

Nuclear Industry Association Response to the House of Lords Environment and Climate Change Committee's 'Dunkelflaute and the Risks of Electricity Intermittency' Inquiry

The Nuclear Industry Association welcomes the opportunity to respond to the House of Lords Environment and Climate Change Committee's 'Dunkelflaute and the risks of electricity intermittency' inquiry.

The NIA is the trade association and representative body for the civil nuclear industry in the UK. We represent more than 340 companies operating across all aspects of the nuclear fuel cycle, including the current and prospective operators of nuclear power stations, international designers, and vendors of nuclear power stations, and those engaged in decommissioning, waste management and nuclear liabilities management. Members also include nuclear equipment suppliers, engineering and construction firms, nuclear research organisations, and legal, financial and consultancy companies.

Executive summary

Expansion of nuclear baseload power in the UK electricity mix is the simplest and most effective way to strengthen the resilience of the grid to Dunkelflaute (simultaneous low wind and solar generation) and Hellbrise (simultaneous surge in solar and wind power generation) conditions and protect consumers from resulting price fluctuations. Nuclear is the only clean energy technology capable of providing 24/7 domestically produced power, regardless of the weather.

Renewable and nuclear technologies both play an important role in decarbonising the UK electricity system in pursuit of Net Zero by 2050, however, only through sufficient nuclear deployment can this goal be achieved with energy security and strong economic growth. According to the United Nations Economic Commission for Europe (UNECE), nuclear has the lowest land use, lowest ecosystem impact and the lowest lifecycle carbon of all generating technologies at 5.1-6,4g CO₂/kWh.¹ Nuclear provides reliable baseload power which reduces grid balancing costs for consumers, provides inertia to the grid, and requires less transmission infrastructure investment than renewables. Despite these known benefits, clean baseload power from nuclear only accounted for 12.2% of generation in 2025, with renewable sources accounting for 52.1%.²

The reliance on majority variable renewable energy (VRE) in the electricity mix leaves the grid vulnerable to Dunkelflaute conditions, and as a result, consumers vulnerable to spikes in electricity prices. To address demand-supply gaps during low renewable

¹ United Nations Economic Commission for Europe (2022) *Carbon Neutrality in the UNECE Region: Integrated Life-cycle Assessment of Electricity Sources*. Available at https://unece.org/sites/default/files/2022-04/LCA_3_FINAL%20March%202022.pdf

² DESNZ (2026) Digest of UK Energy Statistics — Annual Data for UK, 2025. Available at: https://assets.publishing.service.gov.uk/media/6aba9601a9c3d267bccceff7/DUKES_2026_Chapters_1-7.pdf

generation, gas power stations are paid to sit idle or at very low load factors to stay available for grid balancing purposes. To make up for the cost of maintaining these power stations, gas plant operators can charge a lot when increasing production to meet demand, with prices regularly reaching near £1000/MWh.³ Emergency imports from neighbouring countries can similarly contribute to spikes in electricity prices. Increasing the proportion of predictable, domestically produced baseload power from nuclear would significantly minimise the risks and costs associated with Dunkelflaute conditions.

This would simultaneously address the risks and costs associated with Hellbrise — the opposite event to Dunkelflaute, defined as the simultaneous surge in both solar and wind power generation. To stabilise the grid in such conditions, renewable operators are paid to curtail output, and these costs are ultimately covered by consumers — in 2025, constraints costs in the UK reached £1.77bn, with total balancing costs adding £40.51 to annual domestic consumer bills.⁴ BSUoS Tariffs are currently £12.49/MWh but expected to increase to £21.67/MWh from April 2027.⁵ Annual balancing costs in the UK are expected to increase to £4-8 billion a year by 2030.⁶

Majority solar and wind generation also results in a lack of inertia in the grid. On 28 April 2025, this lack of inertia from renewable generation left the Spanish grid without a buffer to respond to grid disturbances, causing a blackout as 15GW of solar generation collapsed in 1.5 seconds. Inertia from the French nuclear fleet was vital for protecting Europe from a continent-wide blackout.^{7 8}

To enable the expansion of clean baseload power from nuclear in the electricity mix, we encourage Government to support the deployment of the next wave of projects through the Advanced Nuclear Pipeline and planning for the next large-scale project. We also encourage Government to continue to support the development of nuclear fusion technologies, which in the future could also provide reliable baseload power to the grid and may also be suited for flexible operations. However, with the commercial deployment of nuclear fusion in the UK expected in 2050s and beyond, the main path to strengthening domestic energy security in the lead up to 2050 is the expansion of proven nuclear technologies in the electricity mix.

