UK Government

Vision for an AI-enabled clean energy system

A call for evidence

Closing date: 6 November 2026

Department for Energy Security and Net Zero (2026)

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Ministerial foreword

We want to make energy affordable for everyone, and we know this hasn't been the case for far too long.

The only long-term solution is to reduce our reliance on volatile global fossil fuel markets and move to a clean homegrown power system that we control.

This is the great industrial challenge of our time, one that will bring good jobs and revitalise our communities, and to meet it we need to harness the new technologies that are bringing new possibilities.

One of these, of course, is artificial intelligence (AI). The possibilities for AI in our energy system are as exciting as they are fast-moving. But any deployment of AI in the energy sector must be undertaken responsibly.

AI could enable renewable power sources, electric vehicles, heat pumps, batteries and smart appliances to work together more effectively. It could help us identify faults before they happen, forecast demand more accurately, make better investment decisions and accelerate the development of new energy technologies.

These changes are already underway, and the decisions we take now will shape where the new industries of the future take root, and whether Britain leads or follows in the wake of this next industrial revolution.

As a government we therefore have a clear responsibility - to create the conditions for innovation to move from promising trials into tangible results, whilst protecting the security, resilience and fairness of our energy system.

This Vision is the beginning of that work. We're looking to understand where AI can make the greatest difference, the barriers that are preventing progress, and where government action is needed.

It is the start of a conversation between government, the public, industry and the wider energy sector, and the potential rewards are great.

By acting now, we can ensure that AI makes energy more affordable, creates good jobs, and supports a cleaner, more secure energy system that benefits communities across Britain.

Martin McCluskey MP
Minister for Local Energy and Jobs

General information

Why we are consulting

The government's aim is to ensure that artificial intelligence supports a cleaner, more affordable, efficient and secure energy system. The Vision sets out emerging thinking on the opportunities AI could create, including through better forecasting, planning, optimisation and coordination, while recognising that its deployment will also present risks and wider system implications that need to be managed.

Through the Vision, the government is seeking to:

- signal that it is taking both the opportunities and risks associated with AI in the energy system seriously
- test its understanding of how AI could affect the energy system in the near and longer term
- identify the barriers preventing beneficial AI applications from being adopted
- understand where government action may be needed, including to support coordination, standards and regulatory clarity; and
- gather evidence from across the energy and AI sectors to inform future policy development

Call for evidence details

Issued: 8 September 2026

Respond by: 6 November 2026

Enquiries to email:

aiforenergy@energysecurity.gov.uk

Audiences:

Organisations across the energy sector, including industry, regulators, innovators, researchers and consumer groups.

Territorial extent:

England, Wales and Scotland

How to respond

We welcome responses from organisations across the energy sector, including industry, regulators, innovators, researchers and consumer groups to: aiforenergy@energysecurity.gov.uk.

Your response will be most useful if it is framed in direct response to the questions posed, though further comments and evidence are also welcome. Responses should, where possible, include evidence, examples and views on which actions should be prioritised. We may hold follow-up workshops with interested participants.

We welcome responses in any form, including PDF, DOCx or ODF.

Wherever possible, avoid including any additional personal data beyond that which has been requested or which you consider it necessary for the Department for Energy Security and Net Zero (DESNZ) to be aware of. When responding, please state whether you are responding as an individual or representing the views of an organisation. You can leave out personal information from your response entirely if you would prefer to do so.

Confidentiality and data protection

Information you provide in response to this call for evidence, including personal information, may be disclosed in accordance with UK legislation (the Freedom of Information Act 2000, the Data Protection Act 2018 and the Environmental Information Regulations 2004).

If you want the information that you provide to be treated as confidential, please tell us, but be aware that we cannot guarantee confidentiality in all circumstances. An automatic confidentiality disclaimer generated by your IT system will not be regarded by us as a confidentiality request.

We will process your personal data in accordance with all applicable data protection laws. See our privacy policy.

