CATAPULT
Energy Systems

Delivering a Digitalised Energy System

Energy Digitalisation Taskforce report

Chaired by Laura Sandys CBE

An independent report sponsored by

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ofgem

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Purpose, remit and acknowledgements

The Energy Digitalisation Taskforce was established by The Department for Business Energy and Industrial Strategy (BEIS), Ofgem and Innovate UK to deliver a set of actionable recommendations that challenge the status quo and help deliver the digitalised energy system needed to reach Net Zero.

The key objectives of the taskforce were to:

- Refocus the energy sector on the challenge and opportunities of Digitalisation as a core component of transformation, not just an enabler
- Accelerate digitalisation of the energy system, enabling Net Zero compatible business models, markets, and industry structures
- Draw on experience from other sectors and provide a focal point to ensure digitalisation efforts are coordinated and effective
- Identify digitalisation gaps that require innovation support
- Identify the governance risks that digitalisation raises and present frameworks to mitigate issues.

We have benefited greatly from the expertise, knowledge, guidance, and insights from an invaluable Project Board. We have also been privileged to have the support of an exceptional Advisory Group. Populated by experts from a diverse range of industries, Advisory Group members shared experiences and lessons from their respective digitalisation journeys, which played a significant role in shaping the final recommendations.

Project Board

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In addition, we are indebted to the stakeholders across the energy sector and beyond who have helped to shape and challenge the Taskforce recommendations across many workshops, meetings, and discussions.

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Contents

Digitalisation of the energy system is not just a 'nice to have', it is a core requirement of a Net Zero economy.

Foreword

Our success in achieving net zero will require harnessing energy from low-carbon sources to power our homes, businesses, and vehicles. To achieve this, millions of installations — including solar panels, battery storage, heat pumps and electric vehicles — will need to be seamlessly integrated onto our electricity networks. This move to a more decentralised energy system will create more complex energy flows, which will rely on the digitalised exchange of data to be managed effectively in, real-time. This digitalised data exchange facilitates an energy system which can accelerate, automate, plan, and anticipate processes far better than at present.

In July 2021 my department, in partnership with Ofgem and Innovate UK, published the UK's first Energy Digitalisation Strategy. The Energy Digitalisation Strategy is an essential step the government is taking, alongside Ofgem and Innovate UK, to ensure that the energy system has the digitalisation policies, regulations, and innovations in place to meet the needs of a net zero system. Furthermore, the Energy Digitalisation Strategy follows on from wider government publications such as the National Data Strategy and Energy White Paper to emphasise the importance of data and digitalisation.

Earlier this year, we launched the Energy Digitalisation Taskforce, in partnership with Ofgem and Innovate UK, to continue the Government's focus on modernising the energy system, to unlock flexibility and drive clean growth towards net zero emissions, by 2050. The Energy Digitalisation Taskforce, like its predecessor the Energy Data Taskforce, has been led by Energy Systems Catapult and Laura Sandys. Both the Energy Data Taskforce and Energy Digitalisation Taskforce were commissioned to deepen policy understanding about the energy sector's journey to digitalisation.

I would like to thank Laura, the team at Energy Systems Catapult and the Taskforce for their efforts. We welcome the work they have put into developing these recommendations and look forward to considering them.

The Rt Hon Greg Hands, MP
Energy and Clean Growth Minister

Introduction

The future energy system will be profoundly different to the one that exists today; it will have to manage hundreds of millions of actions and assets every year,[1] each interacting, engaging, and delivering value to customers and the stakeholders.

The Energy Digitalisation Taskforce aims to empower consumers and drive decarbonisation by outlining the digital journey that must be undertaken.

Customers will have the opportunity to access more complex, blended products through digital platforms and services, with algorithms and smart technology managing energy needs on their behalf.

Generators and storage vectors of all sizes will need to respond to demand profiles, optimising their assets in a more dynamic manner to unlock value in their respective business models. Stability will need to be managed throughout the system at all levels, with varied and multiple roles interacting with new actors and actions.

This is a significantly more complex operational environment and will require a different approach to the design, management, and governance of the system. Furthermore, these outcomes will need to be flexible enough to adapt to changes in the system as the energy transition evolves.

The Energy Digitalisation Taskforce aims to empower consumers and drive decarbonisation by outlining the digital journey that must be undertaken. Importantly, these benefits must be realised without compromising the high standards of system stability, security, and resilience.

Finally, two key principles have been used to test and guide the recommendations throughout the Taskforce, customer satisfaction and decarbonisation; these are the ultimate outcomes that we must deliver to declare the energy transition a success.

Energy is no Longer an Island
The energy sector will support countless other sectors in their drive to decarbonise, achieving Net Zero through electrification and new low carbon energy vectors. In addition, energy is becoming more reliant on other sectors to ensure the smooth operation of the system, utilising new flexible energy assets across sectors such as water, waste, and manufacturing, as well as increasingly and crucially relying on digital systems and telecommunications networks to operate a highly distributed energy system. Energy is closely intertwined with other sectors and this presents a range of challenges and opportunities.

Introduction — continued

What should a digitalised decarbonised energy system “feel” like?

The energy system we will create is an energy system that is designed for customers, shaped and controlled by their actions and needs, anticipating and adapting to their changing preferences, served by frictionless retailers all rewarded for outcomes, not inputs. Customers have a whole system carbon account revealing their carbon consumption.

New business entrants can tailor and shape new propositions to a wide and varied range of options designed around customer products as well as commodity needs. New propositions can access markets scale and deploy many more plug and play options rather than expensive, clunky navigation around an overly complex marketplace.

Networks can manage their network dynamically, responding to changing needs and opportunities; creating integrated market options for their capacity management while also being able to offer options to a wide and varied number of participants to deliver their growing system operation functions. Network interventions are reduced, physical interventions are predicted and mitigated before any outage, and the networks can actively plan investments to get more from less.

The national System Operator can predict, visualise, and oversee the key drivers of imbalance, anticipate responses utilising the most cost-effective response to deliver system stability, providing an open and accessible market portal that triages options autonomously, driving down costs and utilising all existing assets and capabilities.

There are small, medium, and large generation and storage assets, in a more dynamic, renewables led environment they access much more information about the demand profile, maximising their asset utilisation and their rewards through greater responsiveness to changing demand dynamics.

Regulation can manage risk with the data and analysis to anticipate, strategically plan and adapt with agility to the changing market, the new level of interactions, and customer enablement and protection. Regulated investments are informed by excellent data and quality anticipatory analytics, with all actions and interventions producing a whole system carbon read-out.

New propositions can access markets scale and deploy many more plug and play options rather than expensive, clunky navigation around an overly complex marketplace.

Principles guiding the taskforce

The energy system must change substantially to support the delivery of a Net Zero economy.

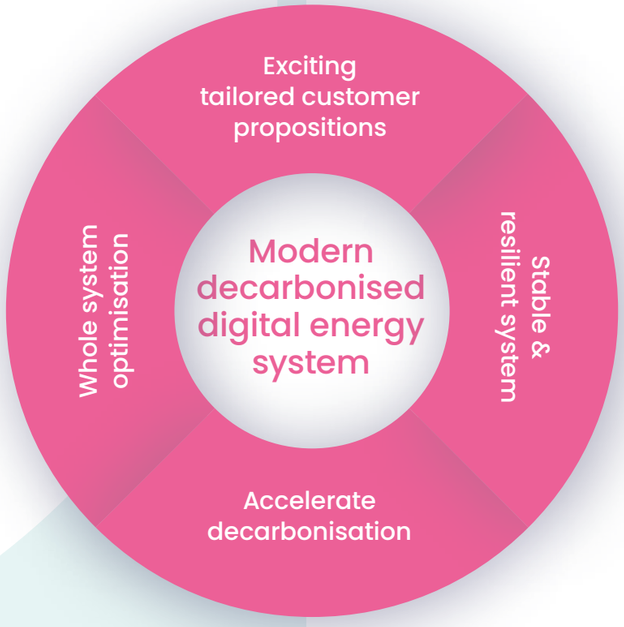
However, there are many possible choices and it is unclear what the ultimate architecture of a future, Net Zero energy system will be.

Within the Energy Digitalisation Taskforce, we have considered a wide range of possible technical, operational, and commercial options and made recommendations which will help to guide the sector to progress towards a digitalised energy system. These recommendations aim to provide policy leaders and regulators with a clear outline of the key requirements, enabling them to implement new policies without predetermining any specific architecture.

We have strived to propose the thinnest policy and regulatory recommendations which support innovation and commercial development, whilst retaining the ability to be flexible and agile as the digital environment evolves. Our recommendations aim to enable others to develop the innovative propositions and solutions to deliver a truly modern, decarbonised energy system.

To guide our work, we have focused on 4 key drivers:

Key outcomes: 4 drivers for digitalisation



- → **Exciting tailored customer propositions** Enabling Net Zero compatible products and services which provide customers with compelling, personalised offers that deliver outcomes the customer values
- → **Accelerating decarbonisation** Creating a digitalised energy system that supports and encourages rapid decarbonisation across energy vectors and user needs
- → **A Stable and resilient system** Developing a system which continues to deliver high levels of stability for end customers, whilst using digitalisation to create additional resilience through more accurate forecasting and dynamic responses
- → **Whole system optimisation** Making the best use of all energy assets across vectors and locations. Using digital tools to guide strategic investment in new infrastructure which deliver an ideal overall solution.

Principles guiding the taskforce — continued

Whole system ambitions and requirements

Whilst we know what many of the components of the Net Zero system architecture could be and we understand many of the deployment and integration challenges, there are still many unknowns. This requires us to design the digital infrastructure with flexibility at its heart.

