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## DIGITAL INNOVATION FOR A NET ZERO ELECTRICITY GRID

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The transition to an affordable zero-carbon electricity system will be at risk unless there is a fundamental step change in the use of digital technology. Achieving this brings challenges to the incentives, capacity, processes, and governance that support digitalisation of the electricity system. The work of the Energy Data and Digitalisation Task Forces have been positive steps and BEIS should establish a digital delivery body as recommended by the Task Force. However, it needs to go further. Specifically, the market design and governance processes being developed in BEIS should consider how to fully integrate digital considerations to ensure they are fit for a digital future.

The upcoming Energy Bill presents an opportunity to create a modern, digitalised, decarbonised, and consumer-focused energy system. It must ensure policy decisions by BEIS and Ofgem are fully informed by considerations relating to digital technologies and opportunities. BEIS, Ofgem and UKRI should implement measures that enable electricity networks to move from innovation to deployment of digital technologies in line with the target to decarbonise the electricity system by 2035.

This note sets out specific recommendations for how this can be achieved.



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## The current digital innovation landscape for electricity networks in the UK

**The energy policy paradigm in the UK is changing with new imperatives.** The UK Government has set a target for decarbonising the electricity grid by 2035. It is important that this is achieved at least cost to consumers. This will involve building, connecting, and integrating huge volumes of relatively cheap renewables which will protect consumers from volatile fossil fuel prices. Cost-effective integration of renewables requires a more efficient and flexible power system that allows consumers, flexibility providers, network operators and the system operator to manage demand to match increasing percentages of renewable supply. At the same time the electricity system will see rapidly increasing demand for electricity due to the electrification of heat, transport, and various industrial processes. New governance structures will be required to manage these changes, including an independent system operator and a growing remit for distribution networks to actively manage supply and demand across their networks.

**Cost-effective integration of renewables cannot be achieved through incremental changes to the way the system operates.** The electricity sector must move from a situation where we have a few large power plants that can be controlled to one where we will have millions of connected devices offering and requiring electricity services. This cannot be achieved without innovation in, and deployment of, a range of digital technologies. Whilst the energy sector currently uses a range of digital processes, it will need to ensure that data collection is expanded and automated, that all data collected is machine-readable to allow for more automation of processes, and that digital architecture is designed to support easier deployment of new applications. These digital processes and technologies must support new planning and operational approaches by network operators, including new markets for grid services that will allow efficient development and use of all assets, from generation to storage to EVs and heat pumps. It is this aspect of the broader digitalisation agenda that is the focus of this paper.

**Cost-efficient decarbonisation requires maximum utilisation of all generation and network resources.** A large proportion of the new sources of demand for electricity are going to be connected to the distribution networks (EVs, heat pumps) and, to avoid having to massively reinforce the network, operators will need to use incentives and protocols to ensure efficient use of their existing assets. For example, the increasing demand caused by EVs could be addressed by



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distribution networks either by expensive network reinforcement, or through digitally optimised markets and protocols that spread the demand out in time to avoid peaks that would overwhelm network capacity. Without such changes, there is the real prospect that consumers will be prevented from using EV chargers and electric heat pumps due to the lack of network capacity.

**Digitalisation and market design must be considered together with the goal of incentivising demand flexibility.** Network incentives and markets will need to be designed to optimise grid development and operation and support the development of consumer-focused solutions. This means that they must allow consumers to easily take part in the electricity markets, both by procuring electricity services, and by creating markets for the use of network assets to support grid optimisation.

**Support for digital innovation in energy network companies must be focused on delivering the changes needed to decarbonise the electricity system by 2035.** Funding has been available for early-stage pilot projects through Government grants (e.g. MEDA, MEDApps) and the Ofgem Network Innovation Fund. Network operators have been required to propose digitalisation strategies. However, these are all bottom-up processes which are not coordinated to support a system-wide net-zero objective. The consequence of a focus on bottom-up projects is that the incentives for innovation and the ability of innovators to achieve a route to market remain unaddressed. As a result, the individual projects that are supported through the various network innovation funds have largely failed to scale and commercialise the solutions involved. The absence of a clear longer-term pathway to commercialisation means that there is little incentive for technology companies, who are often small start-ups, to work in this area. Decarbonisation of the power system requires a coordinated mission-based approach to digital innovation, involving identification of need, financial support, monitoring of progress, and system-wide deployment.

