Energy Sector Resilience position paper

Executive summary

Strengthening the resilience and security of critical national infrastructure, such as the electricity generation, transmission and distribution system, is a key priority for the Government. As the UK progresses towards its Net Zero targets there will be changes to the energy supply mix and demand. Attempting to achieve this transition without the appropriate strategy in place could prove costly for the UK; a brittle infrastructure can induce a negative chain reaction throughout the wider system. To create resilience, there needs to be a technical understanding of the issues, processes, and interdependencies when assessing risks with a whole-system engineering perspective informing decisions.

Cyber, geopolitical, and Net Zero developments mean that investment in resilience and mitigation planning is vital for the UK's economic security. An increased commitment to renewable sources of energy without a joined up public awareness campaign around demand and natural phenomena risks lowering our resilience having an impact across the country. For example, the UK's electricity supply underpins all other sectors, including healthcare, finance and transport. Therefore, threats to the national grid would compound several severe impacts, disrupting supply chains and the delivery of financial and public services.

With government budgets strained departments are tasked with balancing of efficiencies and expenditure, the Government must build system resilience into that equation. However, investment in one area does not necessarily mean resilience across the entire system. Developing resilient and stable complex systems will play an increasingly important part in people's lives. With the right investment in system resilience and skills, the Government can protect the critical national infrastructure systems on which our economy and lives depend. (Source: IET, Spending Review 2025)

Recommendations

1. **Skills to aid the electricity system** (Source: IET, Invest 2035 in the UK modern industrial strategy)

Changes to the UK's power system need to happen at a scale and pace that will significantly challenge the planning and operation of an economic and secure electricity system. Extreme care needs to be taken as the UK transitions away from gas to ensure that the UK doesn't become dependent on importing gas from other nations to account for shortfalls.

As the UK pursues its Net Zero targets, it will be pivotal to appropriately invest in upskilling and reskilling the current workforce to be able to manage the newer energy infrastructures. In the IET's 2025 skills survey highlighted that more than a third (36%) of engineering employers do not feel their organisation has the skills needed to decarbonise by 2050, technical/ specialist sustainability skills/ knowledge are considered the most necessary skills to decarbonise by 2050 (39%), and are also cited as the top necessary decarbonisation skill missing (35%). Introducing new technologies (39%) upskilling/ reskilling existing employees (36%) and hiring new employees with those skills in the UK (34%) are the most cited responses to demand for decarbonisation skills (Source: IET, 2025 UK Engineering and Technology skills survey).

2. **Grid infrastructure**

The fundamental operation of power systems relies on the balance of generation with demand. Mismatches cause the grid frequency to change, and generation will need to compensate accordingly. Power outages can have widespread and serious consequences for individuals and society. Fortunately, there are very few major grid events, but despite removing the risk entirely being impossible, they can be reduced through engineering design and operation.

The duration, geography, and affected sectors all contribute to the social and economic cost of an electricity blackout; estimates suggest that a nationwide blackout lasting 24 hours could cost billions of pounds, loss of life and potential civil unrest. Research found that the UK economy suffered a loss of £17.6 billion in economic output between 2023 and 2024 due to connectivity outages, with the average UK business losing over £11,000 in economic output (source: Vorboss, Reliability and compensation report: the impact of poor business fibre connectivity). Power outages could hit services across the economy, therefore strangling growth and has huge social knock-on effects to regional economies.

The design of the underfrequency load shedding (UFLS)[1] scheme needs to consider the characteristics of the grid system. Over the last 30 years there have been substantial changes in the British grid, with less rotating power plant and more inverter connected plant including interconnectors, solar photovoltaics (PV), and wind. The reduction in gas and coal power means less mechanical grid inertia, However, inertia can still be present with: solar, wind, and battery power, this is often referred to as 'synthetic inertia'. This can provide fast frequency response which mimics the stored energy characteristic of rotating plant by using electronic sensors to increase the power output of the inverter connected plant Ultimately, as quantity of renewables on the system increases, the more 'synthetic inertia' will need to be produced. This can be done through grid forming inverters (which are part of the grid code now), advanced control algorithms (AI), and energy reserves, (batteries or Hydrogen).

With an increase in the number of devices connected by digital networks (Source: DCMS committee, Connected tech: smart or sinister?) including in energy infrastructure, the grid is exposed to new risks. Misinformation can be a tool of cyber attackers aiming to disrupt grid operations. AI-driven malicious misinformation campaigns could mislead operators or automated systems, causing disruptions and outages. An AI system manipulated by false data could also open vulnerabilities that hackers could exploit, such as misleading data analysis and faulty decision making, potentially impacting on critical infrastructure like the electricity system.