To address this, we have put forward a set of whole system ambitions that capture the opportunities and challenges ahead, allowing us to identify whole system digital requirements. These have enabled us to reflect on the digitalisation needs of today and the future energy system in parallel.

We have developed our approach against two wide and comprehensive “use cases” to provide the policy, operational and business model optionality to meet future needs.

Prices to devices

Within this setting, we imagine a future energy system with many distributed energy assets that can seamlessly communicate and coordinate to deliver a stable, balanced energy system with minimal human intervention.

Devices spanning the entire energy system, from offshore wind farms to flexible assets in domestic homes, can describe their needs and capabilities, securely communicate these across the system and create commercial agreements that enable value to flow. Customers do not actively interact with the energy system, instead they describe their needs and allow devices to deliver the outcomes whilst minimising carbon and costs. Devices understand their location in the energy system and can coordinate with networks and system operators to work within system constraints, minimising the need for external intervention. Financial reconciliation for interactions is clear and auditable.

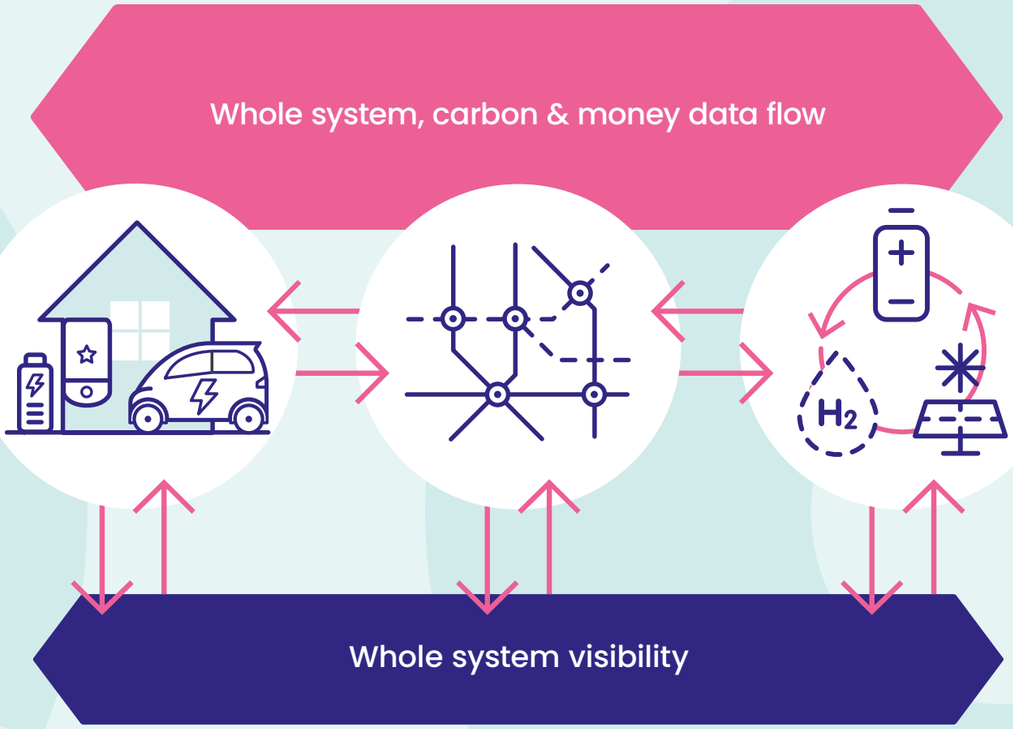
Prices to Devices describes a lean vision of the future energy system, where many of the functions that exist today are automated using energy system data, with both money and carbon flows integrated into the service offering.

Customers describe their needs and allow devices to deliver the outcomes whilst minimising carbon and costs.

Electric vehicle example

An electric vehicle (EV) driver sets their usage preferences (such as a minimum available range after charging) and expects the EV to realise these at the lowest cost and lowest carbon intensity. When the EV is plugged in, it can communicate its needs with energy sources and offer optional services (demand flexibility, V2G, etc.) to the system. The EV identifies other energy assets that can meet its needs and others which want its services, providing these relationships do not violate a constraint from the networks or system operator. The agreement is then made, and the transaction can proceed.

Prices to devices: Delivering end to end digital connections including carbon data flows



Principles guiding the taskforce — continued

Automated and optimised system stability and resilience

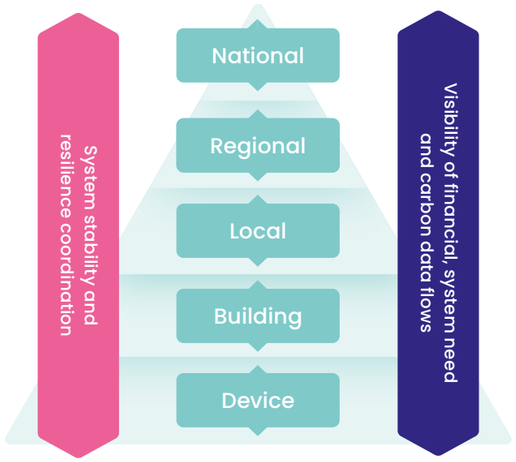
Within this setting, we imagine a future energy system with many actors responsible for system operation at different levels, who need to collaborate and coordinate to deliver a stable and secure system. This use case doesn't determine any centralised or decentralised architecture but by focusing on the potential of multiple system managers at different levels provides the optionality for policy and market design.

To deliver this optionality, decentralised systems are deployed, this enables informed choices to be made about sector operation and structure. There are many business and system stability benefits from multiple, varied actors managing the system.

The digital architecture needs to enable the following:

- → **Devices** can automatically respond to system needs such as voltage or frequency
- → **Buildings** seek to manage energy assets such as self-generation and energy storage to 'balance' their system, only looking to the local level where this is not possible
- → **Local areas** seek to utilise the energy assets under their control such as heat networks or hydrogen heating to manage the system, only looking to the regional and national level where this is not possible
- → **Regional Networks** that self-manage their system utilising localised assets and responses to maintain stability
- → **Transmission Operators** that are responsive and anticipate changes in the system as they feed regional networks
- → **National System Operation** focused on oversight and assurance, only stepping in during exceptional circumstances where regional, local and building level systems have not been able to deliver. This point is critical because it does not mean that the national operator should be totally reactive, rather they should be overseeing and anticipating national need for example during extended periods of low wind or sun.

Delivering system stability: Creating the optionality of stability being delivered at any point of the system



This approach could be decentralised with multiple, distinct operators or centralised with one operator who has multiple levels of focus. In addition, this approach could reveal direct and bi-directional contract option information on availability of assets, networks, and systems. This approach enables entities to bilaterally agree to balance each other through generation, storage, and demand side response. This could be highly decentralised or centralised in terms of ownership and control, but the actions remain the same.

We imagine a future energy system with many actors responsible for system operation at different levels, who need to collaborate and coordinate to deliver a stable and secure system.

Principles guiding the taskforce — continued

With or without digitalisation

The future Net Zero system will not be able to function without deep digitalisation. There are significant benefits to digitalisation for both the customer and system, such as reduced Net Zero transformation costs,[2] increased value for customers, enhanced system stability and resilience as well as exciting new products and services.

Customer benefits and satisfaction

With digitalisation	Without digitalisation
→ **Simplicity and automation** With the crucial need for demand side assets to help reduce the overall costs of the system, customers interaction and participation must be made as simple, fair, and automated as possible → **Appropriately rewarded** Customers actions and the value of their assets need to be rewarded for their whole system value which requires whole system "accounting" → **Exciting new digital products and services** The current customer proposition is very much designed around an analogue world and will be significantly changed through digitalisation with valuable propositions that enable flexibility and choice → **Carbon clarity** Customers have a good understanding of the carbon intensity of their energy and energy services	→ **Integration complexities** Interactions between systems, organisations and customers are clunky and require significant manual intervention → **Lack of incentives** Participants in the energy system are not adequately rewarded for actions that support Net Zero, this is especially true for customers who are not incentivised to make their assets available for system needs → **DIY solutions** Customers are expected to buy energy and technology separately to achieve the desired outcome. This creates complexity and makes it challenging to resolve issues when they occur → **Carbon confusion** Customers have limited visibility of their carbon consumption and cannot meaningfully understand the impact of their actions

Better and more anticipatory and adaptive regulation

With digitalisation	Without digitalisation
→ **Whole system optimisation** With appropriate digital tools and platforms the system operator(s) will have much greater ability to drive best utility from carbon, customers, cost, capacity, and commodity delivering a cleaner, more cost effective and more equitable system outcome → **Customer opportunity and detriment** With new customer digital risk dashboards and visibility of algorithms, the Regulator can anticipate, respond, and intervene in a timely manner → **Infrastructure anticipation** With much greater visibility of both the existence but also the operational capabilities of the system, infrastructure investment can be much more effectively anticipated and planned	→ **Tactical regulation** Interventions driven by events and crisis, resulting in suboptimal solutions that need regular revision → **Customer impacts** Customers either miss out on innovative solutions or are asked to accept an unreasonable level of risk → **Foundational gaps** Without digital transformation leadership: digital infrastructure gaps appear, solutions that do arise are not interoperable and unregulated digital monopolies may thrive