³ Enact (n/a) The Energy Current. Available at: <https://enact.lcp.energy/>

⁴ NESO (n/a) Balancing costs. Available at: <https://www.neso.energy/industry-information/balancing-costs>

⁵ NESO (2026) BSUoS Draft Tariffs for 2027/28. Available at: <https://www.neso.energy/document/388126/download>

⁶ NESO (2025) 2025 Annual Balancing Costs Report. Available at: <https://www.neso.energy/document/362561/download>

⁷ C. Keefer & A. Stahel (2025) Hellbrise. Available at: <https://www.decouple.media/p/hellbrise>

⁸ C. Keefer & G. S. Ramirez (2025) The Iberian Blackout. Available at: <https://www.decouple.media/p/the-iberian-blackout>

Dunkelflaute likelihood and impact

1. How are Dunkelflaute events defined and how far in advance can they be predicted? How likely is it that the UK will be impacted by dunkelflaute events lasting days to weeks and is that likelihood expected to change in the future?

- a. Dunkelflaute events are defined as periods of simultaneous low wind and little to no sunlight, leading to a significant drop in wind and solar power generation. In Europe, these conditions are most common between November and January.⁹
- b. In the past month there have been days of simultaneous low wind and solar generation in the UK nearly every week, with increased gas generation and imports used to meet demand:
 - i. 13 September: 7.2% wind, 5.93% solar, 32.99% gas, 23.01% imports.
 - ii. 22 September: 9.63% wind, 7.58% solar, 40.62% gas, 13.72% imports.
 - iii. 28 September: 12.64% wind, 7.65% solar, 38.28% gas, 10.36% imports.
 - iv. 6 October: 6.95% wind, 4.47% solar, 45.26% gas, 13.3% imports.¹⁰
 - v. Throughout these weeks, nuclear generation consistently made up 10-14% of the electricity mix, ensuring the availability of reliable baseload power.¹¹
- c. Whilst modern weather forecasting is usually able to give sufficient warning before these situations occur, requesting additional capacity from gas plants and through imports at relatively short notice drives up the price of electricity for consumers.¹²
 - i. In preparation for the Dunkelflaute conditions on Monday, 28 September, NESO issued an electricity margin notice to operators at 11.30pm on Sunday to notify it of any extra megawatt capacity. NESO also called on neighbouring countries to provide additional

⁹ J. Wertz (2025) Europe's Energy Security Threatened by Cloudy and Windless Days. Available at: <https://www.bloomberg.com/news/articles/2025-07-31/europe-s-energy-security-threatened-by-cloudy-and-windless-days>

¹⁰ NESO (n/a) Historic generation mix and carbon intensity. Available at: <https://www.neso.energy/data-portal/historic-generation-mix>

¹¹ NESO (n/a) Historic generation mix and carbon intensity. Available at: <https://www.neso.energy/data-portal/historic-generation-mix>

¹² Dr. J. Mollard et al. (2025) A flexible energy grid can cope better with Britain's weather. Available at: <https://impact.ed.ac.uk/research/climate-environmental-crisis/flexible-energy-grid-cope-better/>

energy.¹³ The day-ahead price for 28 September was £171.96/MWh.¹⁴

- ii. On the morning of October 6th, NESO issued three electricity margin notices for the day ahead, reflecting issues with predicting wind output and demand. To resolve the demand-supply gap, NESO exceeded intraday interconnector trading limits and paid almost £1000/MWh to gas plant operators in the Balancing Mechanism.¹⁵ The day-ahead price for 6 October was £170.62/MWh.¹⁶
- d. Regarding future predictions, in 2025 a NESO project aimed to address the critical gaps in understanding the likelihood and impact of Dunkelflaute events to enable NESO to incorporate these risks into future energy scenarios, however, the project was ultimately unable to predict specific weather impacts due to time and resource constraints.¹⁷
- e. A study focused on Japan found climate change likely to increase the frequency of Dunkelflaute events. Coupled with increasing electricity demand, the study indicates the potential emergence of unprecedented, long-duration high-residual-load events, which are expected to intensify with further expansion of VRE.¹⁸

2. How significant could the future demand-supply gap be during a Dunkelflaute in 2030 and 2050, under current plans and targets? Is the UK on track to deliver the infrastructure required to address these gaps?

- a. Whilst there are significant knowledge gaps in understanding the future likelihood and impact of Dunkelflaute, these weather conditions are expected to increase due to climate change. In conjunction with annual electricity demand in the UK estimated to increase to 705-797TWh by 2050, and the Government and NESO planning for majority renewables in

¹³ E. Taggart (2026) Britain fires up gas power stations as wind power fails to deliver. Available at: <https://www.telegraph.co.uk/business/2026/09/28/britain-fires-up-gas-power-stations-as-dunkelflaute-hits/>

¹⁴ Nord Pool (n/a) Day-ahead prices. Available at: <https://data.nordpoolgroup.com/auction/n2ex/prices?deliveryDate=latest¤cy=GBP&aggregation=DailyAggregate&deliveryAreas=NO2,UK>