Your responses, including any personal data, may be shared with a third-party provider, or other government department or organisation acting on behalf of DESNZ under contract or an equivalent agreement, for the purpose of analysis and summarising responses for us and may use technology, such as AI. Your response may also be shared with the devolved governments. An anonymised version of responses may be published, in a list or summary of responses received, and in any subsequent review reports.

Quality assurance

If you have any complaints about the way this call for evidence has been conducted, please email: bru@energysecurity.gov.uk.

Executive summary

Artificial Intelligence (AI) may be the defining technology of our era. It will transform jobs, businesses and industries, drive productivity and boost long-term economic growth. In the energy system, AI technologies can make more efficient use of assets, meaning we need to build less at lower cost while improving the quality of service for consumers. Put simply, better forecasting, planning and operation will reduce waste and avoid precautionary overbuild, lowering system costs and, ultimately, household bills and emissions. For consumers, this means a system that is not only lower cost, but more predictable, and more responsive to demand. This potential is amplified by the UK's position: the transition to a more distributed and dynamic energy system creates the demand, and digitalisation provides the platform, for deploying new AI applications. The potential benefit is not only domestic. If the UK moves quickly, it can be the place where new start-ups building AI applications for the energy system, scale up. With world leading deployment of renewable generation, strong scientific and innovation capabilities, and deep capital markets, the UK is well placed to lead.

AI is already being adopted across the energy system, and this will continue with or without government action. But as with previous technologies, adoption may be uneven, slowed by structural challenges, or pose new risks to the energy system and the consumer. So, the question is not whether AI will be adopted in the energy sector, but whether government acts to shape adoption early and actively enough to capture its benefits and manage its risks.

This Vision is a structured assessment of opportunities, risks and key uncertainties intended to inform further evidence gathering and policy development. It sets out early thinking and raises questions that must be answered by government and industry across three areas:

1. **Principles for AI deployment**: to steer use of AI in the energy system, this document sets out three high-level outcome-based principles for deployment in the sector: lowering costs for consumers, increasing the efficiency of the system and support decarbonisation, and ensuring energy security.

2. **Barriers to near-term adoption**: many AI applications for energy are already technically proven. Cross-economy evidence shows that adoption of new technologies is often uneven and lags technical capability, particularly for general-purpose technologies like AI. Therefore, realising near-term benefits in the energy system will require deliberate work addressing the barriers to adoption, which include data access, economic incentives, regulatory clarity and assurance, technical integration, and capability, skills and culture.

3. **Longer-term transformative change**: AI could fundamentally reshape how the energy system is planned, operated and governed. But the scale and nature of that impact is uncertain. To explore this, the document examines an illustrative future in which highly autonomous agentic AI is embedded across the energy system. This raises key questions, such as how decision making, control and accountability shift when optimisation becomes more automated; whether current market, regulatory and governance arrangements stay robust when AI systems coordinate activity at greater speed and scale; or what risks emerge at system-level from interactions between multiple AI-enabled components.

The opportunity for AI in clean energy

Purpose of this document

The purpose of this document is to set out our emerging view on how AI could transform the energy system and test this with external stakeholders. The understanding of AI's role in the energy system is developing, and further evidence is needed.

This Vision sits alongside other work that will strengthen the evidence base for government action, including the government's AI Champion for Clean Energy, Lucy Yu's review of AI deployment in the electricity networks. The review focuses on how AI could help realise system transformation and makes recommendations on the reforms that may be needed to support safe, effective and timely deployment.

Together, these will inform decisions on where and how government should act to support AI adoption, address barriers and manage risks, culminating in the UK's first AI for Clean Energy Strategy. The strategy will be the government's main vehicle for responding to Lucy Yu's review. It will consider the review's recommendations in the context of wider energy and AI policy, set out where further action is needed, and identify next steps on specific reforms, such as changes to funding, legislation or regulation.