Assuring service and outcomes

With digitalisation	Without digitalisation
→ **Sustained stability** Millions of assets on the system that can perform energy system services creates more redundancy and optionality, this potentially creates greater resilience for the system → **Demand the new balancer** Weather dependent renewable energy doesn't respond to price signals. This means that system balancing and management will rely on demand side actions, these require digital tools to manage and access → **Asset and action visibility** Digitalisation provides more detailed and accurate data about assets at all levels within system → **New understanding of security of supply** With the access to multiple assets, customers will be able to access security of service via their own actions rather than only dependent on the system's supply creating a more robust and resilient system	→ **Expensive Stability** The system will have to build excess capacity for both networks and generation to provide stability at peak. Distributed assets cannot communicate or coordinate so they clash and cause stability issues → **Generation focused operation** Reliance on limited number of large storage and flexibility assets to manage renewables. As the penetration of renewables increases, so does the complexity of operation → **Poor system visibility** Distributed energy assets are poorly understood and cannot provide useful system functions → **Security through excess** Security of supply is delivered via extending the life of antiquated assets and procuring excess generation. Decarbonisation is slow and customer bills are high

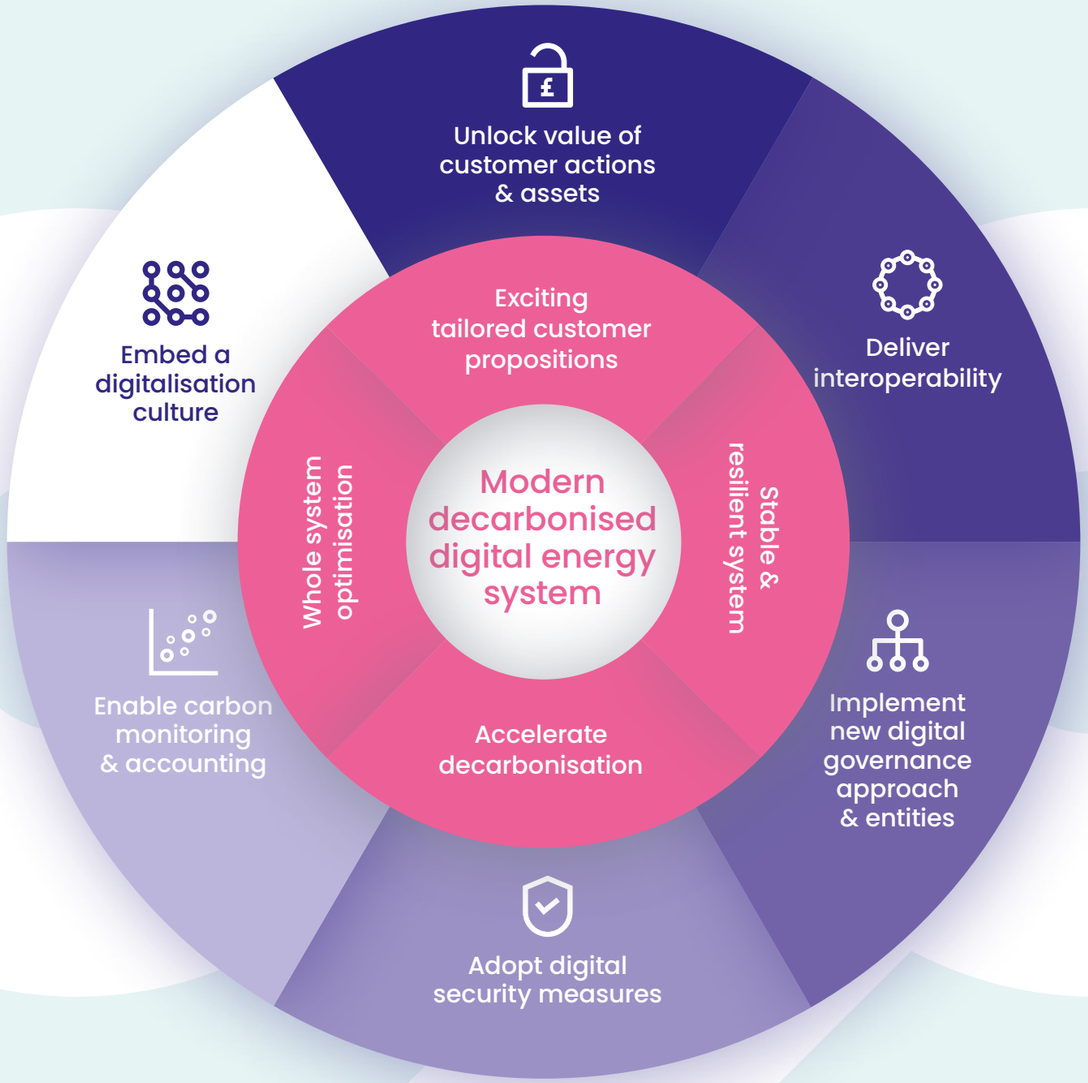
Delivering at the best cost

With digitalisation	Without digitalisation
→ **Getting more from less** Customer assets will provide increased utility to the system and play a more important part of the normal operation of the system. These assets and actions will deliver cost reductions, customer value and optimisation across the board → **Visibility driving optimisation** Visibility of assets, their capabilities and their contractual arrangements will provide significant optimisation opportunities to utilise assets more productively → **Enabling blended solutions** In a multi-actor, multi-product, and multi-service system the digitally enabled interaction between actors, assets and actions will be important to deliver the best outcomes → **Anticipation, prediction, and remediation** Infrastructure investment, management and planning should be more efficient, more anticipatory and provide new approaches to cost reduction	→ **Excess as standard** System stability, energy security and service resilience are delivered by building in excessive amounts of surplus which drives costs up → **Dormant assets** Poor visibility of and access to assets leads to suboptimal utilisation and duplicates investment → **Basic services** Delivery of integrated solutions is challenging so customers are offered basic services which do not deliver value to them or the system

Recommendations

Overview

The Energy Digitalisation Taskforce recommendations are based around a single strategic aim of developing a **modern, decarbonised digital energy system**.



Unlock value of customer actions & assets

Government and the Regulator need to create policy, regulation, and digital infrastructure which enables industry to deliver the trust and assurance to unlock the value of customer actions and assets.

Actions

- → Develop a simple customer consent dashboard
- → Mandate smart enabled energy assets
- → Streamline asset registration
- → Review customer protection regime
- → Utilise smart meter data for public good
- → Recognise data based, virtual solutions

Deliver interoperability

The sector needs to deliver interoperability through the development and deployment of key Public Interest Digital Assets including a Digital Spine solution.

Actions

- → Deliver data sharing fabric
- → Adopt network data standard
- → Deliver energy asset register
- → Deliver energy data catalogue
- → Evolve flexible asset standards
- → Deliver a digital spine for the system

Implement new digital governance approach & entities

Digital Governance needs to be embedded as business as usual with a new Energy Digitalisation Delivery Body to develop the Public Interest Digital Assets and support sector-wide Digitalisation.

Actions

- → Establish governance principles for Public Interest Digital Assets
- → Establish Algorithm Governance
- → Promote Digital Energy Competition
- → Establish a Delivery Body for Public Interest Digital Assets
- → Regulate Interdependencies
- → Develop a Dynamic Risk Dashboard

Adopt digital security measures

Digital security principles and interventions need to be embedded throughout the sector to collectively enable safe digitalisation at scale.

Actions

- → Implement modern password policies and merit order of patching
- → Map cascade effects of system security zones
- → Increase frequency of regular penetration testing
- → Adopt zero trust and least privilege
- → Work towards a Just Culture
- → Run drills and threat assessment exercises
- → Leverage cross-sector collaboration

Enable carbon monitoring & accounting

Carbon emissions from energy production, storage and delivery need to be measured at source with data reported and shared in a standard format.

Actions

- → Mandate dynamic carbon reporting
- → Mandate dynamic carbon monitoring
- → Require separate emissions and offsetting reporting
- → Adopt carbon data open standard

Embed a digitalisation culture

A digitalisation culture needs to be embedded throughout the energy sector by promoting digital leadership, valuing digital assets, and focusing on whole system user experience.

Actions

- → Promote Digital Leadership
- → Value and Investment in Digitalisation
- → Focus on whole system user experience

Recommendations overview — continued

Our implementation plan for the recommendations

Each recommendation has a series of actions, these are categorised in the following format.

Categorisation	Description
Quick wins	→ Least regret interventions that deliver near-term value → Small scale projects with low risk → Deliverable within current policy and regulatory frameworks → 0–24 month delivery
Iterative improvements	→ Interventions that build on existing work to make an incremental step toward a Modern Decarbonised, Digital Energy System → Medium scale projects with some complexity and likely have a need for extensive stakeholder engagement → Broadly deliverable within current policy and regulatory frameworks but may require some regulatory change to drive adoption → 12–36 month delivery
Strategic interventions	→ Interventions that require new approaches or solutions that set the foundation for the digitally enabled Net Zero energy system → Large scale projects that may require funding → May require regulatory change or legislation to implement or drive adoption → 24–60 month delivery

The key tasks have been allocated to an organisation, or set of organisations as follows:

→ **Government** The government departments responsible for policy development
→ **Regulators** Organisations responsible for the implementation of policy and regulation, where this is a specific regulator, this is specified (e.g. Energy Regulator)
→ **Industry** The private organisations that are responsible for the running of the energy system and providing energy products and services to customers
→ **Sector** All organisations in the energy sector.

The Energy Digitalisation Taskforce recommendations span Customer Assets, Interoperability, Governance, Security, Carbon and Culture to deliver a modern, decarbonised digital energy system.

Recommendation 1

Unlock value of customer actions & assets

Government and the Regulator need to create policy, regulation, and digital infrastructure which enables industry to deliver the trust and assurance to unlock the value of customer actions and assets.