3. Renewables, storage, flexibility and interconnection

A wider mix of renewable energy sources reduce vulnerability to single-weather events. When one source underperforms, for example low wind, others, like solar, can compensate. Resilience planning needs to go beyond "average" weather scenarios and account for rare but severe events, such as multi-day cold snaps with little wind, that go beyond 'typical' daily fluctuations.

The Government must be cautious that incorporating major grid restructuring does not initially negatively impact the stability of the grid. Some articles have speculated the impact of large volumes of renewables, particularly solar PV panels contributed to the Iberian power outage.

[1] A critical emergency mechanism in power systems designed to prevent a total system collapse by automatically disconnecting ("shedding") portions of the electrical load when the system frequency drops too low.

Building more interconnectors to neighbouring countries helps the UK import/export electricity during extreme weather, smoothing out local shortfalls or surpluses. The UK is susceptible to other nations wanting to buy electricity from them, therefore, if neighbouring countries are experiencing the same extreme weather, the UK's interconnector systems are less effective. Energy storage systems, such as batteries, and flexible demand responses are essential to quickly adapting to sudden drops or surges in renewable generation caused by weather changes. The Government needs to focus on developing true long-term storage, not just daily or hourly, but seasonal or annual storage. As this technology does not exist yet, it offers a huge opportunity for the UK to be a world-leader in energy storage. (Source: NIC, Study highlights opportunities for interconnection and diverse renewables mix to build resilience of UK energy networks to weather changes)

The Iberian grid outage will provide important lessons to be learned. Subsequent management in terms of minimising impact as well as grid restoration (bringing a power grid back online after a complete or partial shutdown) is also important. Whilst awaiting the outcome of ENTSO-e investigation, grid operators would be wise to ensure they are well positioned if such an event were to occur to them.

Considering the Iberian grid outage, and the importance of cybersecurity and a resilient grid, it would be beneficial to 'virtually rehearse' cyberattacks or major outages to assess how prepared organisations are for such events. Whilst we acknowledge that many organisations prepare for cyber-attacks through a virtual cyber tabletop approach, it would be valuable to ensure that preparations also happen at a system of systems level with multiple businesses. The importance of preparation for major events will only enhance infrastructure resilience.

4. Gas resilience

Government should look to make the North Sea their primary resource for importing gas. In 2024, the UK took just 33.8% of gas from British North Sea reserves, importing 50.2% from Norway, 11% from the USA, and 5% from other nations. (Source: Sunsave energy, Where does the UK get its gas from?, 2025) Not only will the gas infrastructure be more resilient through increased importation of gas from the North Sea other factors will also improve, such as:

Cleaner Gas:

- North Sea gas has a lower carbon intensity (21 kg CO2/boe) compared to liquified natural gas (LNG) imports (79 kg CO2/boe), making it a better option for achieving the UK's Net Zero goals. (Source: North Sea Transmission Authority, North Sea gas is almost four times cleaner than LNG imports, 2023)
- A greater reliance on North Sea gas would align with the UK's climate targets by supporting domestic, cleaner energy production.

Energy Security:

- Sourcing gas domestically would reduce the UK's vulnerability to unpredictable international forces and hostile states, enhancing energy security. (Source: Prime Ministers Office, New opportunities for North Sea oil and gas, 2023)

Economic Benefits:

- The UK's oil and gas industry supports over 200,000 jobs and contributes significantly to the economy annually. (Source: Prime Ministers Office, New opportunities for North Sea oil and gas, 2023)

5. Nuclear

Nuclear infrastructure, both large and small, can play an important role in developing a secure, affordable and sustainable energy system for 2030 and beyond providing “available” balancing through rotating inertia.

To meet our net zero ambitions and build a resilient system we must significantly scale up electricity generation by two to three times current levels. Large-scale projects like Sizewell C and the Small Modular Reactor (SMR) programme can significantly contribute to this. The £14.2 billion of funding for the development of Sizewell C, alongside the selection of Rolls-Royce SMR as the preferred bidder to develop the UK’s first SMR, marks an important step towards nuclear playing a significant role in the UK’s energy mix. However, the Government must also take a whole-system view of the wider energy system to ensure new nuclear infrastructure compliments other energy generation and distribution resources currently deployed and being developed.

The clarification of roles between Great British Energy and Great British Energy – Nuclear, with NESO overseeing the critical upgrades to our national electricity infrastructure is welcomed. These upgrades are vital and must be properly funded, not treated as an afterthought.