**Supporting UK digital innovators to develop energy system solutions for the UK energy market will position them well for international expansion.** The challenges faced in the UK are similar in many other countries and energy markets. The UK could position itself as a leader in digital energy technology and support energy entrepreneurs to offer their solutions to the international market.

**The Energy Data Taskforce and subsequent Energy Digitalisation Taskforce have been positive initiatives.** They have identified several helpful



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recommendations including ones seeking to improve consumer consent, interoperability, and delivery. However, more needs to be done to trigger a step-change in the rate of progress towards a digitalised grid and support decarbonisation of the power system by 2035.

## A range of challenges need to be addressed to accelerate digitalisation to unlock change at the grid centre

**The key policy challenge is to harness the creativity of digital innovators whilst ensuring timely decarbonisation of the power system.** This will require a process that recognises the fast-moving nature of digital innovation and the inherent uncertainty regarding the optimal pathway to digitalisation of the system, alongside the need for a strategic direction that ensures progress and mass-deployment at the rate required. To date support for digital innovation has focussed on bottom-up support that has sought to allow ‘a thousand flowers to bloom’. This approach will need to continue but be coupled with a new more strategic assessment of digital technology needs across the system.

*Recommendation 1: BEIS, Ofgem and UKRI requires advice from industry experts to identify the digital standards and architecture required to achieve an efficient, secure net-zero energy system by 2035. The ‘independent energy expert panel’ proposed in the recent BEIS decision document on the Future System Operator includes representation from individuals working in the tech sector or with independent expertise in digital technology, to advise on digital implications of policy proposals.*

**Networks are shaped by the regulation and legislation that guide and inform their roles and responsibilities.** There are a range of reforms to the governance and operation of the electricity market currently underway and these must be coordinated with the grid digitalisation process. Network businesses are driven by the regulatory framework within which they operate. The current RIIO-ED2 price review is extremely important since it will set the incentives for distribution network operators out to 2028. Also, the mandate for a new Future System Operator is being developed and the National Grid Electricity System Operator is preparing recommendations to reform electricity markets. The design of these processes and mechanisms is critical in shaping how much digital technologies will be able to support an efficient transition to net zero. However, there is little evidence that they are effectively coordinated within a strategic framework provided by BEIS. This lack of coordination represents a strategic risk to the



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development of an efficient zero emission electricity grid. The lack of coordination is in part due to a lack of digital expertise within senior management and market design teams in BEIS and Ofgem.

*Recommendation 2: BEIS and Ofgem need to ensure greater coherence between the digital and energy system market design policy development teams.*

*Recommendation 3: BEIS and Ofgem need to integrate digital expertise in their senior management teams and build digital capacity within market design teams. BEIS should appoint a Chief Energy Data and Digitisation Officer in a senior civil service (SCS) grade to oversee the integration of energy policy and digitalisation.*

**Innovation funding for digital energy solutions should support the delivery of specific missions and should include a stronger connection to digital roll-out.**

Ofgem and Innovate UK (IUK) have launched a new Strategic Innovation Fund to deliver funding for the period from 2021-2026, which is supporting digital innovation. This is a positive step. However, despite the filtering process involving four challenge areas (whole system integration, data and digitalisation, heat & zero emission transport), this remains a ‘bottom-up’ process with no clear missions that are required to be addressed. At the same time there needs to be a clearer path between successful innovation projects and their roll out across the system to offer third party digital innovators a route to commercial scalability.