Purpose and overview

We need to unlock customers actions and assets to provide both value to the customer but also to the system through the essential flexibility required to deliver a decarbonised system at best value. These recommendations focus on 6 key areas.

With the combination of these measures, we will be able to unlock the value of customers assets and reward them effectively.

Categorisation	Description
Quick wins	→ **Mandate smart enabled energy assets** Embed smartness into all assets being deployed to enable interaction and value to flow to these assets. Retrofitting expensive assets will be costly and intrusive or will result in consumers being kept out of the value flowing from flexibility → **Streamline asset registration** Accelerate the deployment of the central energy asset register, focusing on Auto Registration and setting the foundation for future sector data flows
Iterative improvements	→ **Develop a simple customer consent dashboard** Build appropriate and simple consent methodology which is crucial for consumer protection and to build trust in what and how the energy sector is using consumer data → **Review a customer protection regime** Dynamic and digital consumer propositions require a new outlook on customer protection with more moving parts and we call for greater clarity around redress and some common terms and conditions developed → **Utilise smart meter data for public good** Adopt the PIAG recommendations on access to depersonalised smart meter data for a public interest purpose with appropriate privacy protections [3]
Strategic interventions	→ **Recognise data based, virtual solutions** Progressively adopt and embrace data-based solutions in place of pre-determined technical solutions to unlock and accelerate innovation

Customers should have a seamless energy experience similar to how they enjoy other customer propositions, with the appropriate controls and protections that maintain customer experience.

What does good look like?

Customers should have a seamless energy experience similar to how they enjoy other customer propositions, with the appropriate controls and protections that maintain customer experience. Key to building customer trust in the system will be their ability to control the use of their data through a simple data consent dashboard.

The customer and installer journey needs to be as simple as possible with devices auto-registering at the point of connection or made extremely straightforward through QR codes. The consent dashboard with the asset auto-registration would automatically determine the customer data they have consented to share, providing industry operators the “consented” access to the all-important demand data.

Customers can explore the protections in place that determine the interactions between their devices, energy service, and communications, giving them even more confidence in sharing their data. With customer consent, all existing barriers to proportionate data sharing are removed to enable customers and the system to benefit from deeper data sharing.

Regulation, settlement and system operation will be in a position to use data-centric solutions rather than only rely on specific metering options on offer today, providing more intelligent matching of demand and settlement.

Why this is important

Customers are the heart of the energy system as they create demand for energy which must be supported by networks, generators, storage providers, shippers, and many others. However, the drive towards Net Zero means that we must move away from carbon emitting energy sources, and this means that the way customers currently interact with the energy system is set to dramatically change. We must find ways to heat buildings cleanly, maximise the use of intermittent renewable energy and operate the system in a way that minimises the need for costly and disruptive upgrades where possible. In forward analysis by the system operator, demand is going to play a significantly stronger and more prominent, if not dominant, role in system stability.[1]

Managing complexity

The energy sector is no longer an island, there are significant new interactions with mobility, heat, self-generation, and storage. Integration across these traditionally siloed areas is complex and it is unfeasible for customers to manage this alone. It is essential we put basic infrastructure in place to enable new business models to emerge and thrive, ensuring even the most digitally excluded customers are able to participate whilst driving towards Net Zero.[4]

Recommendation 1: Unlock value of customer actions and assets — continued

Future proofing energy assets

Customers are starting to deploy a range of energy assets that will reduce demand for fossil fuels but will also drive-up electricity demand significantly such as Heat pumps and EVs. This sharp increase in demand could create a need for substantial network upgrades, however many experts believe that flexibility can help to make the best use of available capacity and reduce infrastructure costs.[5] However, many of these energy assets lack basic smart functionality 'out of the box'. This means the energy system has little visibility of their presence and actions but also means they cannot be flexible energy assets. This creates a huge risk for the future, removing a potentially valuable tool for Net Zero, and possibly creating the need for costly digital retrofit or premature replacement programmes.

Unlocking hidden value for customers

Customers should be incentivised and fairly rewarded for their important new role in system stability and reducing whole system costs, something which is not easily achieved in the current system. To enable these new decarbonised products to fairly reward customers, whole system costs need to be visible, accurate, and realisable to ensure fair renumeration, and to reduce the whole life cycle costs of the products.[6]

Facilitating customer data access

Data is critical to the delivery and operation of a Net Zero energy system. However, key datasets such as customer energy demand data (e.g. smart meter data) are not flowing effectively. Customer trust in the energy sector is relatively low and obtaining informed consent for data access is challenging. Once consent has been gained, it is challenging for the customer to understand who has their data, what they are doing with it and how to withdraw consent if they wish. In addition, even where there are legitimate or public interest uses for anonymised customer data, it is challenging for stakeholders to gain access to this data for the public good. This undermines the business case for smart metering by reducing the value of the data that is generated.[3]

Without the appropriate control and consent mechanisms, customer actions will neither be unlocked nor deliver the true value flow to customers

Estfeed

The Estonian TSO has implemented a cross sector consent solution using the X-Road platform. The solution started with smart meter data but has now integrated with many datasets and provides customers with a single place to grant and manage data consent for energy applications.[22]

* Note, consent is just one lawful basis for processing personal data, removing consent would not stop data access where another lawful basis for processing is used (e.g. contract or legal obligation)

Key recommendations

It is critical that Government and the Regulator create and implement policy and regulation that supports a decarbonised customer-centric energy system and enables key functions and resources to be implemented. We recommend that the following actions are implemented.

Develop a simple customer consent dashboard

To facilitate customer data access and manage complexity for customers, it is necessary to develop a solution which enables customers to manage data access consent in a consistent way. Customers should be able to confidently provide consent for data access, understand who has access to their data, for what reason and be able to simply withdraw consent when they see fit.* It is critical to get this right to unlock a swath of new, Net Zero business models that are reliant on customer data and avoid a potential trust collapse.

Government and the Regulator should drive the development and adoption of a simple, unified consent mechanism and dashboard that enables customers to manage their consent. The solution should start with smart meter data with the intention to roll out to other types of personal energy data, setting the standard for economy wide consent management. This type of intervention has strong international precedence, these interventions have delivered significant value to customers and innovators alike.

This could be implemented centrally through an entity such as the Smart DCC or in a distributed way enabled by standards and common interfaces combined with a standalone portal.

Customer protection regime

To **unlock hidden value for customers** and help them to **manage complexity**, it is essential to ensure that customers have the right protection and redress mechanisms to mitigate the risk of new products and services.

- → **Redress** Review of current Ombudsman responsibilities to ensure that there is one stop redress
- → **Core rights** Development of some core Terms and Conditions required to "integrate" their customers into the system through the digital spine which should not preclude innovation but provide the basic protections required
- → **Iterative alignment of customer facing regulatory regimes** Customer energy propositions will rely on functionality from adjacent sectors (e.g. Telecommunications), it is therefore important that customer protection needs are aligned with other regulatory regimes to ensure that there are no underlaps and provide ease of redress
- → **Digital exclusion** Monitor where customers are not able to access the best products or services due to digital exclusion.

Recommendation 1: Unlock value of customer actions and assets — continued

Mandate smart enabled energy assets

Intermittent renewables need to be supplemented with flexible energy assets to create a stable system. It is critical that we **future proof energy assets** and **unlock hidden value for customers** to ensure that new energy assets can be utilised to deliver Net Zero at the lowest cost for all.

Government should mandate that all significant energy assets* have a minimum level of control hardware and IP connectivity which has the capability to support auto registration, data provision, and flexibility services in the future. While it is too early to specify firmware or software solutions, there should be minimum security standards and provision for easy software and firmware upgrades in the future, for example, by secure over-the-air updates.

The intention of this intervention is to provide optionality. The inclusion of basic control hardware and IP connectivity is low cost, and in many cases will create additional value to the business and customers (e.g., smart control, fault prediction, etc.). However, it also creates a potential for these devices to be used to manage the energy system in the future without the need for costly retrofit of digital functionality.

There is an immediate mechanism to implement this with a valuable class of devices through the heat pump support programme.[7] This can be more holistically implemented via legislation or tactically via individual product standards[8] and regulations.

Asset registration

As more energy assets are deployed it will be essential to **manage complexity** and **future proof energy assets** through a simple asset registration solution. BEIS have been considering policy and action relating to asset registration. This needs to deliver a very easy route for manual registration (such as the QR code methods used by smart home devices) and enable the move towards full auto registration aligned with Energy Enabled Assets. This sets the foundation for key assets data to flow across the system to the appropriate and consented system actor.

Smart TVs

For products that have a long replacement cycle it is common to include ‘future proofing’ technologies. One such example is the introduction of IP connectivity into televisions as standard. Whilst this provided little immediate value to the customer, the hardware was cheap and when the streaming market flourished, customers were rewarded with better service. In addition, connectivity created additional value for the manufacturers in terms of real usage and performance data.

* We propose that significant energy assets include all export devices and demand devices with non-trivial energy and power needs e.g. Power >2kW and Energy Demand >6kWh in normal operation

Government should mandate that all significant energy assets have a minimum level of control hardware and IP connectivity which has the capability to support auto registration, data provision, and flexibility services in the future.

Utilise smart meter data for public good

In addition to unlocking consent-based access to data, it is critical to **facilitate access to depersonalised customer data** for public interest purposes. The Smart Meter Public Interest Advisory Group (PIAG), led by Sustainability First and Centre for Sustainable Energy, identified possible routes by which public interest actors might do this, including where DNO smart meter data was depersonalised and treated as system data. This would be in line with ‘Presumed Open’. More consideration is needed however, as this was not specifically discussed in DNO Data Privacy Plans.