Given the pace of AI developments, it is not credible for government to publish a single, static strategy on AI for Clean Energy. Instead, our approach will be deliberately iterative. The Strategy will provide an initial framework for action, with the expectation that this will be updated as evidence and technology evolve.

Why AI matters

Used well, AI could help make the energy system cleaner, more productive and more adaptable. Better prediction, optimisation and coordination can reduce waste, lower curtailment, improve asset utilisation and support more targeted investment. That matters for affordability and resilience as much as for decarbonisation: the benefits could be felt in lower costs and a more efficient pathway to clean power.

AI could also accelerate innovation; by helping researchers, engineers and firms test ideas, improve designs and shorten the path to deployment. It could become an important part of how the UK builds a cleaner, smarter energy system. For example, the AI for Science Strategy set out to develop frontier capability in AI-driven science, supporting areas of strategic importance including fusion energy.[1]

[1] DSIT (2025) 'AI for Science Strategy'

Government ambitions

The UK government has set out an ambition for Britain to lead on AI adoption and diffusion, ensuring the benefits are felt across public services, businesses and the wider economy. This is supported by a wider programme of measures to accelerate AI adoption and build the infrastructure, capability and evidence base needed to support deployment. Delivery measures include AI Growth Zones to accelerate datacentre development, such as the UKAEA headquarters at Culham; bringing together world leading scientific expertise at the forefront of fusion, alongside a National Data Library, and a "scan–pilot–scale" approach to embedding AI across government operations. The UK government is also developing interventions to support businesses in using data for AI adoption, such as further investment in data sharing infrastructure and secure ways for businesses to trade data through data exchanges

The UK enters this phase as a leading nation, having the third-largest AI market globally and the largest in Europe, with strong capabilities in research, commercial activity and policy leadership.[2] If the UK moves quickly, it can position itself as a leading place for start-ups and established firms to test, validate and operationalise AI applications for the energy system.

The government's mission to make Britain a Clean Energy Superpower is to deliver cheap, secure and homegrown clean energy, while accelerating to net zero. This sits alongside the government's mission to Kickstart Economic Growth. A modern, resilient energy system underpins productivity, strengthens industrial competitiveness, and creates high-quality jobs. Delivering Clean Power by 2030 will be critical to tackling cost-of-living pressures.

A more distributed, dynamic and digital system

The energy system is shifting from a centralised model built around a small number of large, controllable assets, towards one that is more decentralised, dynamic and flexible, with greater participation from consumers.[3] The system must coordinate millions of distributed and variable assets including renewables, electric vehicles, heat pumps, batteries and smart appliances, with energy generated closer to the point of consumption,[4] alongside new infrastructure such as low-carbon hydrogen and carbon capture, utilisation and storage.

This growing complexity will become harder to manage without new tools. As assets, interactions and operational decisions increase, so does the risk of inefficiency, operational error, supply disruption and system management costs. This is already visible in the National Energy System Operator (NESO) control room, where the number of instructions issued to balance the electricity system increased tenfold between December 2023 and June 2025 to over 200,000.[5]

[2] DSIT (2025) 'AI Opportunities Action Plan'; AI Security Institute (AISI) website
[3] The Oxford Institute for Energy Studies (2025) 'Artificial Intelligence and its Implications for Electricity Systems', Oxford Energy Forum, Issue 145
[4] RAND (2024) 'The use of AI for improving energy security'
[5] NESO (2025) 'Defining, measuring and addressing skip rates'

Alongside this, the energy system is undergoing digitalisation. This means putting in place shared digital foundations including common data standards, interoperable platforms and secure data access. The Energy Digitalisation Framework sets out a coordinated approach to this challenge.[6]

Together, increasing complexity and digitalisation provide the impetus and the platform for AI in the energy system. AI is well suited to problems involving high data volumes,[7] rapid system dynamics, and difficult trade-offs across cost, carbon and reliability. In the near-term, it is likely to strengthen human decision-making. As capabilities advance, AI may enable more automated and system-level optimisation, but safe and effective deployment depends on high-quality, timely, and interoperable data, plus robust governance and assurance.[8]