6. Delivering Investment and Innovation for the energy transition

It is integral that government plan to deliver long term resilience by prioritising forward thinking and innovative approaches, this can be done by cross-departmental and cross-sectoral collaboration. To support Net Zero targets, the Government should explore where Ofgem can have a wider role in promoting innovation and reducing barriers to it. They should also review the energy system regulation legislation and remove inhibitors to small-scale local energy systems. Ofgem should proactively sharing successful innovations with other operators. (Source: IET, IET response to the Call for Evidence to Review Ofgem)

The recently announced Cyber Growth Action Plan, including the £16 million of new funding to boost jobs and innovation, is a welcome start to bolstering the UK’s resilience to cybersecurity attacks. This will ensure that more Small-Medium Enterprises (SMEs) receive the opportunities and ecosystem to grow into scaleups, by providing specialist managerial, sectoral and technical skills and knowledge. This can lead to a huge boost for the UK economy, with a sustained positive impact on jobs, local economies and skills development.

7. Changing Geo-political climate

Recent geopolitical events have created global uncertainty and instability in global supply chains. Where industries of the past have been closed the UK should be moving at speed to secure expertise and independence on the industries of the future. Ensuring resilience and security of supply will have a cost premium compared with supply via the international markets. As Russia’s invasion of Ukraine helped demonstrate, a lack of planned resilience can result in much higher costs in the medium to long term. (Source:IET, Invest 2035 in the UK modern industrial strategy)

8. Building resilience through digital

Digital technologies can help bolster resilience across a range of sectors by providing a greater insight into scenario modelling and provide insightful data analytics to help inform decision making. However, as with any other technology, it can also pose its own risks, and it is important to be aware of vulnerabilities that digital technologies may introduce to a system of systems.

Energy infrastructure outages can have widespread and serious consequences for both individuals and society. The risk of energy infrastructure failing due to AI misinformation or cyber security attacks can be quite significant. With an increase in the number of devices

connected by digital networks, including in energy infrastructure, it exposes the grid to new risks. Misinformation can be a tool of cyber attackers aiming to disrupt grid operations. AI-driven malicious misinformation campaigns could mislead operators or automated systems, causing disruptions and outages. An AI system manipulated by false data could also open vulnerabilities that hackers could exploit, such as misleading data analysis and faulty decision making.

In order to minimise this risk, it is imperative to develop a better, broader definition of safety and risks of AI tools, this will also help AI developers ensure their product is safe and fit for purpose before going to market. This will lead to robust and transparent AI systems that are subject to comprehensive ongoing validation and verification processes (Source: IET, Spending Review 2025). There should also be effective cybersecurity measures to protect AI systems from manipulation. Communicating the potential threats and risks around AI will increase awareness, develop competence, and create the correct cyber security culture within an organisation. This will make the UK a leader in AI safety.

Reskilling and upskilling are critical to ensuring robust cyber resilience on a day-to-day basis. A cyber cultural change needs to be encouraged through greater learning and cyber awareness, to ensure that the UK is protected from the increasing threat of cyber-attacks. According to the latest IET Skills Survey one of the most important digital skills that employers ranked highly for growth is cyber security (38%), however cyber security is also the digital skill that employers find the most difficult to recruit for (17%) (Source: IET, 2025 UK Engineering and Technology skills survey).

The use of digital twins, using a combination of technologies, can also help support greater resilience across sectors. A digital twin is a “virtual model of an object, a system, or a process. It is connected to its real-world counterpart by a 2-way flow of right-time data, meaning it mimics it in all aspects.” (Source: What a digital twin is and how you can contribute, GOV.UK, 2024). They are widely used across different sectors to test decisions before they are made and understand how different actions might affect the real world. Digital twins can predict and model scenarios to help build resilience into national infrastructure, however, there is often a lack of clarity about what a digital twin is with products being mislabelled as such. It is important to ensure clear labelling and expertise to ensure that it is fit for purpose and a good use of investment.

One such example of where digital twins would support greater resilience is in the Public Switched Telephone Network (PSTN) switchover. The resilience of the digital infrastructure networks is becoming increasingly important for keeping people connected. In 2017, the telecoms industry announced its intention to retire analogue telephone networks. Most customers are expected to have made the switch by the end of January 2027 (Source: UK transition from analogue to digital landlines, GOV.UK). However, a number of systems rely on analogue signals, which makes transition more complex, such as CCTV cameras, payment machines and alarms. This is an ideal opportunity to run a virtual switchover scenario across sectors to outline potential impacts and mitigate in advance to build greater resilience.

Conclusion

Resilience is integral to a long-lasting, strong infrastructure, and should be strongly considered when digitising and transforming the energy developments as it ensures longevity.

Due to the magnitude of upcoming changes to the energy infrastructure, there will be changes to the energy supply mix and demand. Attempting to achieve this without strengthening the resilience and security of the infrastructure could prove costly for the UK. A brittle infrastructure can induce a negative chain reaction throughout the wider system.

If implemented and adopted appropriately, digitalisation can bolster resilience across a multitude of sectors by providing greater insight into scenario modelling, operability and data. For example, digital twins are able to predict and model scenarios to help build resilience into national infrastructure.