The regulator should work with DNOs and GDNs to clarify the regulatory position on access to suitably anonymised smart meter data. In particular, with respect to the existing, Ofgem approved Data Privacy Plans. This is a simple step that could unlock significant value within the Data Access and Privacy Framework.[9]

The Taskforce also supports the wider Smart Meter PIAG recommendations to expand BEIS energy statistics, extend SERL, use smart meter data to improve energy demand representations and focus on the wider use of gas demand data.[3]

We propose that significant energy assets include all export devices and demand devices with non-trivial energy and power needs e.g. Power >2kW and Energy Demand >6kWh in normal operation.

Recognise data based, virtual solutions

The current setup in the energy sector tends to recommend specific technical solutions based on specific hardware or overly prescriptive data processing (e.g., DNO Smart Meter data processing). This has the effect of limiting innovation which restricts the products and services that can be developed and impeding new business models which may be able to better facilitate Net Zero. To address this issue and in turn, **unlock hidden value for customers** it is essential to recognise data based, virtual solutions and enable more assets to be valuable parts of the energy system.

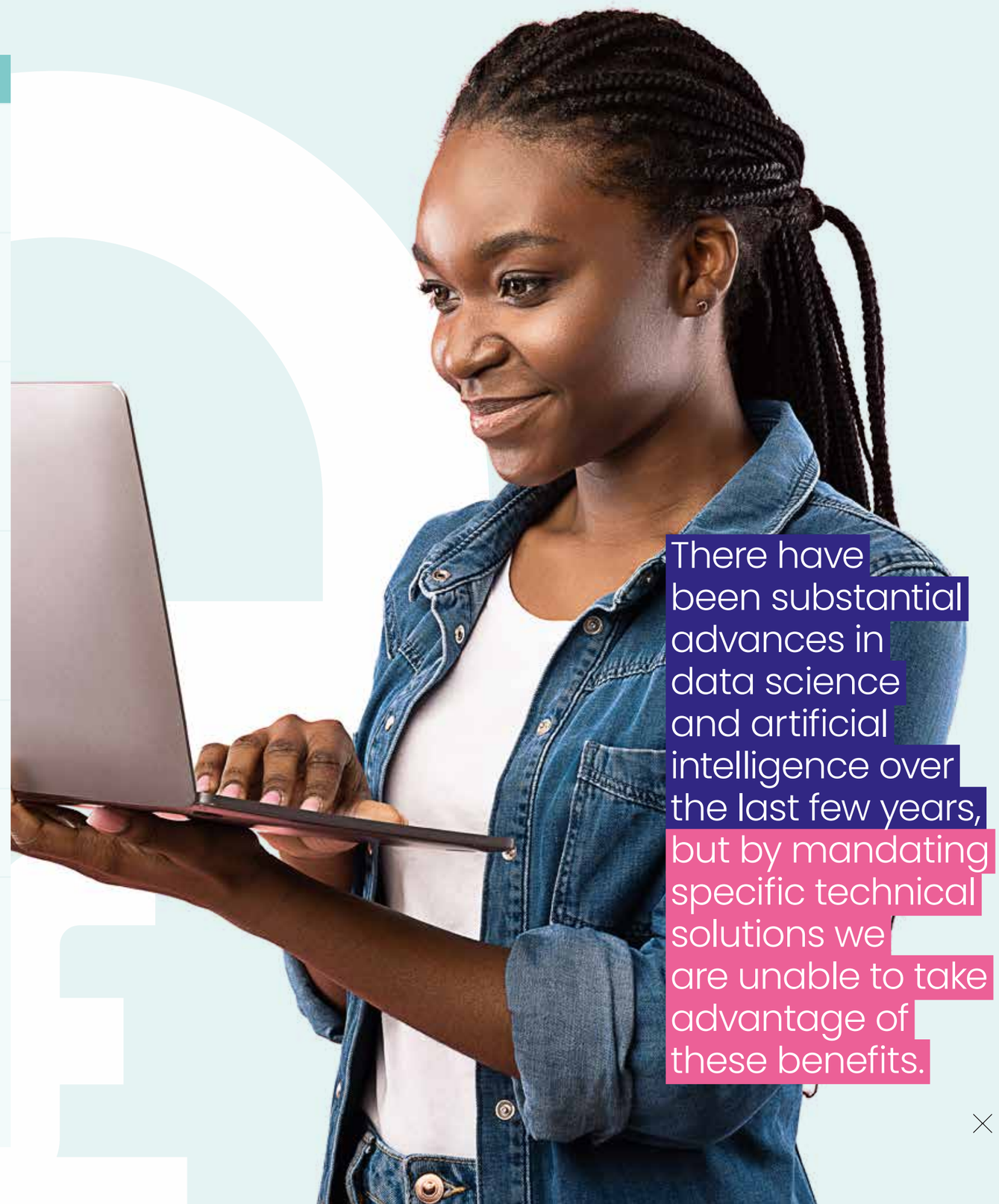
There have been substantial advances in data science and artificial intelligence over the last few years, but by mandating specific technical solutions we are unable to take full advantage of these benefits. For example, it is possible to use data science to disaggregate demand data and demonstrate demand response from individual devices with significant load, but this evidence is not universally accepted in markets which creates a barrier to unlocking flexibility income streams.

The Regulator should review licences and codes to identify and remove the current specific technical solutions and instead define the desired outcome and validity tests so that industry can innovate and deliver solutions which deliver the desired outcome and maximise benefit.

Recommendation 1: Unlock value of customer actions and assets — continued

Key tasks

Task	Lead actor	Description
Develop a simple customer consent dashboard	Government	→ Deliver customer consent dashboard for smart meter data based on leading international implementations → Define approach for third party integration of additional energy data consent → Drive value-based adoption across industry
Review customer protection regime	Energy Regulator	→ Review existing redress process (ongoing) and consider fitness for digitalised energy sector → Consider the need for core rights of energy customers → Align protection regimes across regulators to ensure holistic protection
Mandate smart enabled energy assets	Government	→ Define 'minimum smart hardware requirements' for significant energy assets with industry → Consult with industry on the proposed requirements and target assets → Integrate into policy and support regimes such as the upcoming heat pump scheme (7) → Consider regulator integration as appropriate
Streamline asset registration	Government	→ Define user friendly registration process for customers and industry in near term → Define auto registration process for significant energy assets → Consult on auto registration process with industry → Integrate auto registration requirement into policy and regulation as appropriate
Utilise smart meter data for public good energy	Energy Regulator	→ Clarify regulatory position on the publication of suitably aggregated and anonymised smart meter data by network companies as system data
Utilise smart meter data for public good	Government	→ Implement Smart Meter PIAG recommendations particularly the use of granular smart meter data to improve BEIS energy statistics
Recognise data based, virtual solutions energy	Energy Regulator	→ Review regulatory mechanisms to identify overly specific technical requirements and replace with outcome focused equivalent. Specific target areas: • DNO Smart Meter data privacy: use of non-aggregation anonymisation methods • Flexibility Response: review the requirement for physical evidence of response • Balancing and Settlement: use aggregated data as 'virtual meter' to evidence self-balancing across meters in local area → Establish guidelines for verifying the accuracy of data-based solutions



There have been substantial advances in data science and artificial intelligence over the last few years, but by mandating specific technical solutions we are unable to take advantage of these benefits.

Recommendation 2

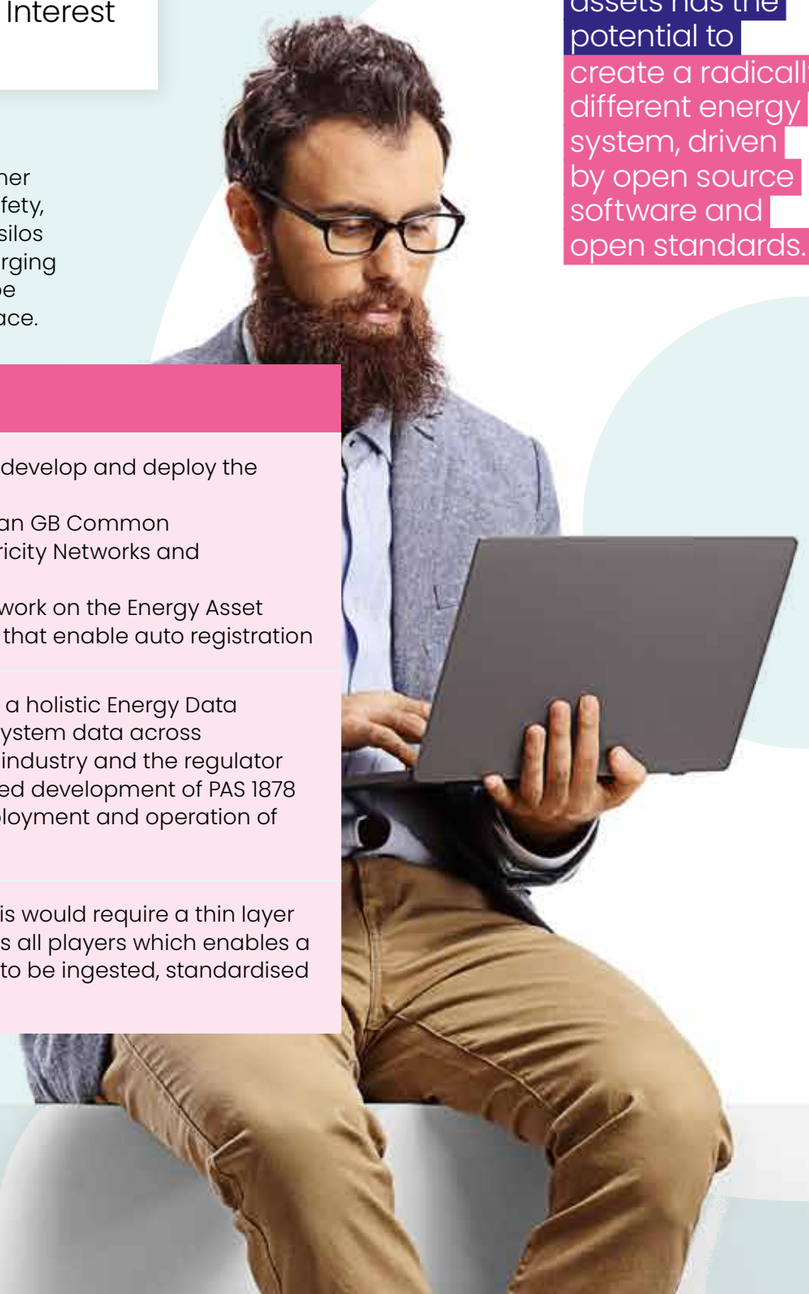
Deliver interoperability

The sector needs to deliver interoperability through the development and deployment of key Public Interest Digital Assets including a Digital Spine solution.