Adoption of AI in the energy sector

Artificial intelligence is a general-purpose technology with applications across the energy system. The UK's AI for Decarbonisation Virtual Centre of Excellence (ADViCE) used a top-down approach to identify over 100 decarbonisation challenges across power, industry, transport and buildings where AI could play a role.[9] While these vary in scale and maturity, they can be grouped into four broad areas:

1. **System optimisation and operation**: using AI to improve real-time network management, optimise and forecast supply and demand, support the integration of renewables, and strengthen system reliability.
2. **Asset planning, operation and maintenance**: using AI to support planning, operations and maintenance of generation, network and industrial assets, reducing downtime and premature replacement while improving reliability and security of supply.
3. **End-use efficiency and demand management**: using AI to optimise energy use, reduce waste, automate flexibility and demand-side response, shifting consumption to cheaper and cleaner periods.
4. **Energy innovation and R&D**: using AI to accelerate discovery, design and scale-up of new technologies, materials and processes, including in renewables, storage, industrial decarbonisation and fusion.

[6] DESNZ and Ofgem (2026) 'Energy digitalisation framework: a vision for a coordinated and connected energy system'
[7] IEA (2026) 'Energy and AI in East Asia'
[8] DSIT and AISI (2025) 'AI Security Institute – Frontier AI Trends report factsheet'
[9] ADViCE AI Carbon Challenge

AI is already being used in parts of the UK energy system, such as to improve forecasting and manage electric vehicle charging, although adoption remains uneven. There has also been progress in domestic decarbonisation, for example by streamlining elements of heat pump design and installation.[10] Internationally, AI is being used in oil and gas for seismic interpretation, predictive maintenance and refinery optimisation, while adoption in manufacturing remains more nascent.[11]

These examples suggest that the immediate value of AI in energy is not a complete redesign of the energy system, but in improved performance and coordination. A plausible 2–5-year future is where AI becomes more embedded across the energy system without changing its fundamental objectives, governance or accountability. Analysis suggests that if existing AI applications only were adopted across industry, transport and buildings sectors globally by 2035, emissions would fall by 1.4 $GtCO_2e$ that year (around 5% of energy-related emissions, and consistent with other analysis), while current AI use in the energy sector could deliver up to $170bn global annual cost savings by 2030.[12]

Principles for AI deployment

AI's value in the energy system will depend not only on technical capability, but on the outcomes it is directed towards and the constraints within which it is deployed. As critical national infrastructure, the energy system is central to people's daily lives, economic activity and national security. Government's role is not to determine which AI models or tools should be used, but to set clear public outcomes and shape conditions for adoption. We propose three high-level principles to guide AI deployment in the energy system:

1. Lower bills for households and businesses
2. Increase the efficiency of the system and support decarbonisation
3. Ensure energy security

Questions for stakeholders

Question 1: Where and how can AI add the most value in the energy system?

Question 2: What are the UK's main strengths in applying AI in the energy system, and where may the UK have a competitive advantage over other countries?

[10] ADViCE (2025) 'State of AI for Decarbonisation 2025'
[11] IEA (2025) 'Energy and AI'; IBM (2025) 'Oil and gas in the AI era'; and ADViCE (2025) 'State of AI for Decarbonisation 2025'
[12] IEA (2025) 'Energy and AI'; Nicholas Stern and others (2025) 'Green and intelligent: the role of AI in the climate transition', npj Climate Action 5, 56; Jonathan Gillham (2020) 'How AI can enable a Sustainable Future'; and Deloitte (2025) 'AI for energy systems'

Barriers to near-term adoption

Adopting new technologies is difficult, particularly in regulated and safety-critical environments. While AI has the potential to deliver significant system benefits, adoption is unlikely to occur evenly and at pace or scale without addressing key barriers and underlying structural, technical and institutional constraints.