*Recommendation 4: Ofgem and IUK should consider developing specific digital missions for the Strategic Innovation Fund in the future.*

*Recommendation 5: Ofgem and IUK need to re-evaluate how innovation funding can connect with digital roll out to support third party innovators to scale their solutions.*

**Network companies need to develop platforms through which innovators can offer digital solutions.** Digital innovation projects in the networks are currently initiated through an opaque process of partnership development between innovators and networks. A new form of market should be developed to support third parties to offer digital solutions to networks in a more open and competitive manner. This could be in the form of an energy system ‘app store’ that would create standards for digital solutions and allow networks to crowd-in a much wider range of potential projects and partners. Such an app store would need to be designed specifically for the energy system, so would need to be very different from mobile app stores. Ultimately, the network companies would



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always need to be in control of applications used in network operation or decision making.

*Recommendation 6: BEIS, Ofgem and UKRI should consider how to support third parties to offer digital solutions to networks in a more open and competitive manner.*

**A new approach is required to allow digital innovators to focus on providing solutions for energy consumers.** The ‘grid edge’ defines the boundary at which network regulation applies and establishes the basis for consumer-facing innovators to add value by offering energy services. Markets must be designed that allow for easy consumer participation and regulators must require system operators to deploy the digital infrastructure that will support consumer-friendly markets. This may require significant changes to current operational practises<sup>1</sup>. Further work is also needed to determine where markets need to be developed, and where non-market-based approaches can be applied. For example, in some instances it may make more sense to use well designed protocols to manage energy assets in the same way that internet traffic on broadband networks is managed by protocols.

*Recommendation 7: The Review of Electricity Market Arrangements (REMA) process should identify a digitally enabled target market design consistent with the efficient operation of a fully decarbonised power system.*

**There is a lack of coordination from a central authority regarding energy data and critical digital architecture, such as digital twins<sup>2</sup>.** It is important to ensure interoperability and to avoid common requirements being re-invented by multiple market participants. There is a gap in the system for an organisation to deliver this function. There would be a significant benefit in building a new team to deliver this function to enable a digital-first culture. The Energy Digitalisation Taskforce has recommended that a new Digital Delivery Body is established to fulfil this function. It is important that decision making on energy system data,

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<sup>1</sup> Energy prices are currently set at the wholesale level and reducing demand can create value by avoiding these costs – this is an ‘implicit market’. Grid operators currently purchase other services through competitive allocation of contracts that involve some mechanisms to ensure delivery when required – this is an ‘explicit market’. Explicit markets allow network operators to continue current operational practices but can present bureaucratic obstacles for demand side participation. An alternative would be to develop markets that allow easy demand side participation as part of the regulatory requirement on system operators. This would force innovation in operational practices including the requirement to take advantage of millions of connected devices.

<sup>2</sup> A digital twin of the grid would provide a real-time virtual digital counterpart of the physical system that can be used to test new innovative approaches to grid system managements.



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standards and digital architecture are not divorced from wider system management decision-making. As such, whilst we support the establishment of the Digital Delivery Body and believe that it is important for it to establish its own culture and approach, we believe that it should be merged with the Future System Operator once this is created.

*Recommendation 8: BEIS and Ofgem should establish a Digital Delivery Body for the energy sector to drive deployment of strategic digital infrastructure and implementation of the associated regulatory framework. Policy makers should consider carefully whether this should be merged at some point with system operation functions to create a Future System Operator with the correct culture and capabilities.*

Ofgem must use the regulatory framework to align network company business models with the digitalisation imperative. Network companies are private, albeit highly regulated, entities whose value has been traditionally derived from attracting low-cost capital investment through a low-risk business model and the prospect of predictable returns. They will only embrace the innovation risk required if they are mandated to deliver new outcomes by the regulator and the risks involved can be managed to allow low-cost funding by investors to continue.

This requires a clear net zero mandate for Ofgem to help it manage the regulatory trade-offs involved. Ofgem has traditionally placed the onus on network companies to prove that new investment, including in innovation, delivers direct benefits to consumers. It does not have a statutory mandate to decarbonise the energy system and, therefore, does not translate this into the licence conditions of network companies. BEIS has been reluctant to provide such a mandate or address the innovation gap created by the lack of such a mandate. It is only now considering consulting on a draft energy sector strategy and policy statement to provide Ofgem with context and strategic guidance. Faced with the uncertainties over the pathway to net zero and the economically regressive nature of energy prices, Ofgem has hitherto adopted a conservative approach to defining outcomes required from network companies. The new regulatory framework must ensure DNOs invest ahead of need to support the required pace of change and implement reward mechanisms that encourage the necessary investment.