Purpose and overview

As the energy system becomes increasingly interdependent with other systems such as telecoms, interoperability will be key to maintain safety, security, and efficiency. There is value in breaking down the existing silos within and between organisations, and value in harnessing the emerging interactions of different assets and actions. Realising this value will be significantly easier with the suitable digital tools and platforms in place.

Categorisation	Description
Quick wins	→ **Deliver data sharing fabric** Continue to develop and deploy the essential Data Sharing Fabric solution → **Adopt network data standard** Develop an GB Common Information Model (CIM) profile for Electricity Networks and develop a solution for Gas Networks → **Deliver Energy Asset Register** Continue work on the Energy Asset Register and seek to develop interfaces that enable auto registration
Iterative improvements	→ **Deliver energy data catalogue** Develop a holistic Energy Data Catalogue that provides visibility of all system data across the energy sector as a valuable tool for industry and the regulator → **Evolve flexible asset standards** Continued development of PAS 1878 & 1879 to support the development, deployment and operation of flexible energy assets [11]
Strategic interventions	→ **Deliver a digital spine for the system** This would require a thin layer of interaction and interoperability across all players which enables a minimal layer of operation critical data to be ingested, standardised and shared in near real time



The development and deployment of limited, common digital assets has the potential to create a radically different energy system, driven by open source software and open standards.

What does good look like?

The development and deployment of limited, common digital assets has the potential to create a radically different energy system, driven by open source software and open standards. Open source is defined by the removal of restrictions on selling or giving away software used in aggregated packages, distribution of source code as well as compiled code, being technology neutral, and allowing derived works.[10]

Customers who engage with the energy system have a much more seamless experience. Customer devices automatically register as required and they can participate in system operations natively through the flexibility standards and their service provider's Digital Spine node. The customer can understand and realise the value of their asset to the whole system, not only in monetary value but also in carbon impact. Digitalised systems can use this information on their behalf to realise their objectives.

Innovators can locate energy datasets and gain access to a wide pool of not just open data but pre-emptively licenced, shared data via the Energy Data Catalogue, auto-registration portal, and the Data Sharing Fabric. This enables them to identify opportunity for new products and services which can then be developed in record time thanks to robust standards and a wealth of open source resources. Carbon data is readily available and provides them with a robust way to demonstrate their carbon impact to customers and investors.

Industry actors can access information about and optimise their own or their customers actions based on the system's needs. This is delivered without navigating multiple and potentially conflicting digital frameworks developed by different actors.

Recommendation 2: Deliver interoperability — continued

Why this is important

The energy system is becoming increasingly decentralised, there are more actors and assets than ever before, and this is set to continue to increase as we deploy the solutions required to reach Net Zero. Each of these assets can be a valuable part of the Net Zero energy system, delivering resilient, reliable services that customers need, but only if they can be coordinated to work together effectively.

Increasing innovation and competition

Interoperability will enable innovators to compete to develop the best products and services at the lowest system cost. Without interoperability, customers and business alike will face higher costs due to the increased complexity to develop and scale products and services, and the suboptimal utilisation of energy assets. In addition, the prevalence of proprietary solutions will reduce competition and limit customer choice as they will be less able to move between service providers and solutions.

Maximising resilience in a distributed system

To maximise resilience, it will be essential for those involved in system operation to have a good understanding of the scale of energy assets available to them, the current and planned action of assets, and their remaining capabilities at near real time. This is not possible today, largely due to the lack of interoperability between systems and the minimal sharing of mission critical data. This needs to be addressed to support a stable and resilient energy system.

Spending customer money efficiently

There are multiple exciting digital solutions being developed today. Whilst they are being developed in good faith, there is a large amount of duplication and customers are ultimately paying for this. In addition, many of the solutions are being developed in silos which means that they are not interoperable and ultimately, they are unlikely to all survive — this is wasteful and again being paid for by customers. By driving interoperability we can reduce waste and maximise the value of customer investment.[6]

Why Open Source is important?

- → For software to be open source it must meet the definition set out by the Open Source Initiative. The accompanying standards must also be open throughout to prevent licence conflicts.
- → Open source software drives interoperability through community development, removes the recurrent issue of vendor lock in, enables flexible iteration through collaboration, and builds skills.
- → With crucial monopoly actors in the energy sector, open source software is important to enable the widest access possible to emerging digital solutions
- → The UK is a leader in open source software infrastructure which should be leveraged to expand globally.

There are a number of projects across the sector which are already developing shared digital infrastructure using open source software and standards and these are to be applauded.

Key recommendations

It is critical that the sector comes together around Net Zero to develop and deploy some key enablers of interoperability. We recommend that the following actions are implemented.

Develop public interest digital assets

It is recommended that the Government, the Regulator and Industry fund and develop a very limited set of **Public Interest Digital Assets**. These should either be developed by Government or carefully managed with strong governance mechanisms in place.

Wherever possible, it is proposed that these should be based on open source software, open data licences and open standards to maximise the utility of the sector investment, increase the likelihood of international adoption and minimise technical monopolies.

There are a number of projects across the sector which are already developing shared digital infrastructure using open source software and standards and these are to be applauded. It is now critical to ensure that these point solutions are integrated to deliver a robust, interoperable digital ecosystem which can deliver the decarbonised products and services customers need as part of a coherent digital architecture. Importantly common “connectivity” interfaces are crucial for new innovators to scale businesses nationally and enter the market

We have outlined some of the key Public Interest Digital Assets below.

Data	Asset	Operations
→ Energy data catalogue → Data sharing fabric → Network data standards (CIM)	→ Energy asset register → Auto registration → Flexible asset standards (PAS 1878 & 1879) [11]	→ Digital spine → Carbon monitoring & data

Energy data catalogue

There is still the need for holistic visibility of data across the energy system to **increase innovation and competition**. This needs to not be limited to just data which is open or shared but all data assets. This is particularly important within the regulated monopoly space and is an essential tool for the monitoring and enforcement of Data Best Practice.

There has been some progress in this area through the BEIS funded, innovation projects with Office of National Statistics and latterly Icebreaker One but there is more work needed to deliver the required outcome.

Public interest digital assets

Technological solutions that are built, managed, developed or operated where a coherent approach benefits wider society.

→

Recommendation 2: Deliver interoperability — continued

Data sharing fabric

Secure data sharing is essential in the future energy system as it can **Increase Innovation and Competition, Maximise Resilience in a Distributed System** and **Spend Customer Money More Efficiently**. We define the Data Sharing Fabric as "The governance, administrative and technological solution for the management of access to Shared Data across organisations."

There has been some fantastic work in this space, funded through the Modernising Energy Data Access funding competition and delivered by Icebreaker One. This competitive process has resulted in Open Energy which is currently in Pilot and could be the basis for further development.[11]

Network data standards

Network data is one of the most critical pieces of information for those seeking to deploy and operate low carbon technologies including generation, storage and flexible assets. This data needs to be standardised across organisations to **Increase Innovation and Competition** and enable innovations to scale up much more rapidly than they can today. The Common Information Model (CIM) is the most established standard available; this should be mandated in regulatory tools (such as the Long Term Development Statement) and the sector should develop and maintain a GB profile to drive consistency. In addition, the sector should develop a CIM like standard for Gas Network data to increase cross vector interoperability.

Flexible asset standards

Flexible Energy Assets are going to be essential to the future operation of the energy system, driving interoperability through standards will **Increase Innovation and Competition, Maximise Resilience in a Distributed System** and **Spend Customer Money More Efficiently**. PAS 1878 & 1897 [11] are a great start, and it is essential that the work to develop the full standards continues. To maximise impact and recognise the role of government funding, these should be open standards as this will enable open source implementations and increase innovation further.

The Taskforce believes that PAS 1878 & 1897 [11] are the most promising standards for flexibility assets and supports their further development. However, we should be cognisant that we are part of a global industry and consider how international adoption can be promoted, or if there is an alternative solution with wider global adoption.

Energy asset register

A central Energy Asset Register is essential to ensure **Customer Money is Spent Efficiently** and **Increase Innovation and Competition**. Fundamental asset registration should not be subject to commercial capture, and we should be striving towards auto registration. BEIS has a workstream looking at this [13] and should set a mechanism to enable assets to easily register.

The sector needs to develop and deploy a very thin Digital Spine across the energy system which enables a minimal layer of operation critical data to be ingested, standardised and shared in near real time.