The aim of this section is to identify and test the most important challenges, and to understand where coordinated action by government, regulators and industry may be required to unlock safe and effective deployment. Responses will inform government's approach to prioritisation. We have identified six overlapping challenges:

1. **Access to data**: Effective AI deployment depends on access to high-quality, timely, interoperable and operationally usable data. While large volumes of energy data exist, AI readiness is constrained by fragmented ownership, inconsistent standards, limited visibility in some parts of the system, and governance barriers such as commercial sensitivity, cyber security, liability and consent.[13]

2. **Innovation, markets and incentives**: Current market structures, regulatory incentives and procurement models do not always support investment in AI, particularly where benefits accrue across the system rather than to the investor. This can limit experimentation, slow the spread of proven solutions, incentivise adoption where it is easiest rather than where it delivers most value, and leave a persistent gap between pilots and business-as-usual deployment.

3. **Regulation and governance**: Clear, proportionate and risk-based regulatory expectations are critical, but many frameworks were designed for static, deterministic systems rather than adaptive AI models.[14] Accountability, assurance and good practice are especially important where AI influences operational decisions in critical infrastructure. Without sufficient clarity, organisations may default to regulatory risk aversion even where technologies are technically mature.

4. **Risk, security and trust**: AI introduces new operational, cyber and systemic risks, including model drift, data poisoning, opaque decision-making,[15] and supply chain vulnerabilities. For critical national infrastructure, trust will depend on robust assurance of safety, resilience, explainability and security. Without proportionate and sector-specific assurance approaches, organisations may either move too cautiously or deploy tools without adequate safeguards. Equally, it is important to recognise that the same technologies that may increase the capability of attackers may also strengthen the ability to detect, monitor and respond to threats.[16] The aim is therefore not to avoid all AI-related risk, but to govern and deploy AI in ways that improve overall resilience.[17]

[13] Energy Systems Catapult (2024) 'AI risks for energy networks: challenges, management and regulation'
[14] POST (2024) 'Energy security and AI'
[15] Schneider Electric (2024) 'AI for impact: A method for guiding AI-energy applications at scale'
[16] NCSC (2026) 'Why cyber defenders need to be ready for frontier AI'
[17] techUK (2026) 'How can the energy sector leverage AI to deliver consumer benefits?'

5. **Technical systems integration**: Integrating AI into the energy system requires working across a diverse set of existing digital and operational systems, many of which were designed for earlier operating models. This can create practical barriers, even where the business case for AI is strong, and may limit deployment to isolated use cases rather than scalable operational capability. In some cases, however, AI may also help to bridge integration challenges for example by supporting interfaces across systems or enabling enhanced decision support without direct integration into operational control layers.
6. **Capability, people and culture**: Successful adoption and scale of AI depend on workforce capability, leadership, organisational readiness and public trust. Shortages in digital, data and AI capability, limited AI literacy among decision-makers, cultural resistance in safety-critical environments, and reliance on external vendors[18] may slow deployment. Public confidence matters, particularly where AI affects consumer data, billing or control of assets.

Priorities for near-term adoption

Work on addressing some of these barriers is already underway across government and wider public bodies. Ofgem has published guidance on the ethical use of AI and is developing regulatory tools, including the AI Regulatory Laboratory and a Technical Sandbox.[19] Meanwhile, NESO is exploring and scaling AI for forecasting, optimisation and real-time decision support, with some tools already delivering operational value and others in development.[20] However, more work will be needed to capitalise on the benefits of near-term adoption.

Not all barriers are of equal urgency or require the same kind of government response. We will focus where progress is unlikely without government coordination, standards, regulatory clarity or public institutions playing a central role. Additionally, we will consider where action could help strengthen UK competitive advantage and develop capabilities with international relevance and replicability. This could include clarifying regulatory frameworks; enabling whole-system interoperability; shaping innovation funding and routes to scale; strengthening skills, tools and organisational capabilities; and ensuring resilience, security and risk management.

