needs to be given to investment and maintenance in the variety of electricity generation we need to ensure we have a secure, reliable and efficient means of supply through the transition as well as at end state.

There are important opportunities that can be taken to enhance the protection and planning of our energy networks:

- Make National Grid a statutory consultee in the planning process where its infrastructure is affected, so that critical networks are properly protected.
- Update the National Planning Policy Framework (NPPF) to include a clear presumption in favour of the protection and enhancement of energy networks to connect the increasing number of new sources of low carbon and green energy. And update the Planning Practice Guidance to explain the purpose and effect of the policies.
- Amendments to the NPPF should reflect the Energy NPS under which DCO applications for NSIPs are considered.
- Ensure that national design advice includes best practice advice in relation to planning development affected by proximity to national energy networks to protect energy network infrastructure.
- In accordance with the guidance set out within the IAM Climate Emergency Action Plan document, we aim to develop robust climate change adaptation plans. This will delineate clear accountabilities for effective management of climate-risk, encompassing asset-health level assessment and extending to the wider business risk. An adaptation plan will also better enable our alignment to Taskforce on Climate-Related Financial Disclosures (TCFD) recommendations.

Question 17: What are the barriers to a decision-making framework on interurban transport that reflects a balanced approach across different transport modes?

Government is already leading the way on decarbonising road transport by ensuring infrastructure is in place, as demonstrated through the establishment of Project Rapid, including a rapid charging fund of £950m to support the full roll out of EV charging infrastructure along the Strategic Road Network (SRN) by 2035.

To deliver decarbonised HGVs, industry has highlighted several technology routes, including batteries, hydrogen powered fuel cells and overhead line catenary[11]. Trials to test and prove these technologies are welcome, but it is essential to address the wider implication on electricity network capacity along the SRN, which is required for any technology solution.

Recent analysis by Element Energy identified that HGV charging will double the power demand required for full EV rollout at Motorway Service Areas (MSAs). The same applies with overhead catenary and onsite electrolysis for fuel cell HGVs. These are factors to be considered while developing electricity infrastructure solutions to enable future-proofed charging or refuelling at MSAs along the SRN. Government should expand the remit of Project Rapid or launch an associated strategy to ensure the delivery of future proofed electricity network infrastructure for all road transport modes along the SRN. This represents a no regrets, cost-effective intervention as electricity infrastructure will be required regardless of the end technology.

Beyond MSAs, the recent Transport Decarbonisation Plan highlighted the need for multi-modal, place-based infrastructure solutions to emission reductions, particularly for freight. We agree and believe that bringing multiple transport types together at a shared interface location would make more efficient use of energy infrastructure as power is brought to key places to meet the demand for the hub. It will be important to ensure that there is infrastructure consistency across the UK, including devolved areas.

We would recommend Government act as a convener to ensure coordination of key industry participants and encourage data sharing across organisations to fully understand the potential demand and required energy solutions for hubs.

[11] a system of overhead wires used to supply electricity to a locomotive, tram, or light rail vehicle that is equipped with an apparatus mounted on the roof to collect power through contact with said overhead line