* e.g. current, voltage, frequency, pressure, flow rate, current demand, available flexibility, storage import/export capacity, generation capacity, etc.

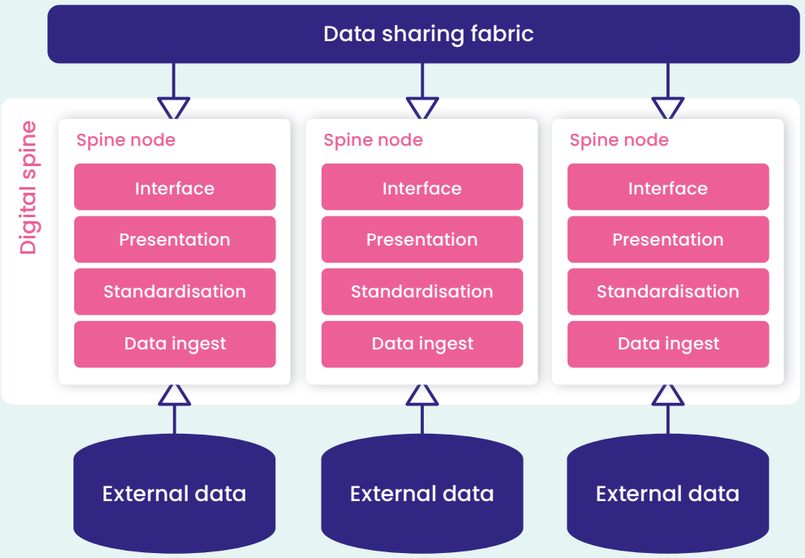
Create a digital spine

The future energy system will be reliant on a huge number of distributed energy assets and may well be operated by multiple entities. In order to **Maximise Resilience in a Distributed System** and **Spend Customer Money Efficiently** it is essential that we put a basic and thin shared infrastructure in place that enables mission critical operational data, financial reconciliation and price signals to flow across actors within the energy system as seamlessly as possible.

The sector needs to develop and deploy a very thin Digital Spine across the energy system which enables a minimal layer of operation critical data to be ingested, standardised and shared in near real time. The Digital Spine should leverage existing data across the energy system to create a virtual nervous system which helps those responsible for operating the energy system at various levels to take actions that ensure the system is stable and resilient.

At its most simple, the proposed Digital Spine is formed by a network of connected nodes that are deployed by organisations across the energy sector. Each node ingests data about the energy system, focusing on a small number of key operation critical metrics,* standardises this key information and offers a basic overview of the status of the system. Each node provides a standard interface which can be accessed by other nodes in the network via the common Data Sharing Fabric to share data across systems. The node owner can choose to expose raw data or aggregated information where more sensitive data has been identified through the Open Data Triage process.

The digital spine: Outline of the architecture



Recommendation 2: Deliver interoperability — continued

Importantly, the Digital Spine should not be owned or operated by one organisation. It should be a network of independent nodes which communicate to create a holistic solution. There may be a need some central functions such as authentication, security and signalling but many of these could be realised through the Data Sharing Fabric operator.

Without this intervention, there is a real risk that we lose potentially valuable optionality and are forced to operate the system in a specific way, based on what is possible within today's technology solutions. This is highly unlikely to be the optimal solution and may not deliver the functionality needed to embrace future decarbonised system.

It is recommended that the Digital Spine is developed as a totally independent project with no commercial interests to ensure that it is built in the interest of customers and stakeholders across the system rather than a specific organisation or operational paradigm. In addition, we believe that the solution should be open source to enable decentralised ownership, development and maintenance of the software by all interested stakeholders. This will further enable companies to easily integrate the Digital Spine into their own products and services which create additional value for customers.

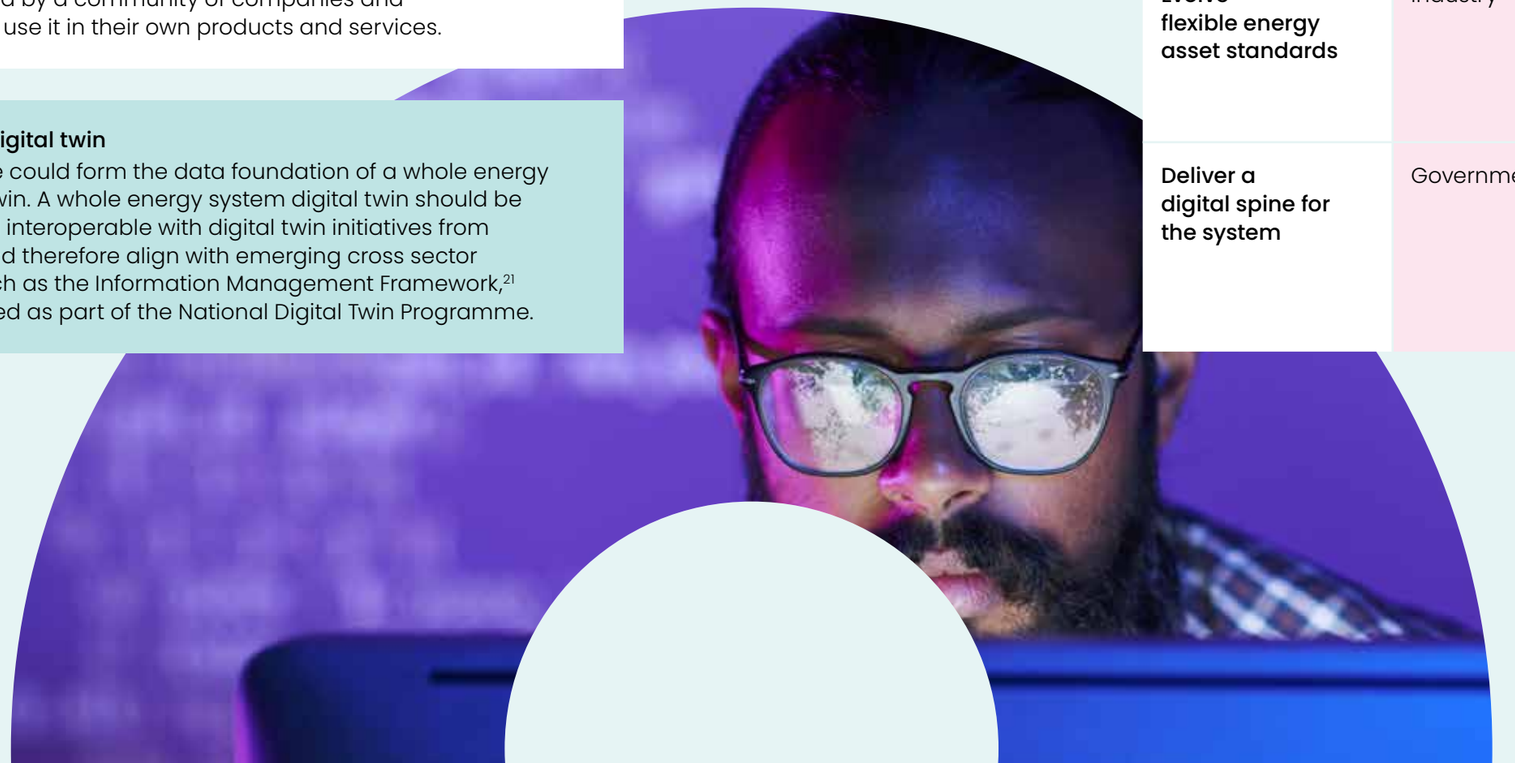
It is recommended that the Digital Spine is developed as a totally independent project with no commercial interests to ensure that it is built in the interest of customers and stakeholders across the system rather than a specific organisation or operational paradigm.

Internet real time communications

WebRTC is an open source project that enables devices to establish real-time communication directly between internet browsers without the need for additional software or plugins. WebRTC enables decentralised, private communications , across browsers and platforms, without the need for platform intermediaries. The solution is not owned by any one company but is maintained by a community of companies and developers who use it in their own products and services.

Whole system digital twin

The Digital Spine could form the data foundation of a whole energy system digital twin. A whole energy system digital twin should be compatible and interoperable with digital twin initiatives from other sectors and therefore align with emerging cross sector approaches such as the Information Management Framework,[21] initially developed as part of the National Digital Twin Programme.



Key tasks

Task	Lead actor	Description
Deliver energy data catalogue	Government	→ Define requirements for Energy Data Catalogue which could provide holistic visibility of data across the energy sector → Develop Energy Data Catalogue solution (possibly building on existing work) → Utilise policy and regulation to drive adoption
Deliver data sharing infrastructure	Industry	→ Continue development of core Data Sharing Infrastructure
Adopt network data standard	Industry	→ Develop common GB CIM profile for electricity networks → Develop MVP Gas CIM solution for gas network data → Drive adoption through shared platforms and solutions
Deliver energy asset register	Government	→ Develop a central Energy Asset Register
Evolve flexible energy asset standards	Industry	→ Continue to develop open standards for Flexible Energy Assets based on PAS 1878 & 1879 [11] → Horizon scan for viable alternatives with significant industry backing
Deliver a digital spine for the system	Government	→ Central funding to develop a core open source Digital Spine solution → Regulation to drive adoption in licenced actors and code signatories → Supply chain terms and conditions to flow adoption down to non-regulated entities

Recommendation 3

Implement a new digital governance approach & digitalisation entities

Digital Governance needs to be embedded as business as usual with a new Energy Digitalisation Delivery Body to develop the Public Interest Digital Assets and support sector-wide Digitalisation.