Questions for stakeholders

Question 3: Do the six challenges set out above reflect the main barriers to safe and effective deployment? Which of these is most urgent to address?

Question 4: For the most significant barriers identified, what specific constraints are limiting deployment (e.g. regulatory uncertainty, lack of data access, skills, integration challenges)?

[18] IEA (2026) 'Key questions on energy and AI'
[19] Ofgem (2025) 'Ethical AI use in the energy sector'; Ofgem (2026) 'AI Reg Lab: February 2026'; and Ofgem (2026) 'AI technical sandbox'
[20] NESO Volta programme

Question 5: Where are current market, procurement or regulatory incentives failing to support AI deployment? In particular, where and why are promising applications struggling to move from pilot to full-scale deployment?

Question 6: Which areas of the energy system should be priorities for government action to unlock near-term AI deployment?

Longer-term transformative change

This section uses a deliberately stretching scenario to explore what could happen if advanced AI were embedded across multiple energy system functions simultaneously. It tests how current arrangements for planning, operation, markets and governance would perform under those conditions. It does not predict the future or set a preferred pathway. Instead, it explores how the energy system might evolve with more advanced, autonomous, and integrated AI.

By transformational, we mean AI that changes goals, rules, institutional roles or decision-making in the energy system. This is one of several plausible futures. The Government Office for Science (GO-Science) has developed scenarios to 2030 spanning key uncertainties including capability, distribution and model access, security, adoption, labour displacement and global cooperation. [21]

The timeline for transformational AI remains uncertain. If new approaches are required for general capability, they may emerge well beyond 2030.[22] If current methods advance rapidly, they could materialise sooner. This uncertainty, in both pace and form, creates challenges for planning. Responses will help identify the most material risks and uncertainties.

Testing a plausible, transformational future

In this future, the energy system largely runs itself. AI is embedded across forecasting, control, markets, planning and end-use, as well as innovation and system design, forming a continuously learning system. Rather than people making decisions in sequence to plan, build, operate, then trade, AI agents representing every asset on the system coordinate continuously, responding to changing conditions in real-time. A human operator today might manually curtail a wind farm during network congestion. In this future, AI agents across generation, storage and demand would coordinate automatically to resolve the constraint before it occurs. Central to this is a fully autonomous optimisation layer drawing on live data from the grid, weather, assets and markets. By running simulations across timescales, from milliseconds to decades, it anticipates faults and continuously rebalances power across networks, storage, distributed energy resources and flexible demand.

This future has the following characteristic features.

[21] GO-Science (2026) 'AI Scenarios 2030: Helping policymakers plan for the future of AI'
[22] Junhao Zheng and others (2025) 'Lifelong learning of Large Language Model based agents: A roadmap'; and Iman Mirzadeh and others (2024) 'GSM-Symbolic: Understanding the limitations of mathematical reasoning in Large Language Models'

Autonomous, distributed decision-making:

Activities are coordinated at system-level but executed locally. AI agents initiate and carry out actions within defined objectives and constraints, coordinating with each other rather than waiting for centralised human direction. For example, a battery storage system might independently decide when to charge and discharge based on local network conditions, price signals and grid frequency, while coordinating with neighbouring assets to avoid overloading a substation. Human roles shift toward setting goals, defining guardrails and overseeing performance.

Embedded control:

System behaviour is increasingly determined by optimisation logic and automated decision processes, meaning practical control sits in how decisions are executed rather than where formal authority resides. Outcomes are shaped through continuously applied decision rules and interactions between agents, rather than discrete human-led interventions.

Continuous optimisation across timescales:

Decision-making shifts from staged interventions to ongoing optimisation, from real-time balancing through to long-term infrastructure planning. Activities previously separated by time horizon are brought into a single, integrated process. For example, instead of reviewing network investment needs on an annual cycle, the system continuously reassesses where reinforcement is needed based on live demand patterns, planned connections and forecast growth, adjusting priorities as conditions change.