¹⁵ Watt-Logic (2026) Early winter EMN rings alarm bells. Available at: <https://watt-logic.com/2026/10/09/early-winter-emn/>

¹⁶ Nord Pool (n/a) Day-ahead prices. Available at: <https://data.nordpoolgroup.com/auction/n2ex/prices?deliveryDate=latest¤cy=GBP&aggregation=DailyAggregate&deliveryAreas=NO2,UK>

¹⁷ NESO (2025) NIA Project Close Down Report Document — Extreme Weather and Climate Modelling (Dunkelflaute). Available at: <https://www.neso.energy/document/367076/download>

¹⁸ M. Ohba et al. (2026) Impacts of climate change on Dunkelflaute events and high residual load in Japan. Available at: <https://www.sciencedirect.com/science/article/pii/S2667095X26000218>

the electricity mix throughout 2030 to 2050, there is significant risk of future demand-supply gaps.¹⁹

- i. In September 2026 the UK experienced record fluctuations in wind output, with 20GW of wind collapsing in 24 hours on 12 September, and at least 10GW of wind collapsing on September 1st, 4th, 8th, 10th and 12th.²⁰ Such events pose significant risk of demand-supply gaps, especially as gas power stations that are idle or operating at very low load factors are more likely to trip when required to increase output so rapidly.
- b. To reduce risks to the grid and consumers from future Dunkelflaute events, we strongly encourage Government to increase the proportion of clean and reliable baseload power in the electricity mix. The UK is currently not on track to deliver the amount of nuclear that would be required to ensure reliable and affordable electricity for consumers in all weather conditions.
 - i. NESO's Future Energy Scenarios envision up to 21.6GW of nuclear in the electricity mix by 2050, which would mean about 25% baseload power in the electricity mix.²¹ With significant interest from AMR vendors to deploy in the UK, and further SMR and large-scale deployment, the UK has the potential to go beyond this aim.

Technologies and solutions

3. Which low-carbon technologies are most effective at addressing long-term Dunkelflaute events, lasting days to weeks? At what point could these technologies be deployed at a system-wide level and what are the main barriers to their deployment?

- a. The most effective approach to addressing long-term Dunkelflaute events would be to prevent them through increasing the proportion of clean and reliable baseload power in the electricity mix, which only nuclear can provide.
 - i. The UK already has operational large-scale nuclear fission reactors, and is currently building two more — Hinkley Point C and Sizewell C. Further large-scale reactors can and should be deployed in the UK in the leadup to 2050.
 - ii. The UK is also preparing to deploy SMR and AMR technologies through the Great British Energy – Nuclear Gwyndod project and the

¹⁹ NESO (2025) Future Energy Scenarios: Pathways to Net Zero. Available at:

<https://www.neso.energy/document/364541/download>

²⁰ B. Watts (2026) Britain just had a record 20 GW wind collapse. Available at:

https://dispatches.kilowatts.io/p/was-ist-eine-sturzflaute?r=iuvmr&utm_campaign=post&utm_medium=web&triedRedirect=true

²¹ NESO (2025) Future Energy Scenarios: Pathways to Net Zero. Available at:

<https://www.neso.energy/document/364541/download>

Advanced Nuclear Framework. The earliest of these power plants are expected to become operational in the mid-2030s.

- iii. In the long-term, nuclear fusion technologies could also provide reliable and clean baseload power and may also be suitable for flexible operation. However, a commercial fusion industry in the UK is only expected to become possible in decades, rather than necessarily being able to make a significant contribution in the wind before 2050.
- b. Funding continues to be a key barrier to further deployment of nuclear fission. Through the Advanced Nuclear Pipeline, the Government is aiming to encourage privately led SMR and AMR projects to come to market, which under the right conditions may also receive funding support from government and the National Wealth Fund.²²
- c. Disproportionate, excessive, and inconsistent regulatory and planning processes have also made nuclear deployment slower and more expensive. This barrier is being addressed through the ongoing nuclear regulatory reform.²³
- d. Supply chain and skills development is another barrier to deployment. Whilst the UK's civil nuclear manufacturing base possesses high technical capability, it is under-utilised due to lack of credible, long-term demand, which disincentivises investment to scale of capabilities. Lack of coherent programme design has also resulted in companies having to repeatedly rebuild a skilled workforce — welding, machining, EC&I engineering and nuclear-qualified inspection are the most pressured skill areas. This barrier can be addressed by the Government through a clear, sequenced and credible multi-programme pipeline for the UK civil nuclear sector.
- e. Beyond the immediate barrier of technology development, fusion technologies would face similar barriers to deployment as currently experienced by fission technologies. Cost competitiveness will be another barrier, as by the time fusion is commercially available it will be competing against solar, wind, batteries, and advanced nuclear fission.