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*Recommendation 9: BEIS should give Ofgem a specific mandate or guidance to use its regulatory powers to support the electricity system to achieve net zero by 2035.*

**The diversity of legacy IT systems in network companies is holding back progress in the development of digital solutions.** Third party digital innovators cannot develop solutions that are applicable across the networks. This lack of interoperability constrains innovators' ability to commercialise products and achieve scale. Energy network digital operating standards should be developed to ensure that solutions provided by third party innovators can be easily integrated across the system whilst allowing flexibility for networks with varying circumstances. However, any such standards will need to be developed carefully to avoid the creation of a monopoly that favours larger tech companies.

*Recommendation 10: Ofgem should work with networks to support them in transitioning legacy digital network operation systems towards a common core digital architecture.*

**Network companies must improve their digital capacity.** There has been some positive progress in developing digital teams and strategies within network companies. However there remains a significant gap between the current digital capacity and that required to deliver a fully digitalised energy system. Informed decision making in addressing this gap will be important. Network executive management teams will need to rapidly upskill and bring in external digital talent to ensure they can make informed decisions<sup>3</sup>. Network companies often struggle to attract digital talent and are wary about working with external solution providers to avoid dependence on a third party for the delivery of their core functions. The procurement functions in network companies are used to procuring physical electrical assets and they adopt a similar approach to procuring digital solutions. This involves distinct design, delivery, and operation phases. Modern digital innovation methods involve constant iteration and improvement throughout these phases. This inconsistency in approach slows progress and can deter digital innovators.

*Recommendation 11: Network companies need to rapidly increase their digital capacity at all levels of their organisations including board, executive management, management and throughout their operational teams.*

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<sup>3</sup> This shortage of digital skills means that this will inevitably come at a cost until the supply chain in digital skills is addressed through the education strategy.



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*Recommendation 12: Network companies need to overhaul their procurement and contract management processes to support iterative development of digital solutions.*

**The current treatment of intellectual property can also act as a barrier to innovation.** The risk-aversion described above deters network companies from innovating to deliver outcomes defined by their basic price control agreement, and yet these are the only ones whereby they could retain ownership of intellectual property rights. Innovations funded by grant support must be shared with other network operators, thereby diluting incentives to participate. IUK must consider how the approach to intellectual property can be adapted to support innovation and rapid deployment of digital solutions.

*Recommendation 13: IUK should launch an independent review of intellectual property requirements for the electricity networks to ensure these are aligned with the requirements of third-party digital innovators.*

### **Summary of recommendations**

1. BEIS, Ofgem and UKRI requires advice from industry experts to identify the digital standards and architecture required to achieve an efficient, secure net-zero energy system by 2035. The ‘independent energy expert panel’ proposed in the recent BEIS decision document on the Future System Operator includes representation from individuals working in the tech sector or with independent expertise in digital technology, to advise on digital implications of policy proposals
2. BEIS and Ofgem need to ensure greater coherence between the digital and energy system market design policy development teams.
3. BEIS and Ofgem need to integrate digital expertise in their senior management teams and build digital capacity within market design teams. BEIS should appoint a Chief Energy Data and Digitisation Officer in a senior civil service (SCS) grade to oversee the integration of energy policy and digitalisation
4. Ofgem should consider developing specific digital missions for the Strategic Innovation Fund in the future.