Convergence of functions:

Outcomes increasingly emerge from the interaction of interdependent AI systems across markets, networks, assets and demand. A single decision such as when to charge a fleet of electric vehicles simultaneously affects system balancing, local network capacity and wholesale market prices. As these systems become more tightly coupled, boundaries between planning, operation and markets begin to blur, making outcomes harder to predict or attribute to any single actor.

Learning over time:

Systems improve through feedback loops, using historical and real-time data to refine decisions. For example, after a period of unusual weather, the system would update its forecasting models and adjust how it pre-positions storage and flexible demand, carrying that learning forward into future decisions. Over time, this accumulated experience enables more adaptive responses to evolving conditions.

What this suggests about system design and governance

If the energy system increasingly runs itself, the way it is designed and governed matters more, not less. The questions shift: from "who made that decision?" to "how was the system set up to make decisions like that?”. Outcomes may increasingly arise from interactions between AI-enabled components, producing system-level emergent behaviour that cannot be attributed to any single decision or actor.

Key considerations would include:

Control and accountability:

When outcomes emerge from thousands of small, automated decisions operating at speed and scale, they cannot easily be traced back to any single choice or actor. For example, a localised pricing anomaly might result not from one decision but from the interaction of hundreds of agents responding to the same signal simultaneously. This makes system architecture the primary means through which control is exercised in practice: what is automated, where decision authority sits, and how actions are observed, audited and reversed. Ensuring that optimisation logic stays aligned with policy intent becomes a central design challenge, alongside explanation and audit mechanisms that remain robust as systems grow more adaptive.

Market design and coordination:

Local flexibility may increasingly be delivered through automated tools acting on behalf of households and businesses, optimising heat pumps, electric vehicle batteries and other assets in response to price signals while respecting user preferences. This could make demand a more responsive system resource, improving efficiency and affordability. But existing market arrangements may lack the granularity to value rapid, location specific responses. This could strengthen the case for more active Distribution System Operator roles and raise questions about whether market rules remain robust when coordination is machine mediated and small design choices can have amplified effects.

Planning and investment:

Self-updating digital twins and layered modelling could connect day-to-day operations increasingly with longer-term planning, allowing a wider range of options to be explored more quickly, including constraints like skills, supply chains and permitting. Rather than reviewing network investment needs on a fixed cycle, the system could continuously reassess priorities based on live data. However, this creates tension with existing planning and consenting frameworks, which are typically episodic and evidence-based at a point in time. A network reinforcement decision based on a previous year's assessment could be overtaken by updated modelling before construction begins, placing pressure on appraisal and governance approaches built around fixed decision points.

Increasingly software defined:

The system may evolve through software updates rather than physical changes, with capabilities introduced and refined continuously. This challenges traditional "test-then-deploy" models. For example, a routine model update might subtly shift how storage is dispatched across a region, through incremental adaptation. Many regulatory tools assume change occurs through discrete, visible decisions; as systems evolve continuously, questions arise about how cumulative effects are governed.

Institutional roles and boundaries:

As functions converge, traditional distinctions between planners, operators, market participants and regulators become harder to sustain. For example, rather than sequential actions by separate actors, an AI system resolving congestion could simultaneously curtail generation, shift demand, adjust prices and reprioritise network investment, with outcomes emerging from a single optimisation process. As a result, operational choices about near-term system management may implicitly embed assumptions about future capacity and investment, shaping outcomes before formal decisions are taken. This too raises questions about whether existing regulatory cycles, statutory powers and oversight tools, designed around discrete decisions and clearly defined roles, remain suited to faster, more adaptive and less predictable change.

Key risks to test with the sector

If AI becomes more autonomous and deeply integrated, a set of system-level risks are likely to grow significantly. These arise not only from autonomy itself, but the pace and structure of adoption.

The risks below are not exhaustive but provide a starting point for discussion.