4. What role will gas with carbon capture or other dispatchable generation need to play during a severe Dunkelflaute? What are the challenges associated with installing carbon capture for retained gas plants?

²² DESNZ (2026) Advanced nuclear framework. Available at:

<https://www.gov.uk/government/publications/advanced-nuclear-framework>

²³ DESNZ (2026) Building Our Nuclear Nation — Government Response to the Nuclear Regulatory Review 2025. Available at:

<https://assets.publishing.service.gov.uk/media/69b3ead0b84f01b2be53a1de/building-our-nuclear-nation-government-response-to-nuclear-regulatory-review.pdf>

- a. No comment.
- 5. What is the role of demand management in shifting or reducing the demand-supply gap during extended Dunkelflaute events (days to weeks)?**
- a. No comment.
- 6. How important is international cooperation on electricity supply for resilience to Dunkelflaute events? What are the barriers to further cooperation?**
- a. International cooperation is currently vital for ensuring sufficient electricity supply during Dunkelflaute events, as electricity imports alongside increased gas generation are used to balance supply and demand in the UK. However, as neighbouring countries often experience similar weather conditions to the UK, reliance on imports is not a viable long-term strategy.
 - i. Furthermore, the UK's general reliance on electricity imports has been continuously increasing in the last decade, despite the Government repeatedly emphasizing the need for enhanced domestic energy security and resilience, especially since Russia's illegal full-scale invasion of Ukraine in 2021.²⁴
 - b. Whilst international cooperation on electricity supply should remain a part of the strategy to address Dunkelflaute events, we strongly encourage Government to reduce the risk of such events in the first place through the expansion of domestically produced baseload power from nuclear.
 - i. The UK also primarily relies on imports from France, where nuclear made up 67% of total electricity generation in 2025.²⁵

Policy, market and governance frameworks

- 7. What analysis has been done to identify the most cost-effective approach to maintaining security of supply and meeting electricity demand under long-term Dunkelflaute conditions?**
- a. A report by the OECD Nuclear Energy Agency and the Electric Power Research Institute highlights that “in the face of extreme weather events

²⁴ DESNZ (2026) Capacity, net imports and utilisation of interconnectors. Available at: https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fassets.publishing.service.gov.uk%2Fmedia%2F6a6a3675bf4a7aca8f8976c3%2FDUKES_5.13.xlsx&wdOrigin=BROWSELINK

²⁵ IEA (2025) France — Electricity generation by source. Available at: <https://www.iea.org/countries/france/electricity>

and risks of intermittency, the security value of an uninterrupted power supply is more important than generation unit costs.”²⁶

- i. While the costs for onshore wind and solar remain attractive at the level of the individual plant, the story changes if their system costs are included. As the share of VRE grows, additional system costs arise for the hourly balancing of demand and supply, guaranteeing technical grid stability, possible addition of energy storage devices, and the expansion of transmission and distribution networks.
- ii. This is why many countries are pursuing the new construction and long-term operations of nuclear power, despite the significant drop in the standalone LCOE of many VRE technologies.
 1. To bring down electricity prices which are among the highest in the IEA, improve UK’s industrial competitiveness, and achieve energy security and decarbonisation objectives, we strongly encourage UK Government to follow this approach and increase the proportion of nuclear in the electricity mix.

27

8. Do current market arrangements provide sufficient incentives for investment in the range of solutions needed to maintain security of supply during Dunkelflaute conditions? Do market arrangements support the establishment of a ‘strategic reserve’?

- a. The Advanced Nuclear Framework aims to support the development, commercialisation and deployment of private SMR and AMR projects within the UK energy system.
- b. Whilst there is currently no framework to bring more large-scale nuclear capacity to the market, the UK Government recognises the value of further large-scale and has commissioned Great British Energy – Nuclear to undertake a study to consider land areas potentially suitable for deploying large-scale reactors in Great Britain.

9. What, if any, are the key decisions that Government needs to take before 2030 in relation to long-duration energy storage and low-carbon dispatchable power solutions to support a resilient decarbonised electricity system?

- a. No comment.

²⁶ NEA & EPRI (2026) The Costs of Generating Electricity 2025. Available at: https://www.oecd-neo.org/jcms/pl_121713/the-costs-of-generating-electricity-2025

²⁷ DESNZ (2026) International energy price comparison statistics. Available at: <https://www.gov.uk/government/collections/international-energy-price-comparisons>

10. What best practice can be learned from other countries about the innovative use of technologies for managing the risk of intermittency from renewables?

- a. No comment.

Further Information

The NIA is happy to provide more context, or any clarifications desired on the content of our response and to ask our members where appropriate for additional information that may be useful.

Please contact Elisabeth Roden, Policy Analyst for the Nuclear Industry Association, at elisabeth.roden@niauk.org to do this.