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5. UKRI and Ofgem need to re-evaluate how innovation funding can connect with digital roll out to support third party innovators to scale their solutions.
  6. BEIS, Ofgem and UKRI should consider how to support third parties to offer digital solutions to networks in a more open and competitive manner.
  7. The Review of Electricity Market Arrangements (REMA) process should identify a digitally enabled target market design consistent with the efficient operation of a fully decarbonised power system.
  8. BEIS and Ofgem should establish a Digital Delivery Body for the energy sector to drive deployment of strategic digital infrastructure and implementation of the associated regulatory framework. Policy makers should consider carefully whether this should be merged at some point with system operation functions to create a Future System Operator with the correct culture and capabilities.
  9. BEIS should give Ofgem a specific mandate or guidance to use its regulatory powers to support the electricity system to achieve net zero by 2035.
  10. Ofgem should work with networks to support them in transitioning legacy digital network operation systems towards a common core digital architecture.
  11. Network companies need to rapidly increase their digital capacity at all levels of their organisations including board, executive management, management and throughout their operational teams.
  12. Network companies need to overhaul their procurement and contract management processes to support iterative development of digital solutions.
  13. Recommendation 13: IUK should launch an independent review of intellectual property requirements for the electricity networks to ensure these are aligned with the requirements of third-party digital innovators.

## A vision for achieving a digitally optimised net-zero electricity grid

Whilst many commentators have painted a picture of how a digitally optimised net-zero electricity grid might operate, there has been far less focus on how it might be achieved. It will require digital innovators to provide new solutions for network companies and energy consumers. This will require two very different approaches. Network companies are regulated entities whose business imperative is to secure funding at the lowest possible costs of capital. This, in



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turn, creates strong incentives to avoid risks that might compromise delivery of required outcomes or increase the costs of delivery. Consumers are a heterogeneous group whose needs not only differ significantly at any moment in time but continue to evolve given economic and cultural drivers.

Regulation will have a key role to play. It must align the business imperative of network companies with the power system decarbonisation target such that they apply the effort necessary to achieve this outcome. Also, it must ensure that it is as easy as possible for consumer-facing innovators to access value through providing grid services. This will ensure that their full focus can be applied to meeting complex and evolving consumer needs rather than navigating the technicalities of interacting with network companies.

This will require new governance structures and a major shift in approach. Firstly, it is no longer appropriate for the regulator to protect consumer interests through challenging a set of proposals produced bottom-up by each network company. Instead, it must be a joint effort by the Government and Ofgem, to identify the changes required to deliver the least cost pathway to a decarbonised energy system. This must be translated into key outcomes that each network company and the system operator must deliver which, in turn, must balance the trade-off between digital and physical infrastructure. These outcomes will inevitably involve the need for innovation and, thereby, risk. The Government and Ofgem should implement an appropriate delivery support framework to enable network companies to manage the risks and access low-cost finance. This will involve the provision of technical advice and opportunities to share best practice as well as guidance on accessing grants and other sources of public funding. This long-term approach will provide a clear pathway to scale deployment for the technology innovators involved.

Secondly, it will be necessary to provide a clear vision for the nature of the grid boundary to clearly distinguish the activities of innovators providing solutions for network operators and those providing services to energy consumers. A target market design should be established to help set the direction for grid digitalisation. It must ensure that the response by consumers (or, more accurately, the automated controls of connected devices) delivers the full range of services necessary to operate a secure and stable grid. This will probably involve prices that vary by location and the use of artificial intelligence to predict the relationship between price and consumer behaviour. The objective should be to create a simple basis for consumer-facing innovators to access value from flexible consumption, allowing them to focus on offering value-adding products



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and services. Also, common digital standards and infrastructure must be identified and delivered to facilitate new grid-edge markets.

The time-bound nature of the grid decarbonisation challenge requires a major shift in network regulation with new approaches to defining outcomes and managing risks to consumers. This will involve a coordinated approach to setting targets related to network operation, capacity, and the associated markets and ensuring investment occurs sufficiently ahead of need. New technical and financial support capacity should be provided to allow network companies to manage the risks associated with delivering outcomes involving innovation and new approaches.

## About E3G

E3G is an independent climate change think tank with a global outlook. We work on the frontier of the climate landscape, tackling the barriers and advancing the solutions to a safe climate. Our goal is to translate climate politics, economics, and policies into action.

E3G builds broad-based coalitions to deliver a safe climate, working closely with like-minded partners in government, politics, civil society, science, the media, public interest foundations and elsewhere to leverage change.

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