Meaningful human oversight:

As AI takes on more continuous and delegated decision-making, it may increasingly shape outcomes with limited opportunity for meaningful human intervention or challenge. This is particularly acute where AI holds the most complete real-time view of the system, while humans retain formal accountability without equivalent visibility. A control room operator may be formally responsible for network security but unable to meaningfully scrutinise decisions made by an AI system processing thousands of variables per second. If deployment in critical roles outpaces the development of safety frameworks and regulation, systems may be used before their behaviour is fully understood. This makes staged deployment, shadow operation and progressive transfer of responsibility key considerations.

Uneven adoption and fragmentation:

AI may be adopted unevenly, with private firms moving faster to capture efficiency gains while system and network operators proceed more cautiously due to safety, reliability and regulatory constraints. Over time, this could allow faster moving actors to exert growing influence over real-time system behaviour, even without formal authority. A large aggregator with advanced AI capability could begin to shape local market outcomes in ways that a Distribution Network Operator, still relying on conventional tools, cannot fully observe or respond to. In practice, control may shift towards those with the most advanced capabilities, while established institutions retain accountability but lose visibility and influence.

Concentration and dependency:

Advanced AI capabilities may become concentrated among a small number of providers. As AI is embedded more deeply into system operation, reliance on proprietary models, platforms and compute infrastructure may grow. In a safety-critical system, such dependencies raise wider questions of energy security. For example, if a single cloud provider underpins the optimisation systems used by both the system operator and major generators, a service disruption could cascade across functions. This highlights the importance of portability, interoperability and

credible fallback options, including the ability to revert to less autonomous modes where necessary. It also suggests a need to consider whether some applications could use more lightweight, local or domain-specific approaches, and how national investments in sovereign capability align with the resilience needs of the energy system.[23]

Accountability and liability:

As AI becomes more embedded, risks are increasingly shaped by interactions rather than individual tools. This can make it harder to determine the cause of an incident, assign responsibility and learn from failure. At the same time, vulnerabilities linked to data, models or interfaces may propagate across interconnected systems, including into environments where reliability and safety are critical. Risk management therefore shifts from assessing individual tools to understanding how risks emerge and spread across the system.

Fairness:

System-level AI optimisation may produce uneven impacts across different consumers, regions or participants, with distributional effects that are not immediately visible. For example, an optimisation process may prioritise areas where flexibility can be more easily measured and accessed, such as those with high smart meter penetration or connected assets, and therefore consistently deprioritise areas where this data or capability is limited, effectively disadvantaging certain communities without any deliberate design choice. These impacts may emerge gradually through many small decisions within complex and interacting processes rather than a single observable event, making them harder to identify, challenge or correct. This underscores the need to consider how fairness, transparency and ethical oversight are maintained as systems become more automated.

Human judgement and skills erosion:

As automation increases, there is a longer-term risk that operational expertise becomes eroded. Even where accountability formally remains with people, the ability to challenge decisions, diagnose failures or intervene effectively may weaken if organisations become overly dependent on AI systems or external vendors.[24]

Questions for stakeholders

Question 7: Can current market structures support coordination at machine speed, or do existing design features (for example, dispatch intervals or product definitions) begin to constrain system performance? What changes could shape a market that supports this?

Question 8: What does effective assurance look like at system-level, rather than for individual AI applications? How can accountability be maintained where outcomes reflect cumulative system dynamics rather than discrete decisions?

[23] techUK (2026) 'How can the energy sector leverage AI to deliver consumer benefits?'; and DSIT (2026) 'AI firms pioneering drug discovery, cheaper supercomputing and more get first backing through UK's Sovereign AI'
[24] Mina Saghafian and others (2025) 'Balancing Automation and Human Oversight: Design Implications for Safety-Critical Systems'

Question 9: What are the most material risks arising from more autonomous and integrated AI deployment, how can these best be managed, and how do we stage autonomy safely?

Question 10: Which of the issues highlighted in the transformative future are most relevant to your organisation and what steps are you already taking to realise the opportunities?

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