Purpose and overview

We are at the beginning of digital journey, an agile, iterative approach to regulation and governance will be required. These recommendations highlight what will be needed to anticipate some of the future governance challenges going forward. As some of these functions will be developed by private sector companies, it is crucial that public interest is served, and appropriate governance is in place.

Categorisation	Description
Quick wins	→ **Establish governance principles for public interest digital assets** Set clear governance expectations for organisations responsible for the development and operation of Public Interest Digital Assets to ensure they are efficient, effective, and transparent → **Establish algorithm governance** Registration of algorithms should be required for those that have system and customer impacts with progressive transparency dependent on their designed impacts on the system → **Promote digital energy competition** Proactive, positive interventions such as Presumed Open, Open source and third-party investment combined with responsive regulatory oversight
Iterative improvements	→ **Establish a delivery body for public interest digital assets** Government should establish an Energy Digitalisation Body that has the mandate and resources to deliver Public Interest Digital Assets on behalf of the sector. Such assets should then be transferred to the sector for ongoing operation and maintenance. → **Regulate interdependencies** With growing convergence across regulatory regimes from customer protection, system resilience and infrastructures, there needs to be much more cross regulatory data and risk sharing mechanisms
Strategic interventions	→ **Develop a dynamic risk dashboard** Deploy a holistic Dynamic Risk Dashboard that enables the Regulator to oversee and manage risks, especially with respect to new digitally enabled business models

What does good look like?

Getting digital governance right will enable the industry to confidently digitalise the energy sector knowing that there are safeguards in place to identify and mitigate negative outcomes. The energy Regulator will be well equipped with tools to enable the effective monitoring of emerging business models, companies and algorithms, which will help to identify system risks before customers are negatively impacted. There will be a suite of effective interventions that help to ensure that Public Interest Digital Assets are managed effectively, promoting competition and innovation.

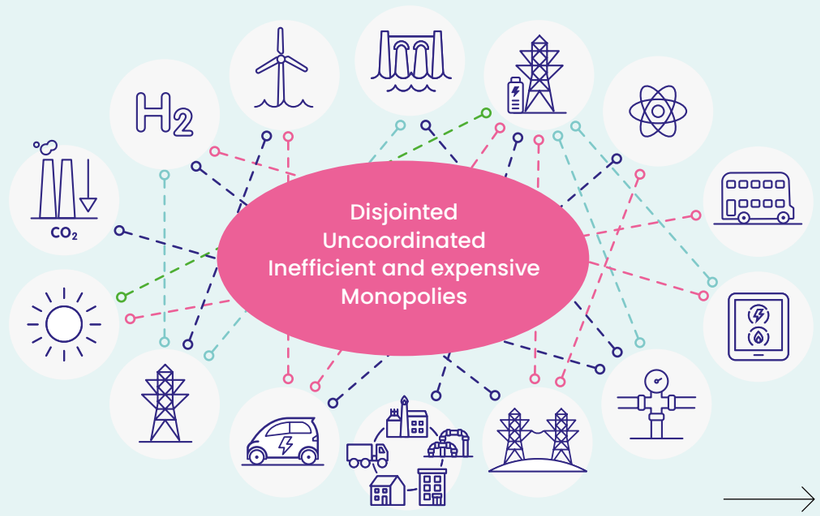
Dependencies on adjacent sectors will be well understood and regulation across sectors will be mutually supportive, creating better visibility of cross sector risks. Most importantly, new digital governance will be agile, anticipatory, and able to mitigate negative trends.

Why this is important

The future energy system will be dependent on digital infrastructure to provide a multitude of vitally important digital functions. From communications networks that are essential for the management of flexible, distributed systems to the Data Sharing Fabric, which enables mission critical data to be securely shared between organisations. If the digital systems the energy system relies on were to fail, the stability of the system would be jeopardised.[13]

We need to recognise that we are at the start of a journey and that regulation needs to be agile and respond to the changing circumstances; what appears to be a risk today might be less of a risk in the future. It is therefore important that governance should evolve with the sector as the digitalisation journey continues — with iteration and on-going review and revision.

The Tower of Babel: The outcome if we do not address whole system interoperability



Recommendation 3: Implement a new digital governance approach and digitalisation entities — continued

Developing public interest digital assets effectively and efficiently

The proposed Public Interest Digital Assets need to be developed rapidly to meet the needs of the future energy system. At present, there is a patchwork approach where different organisations are independently leading on distinct assets with lock-in. This means they are not as well coordinated or integrated as they could be, and the rate of progress will vary wildly. In addition, sector stakeholders are not well informed about the development of the assets or do not understand how they will work together.

Governing the management of public interest digital assets

There are already emerging organisations responsible for operating what could be seen as Public Interest Digital Assets that will have growing influence in the future energy sector. A capable new entrant could absolutely be the force for positive change that we need, but there are risks that need to be managed. It will be essential to ensure that costs are kept low and distributed fairly, technical solutions deliver outcomes users need, and the organisation is prudently managed and appropriately governed to ensure it delivers solutions in the public interest.

Managing new digital risks

There are a growing number of digital systems that have the potential to materially impact the operation of the energy system positively or negatively, for instance, algorithms responsible for controlling flexible energy assets. If an algorithm responsible for controlling a non-trivial amount of energy assets were to fail this could cause issues for system operation or drive-up costs for customers. At present, we have little visibility of digital risk in the sector and this means we are unable to understand the magnitude or what the appropriate mitigation approach should be. Furthermore, there is also a wider risk that a significant system outage could result in a kneejerk reaction that could stifle innovation and slow progress towards Net Zero.

Promoting digital competition

As the energy system is digitalised there will be many new roles and functions that emerge. Some of these will be inherently competitive and attract multiple innovators and investors, such as demand side response, but other areas may be less competitive and pose an increased risk of digital monopolies. Whilst not all monopolies are inherently undesirable, and many will be naturally time limited, it is important that customers are protected from the potential negative impacts of monopolies such as predatory pricing and substandard products or services.

There are a growing number of digital systems that have the potential to materially impact the operation of the energy system positively or negatively.

Preventing customer detriment

Digital innovation will result in many benefits for customers across the energy system. However, new business models and customer propositions may cause customer detriment through unreasonably high costs or interruptions to service as they are developed. In addition, it is critical that we avoid passing on the cost of failure to customers wherever possible, and to make sure that customers who are digitally excluded are not faced with rising costs.

Managing Sector Interdependencies

Infrastructure sectors have historically been regulated in silos based on the perceived needs and risk appetite of each sector. As we see an increasing convergence of sectors (energy, telecommunications, water, waste, finance etc.) there is a risk that certain regulations create gaps or conflicts that impact another sector. This is exacerbated by the fact that many licences, codes, and other forms of governance are reliant on manual processes, it is therefore very difficult to understand the full consequences of a change without a significant understanding of the governance mechanism in question.

The increasing interdependency of the telecommunications and energy systems is a notable example where greater cooperation and collaboration should be encouraged to mitigate risk.

Telecommunications and Energy

As we move towards a flexible energy system that is dependent on communications systems to maintain stability, communications outages will present a significant threat. Outages on the energy system will create a cascade of failure across telecommunications systems where backup is not present, if we are reliant on distributed energy assets to restart the energy system then a lack of communications systems will further complicate the issue of getting back up and running. Telecommunications and Energy should be considered as key aspects of an integrated system.

Recommendation 3: Implement a new digital governance approach and digitalisation entities — continued

Key recommendations

Government and the Regulator should take proportionate steps to realise a governance framework or enhance existing frameworks for digital energy, which establishes trust in digital infrastructure and mitigates the potential negative impact of digitalisation.

Establish a delivery body for public interest digital assets

Public Interest Digital Assets will be vital to deliver a stable and resilient Net Zero energy system. It is therefore critical that the sector can develop Public Interest Digital Assets effectively and efficiently and ensure that the assets deliver the required whole societal benefits. However, it may not be immediately clear which organisation should be the ultimate owner for each asset from the outset, that will create confusion and delays to the development of critical digital infrastructure.

Public Interest Digital Assets will be vital to deliver a stable and resilient Net Zero energy system. It is therefore critical that the sector can develop Public Interest Digital Assets effectively.

It is recommended that an independent, commercially disinterested body is established by Government to develop and/or incubate Public Interest Digital Assets on behalf of the sector. The Body should be given a mandate and funding to develop and deploy assets (either directly or via partners), directed by a stakeholder panel interested in the current and future needs of the energy sector. The benefit of this is that it would report to government but operate to the side of it.

The Body should consider the energy sector's role in the wider Net Zero journey and coordinate with Government entities to ensure that the right digital assets are created and interoperate with those in other sectors or domains.

The Body should not be the enduring home for such solutions. Progressively, they should be embedded into different organisations for ongoing operation or, alternatively, gifted to the energy sector as open source projects for continued development and implementation. Where assets need public ownership the proposed Future System Operator could be a good option, when independent.

The Body should lead the assessment of assets and make recommendations to Government, the Regulator, and Industry for the ongoing governance arrangements. It should be overseen by Government, with an independent stakeholder panel group to direct the Body. Finally, there should be an industry grievance process to ensure it does not stray into commercial territory.

Delivery body: Key characteristics

- → **Independent** Oversight from Government but with a mandate and funding to operate independently
- → **Technically capable** Expertise in the delivery of digital systems
- → **Collaborative** Able to engage and collaborate with sector stakeholders
- → **Time limited** An initial 3-year mandate to accelerate digitalisation and target to transfer assets to sector management in good time.
- → **Vision** Strong understanding of the energy sector needs and able to communicate this with the sector.

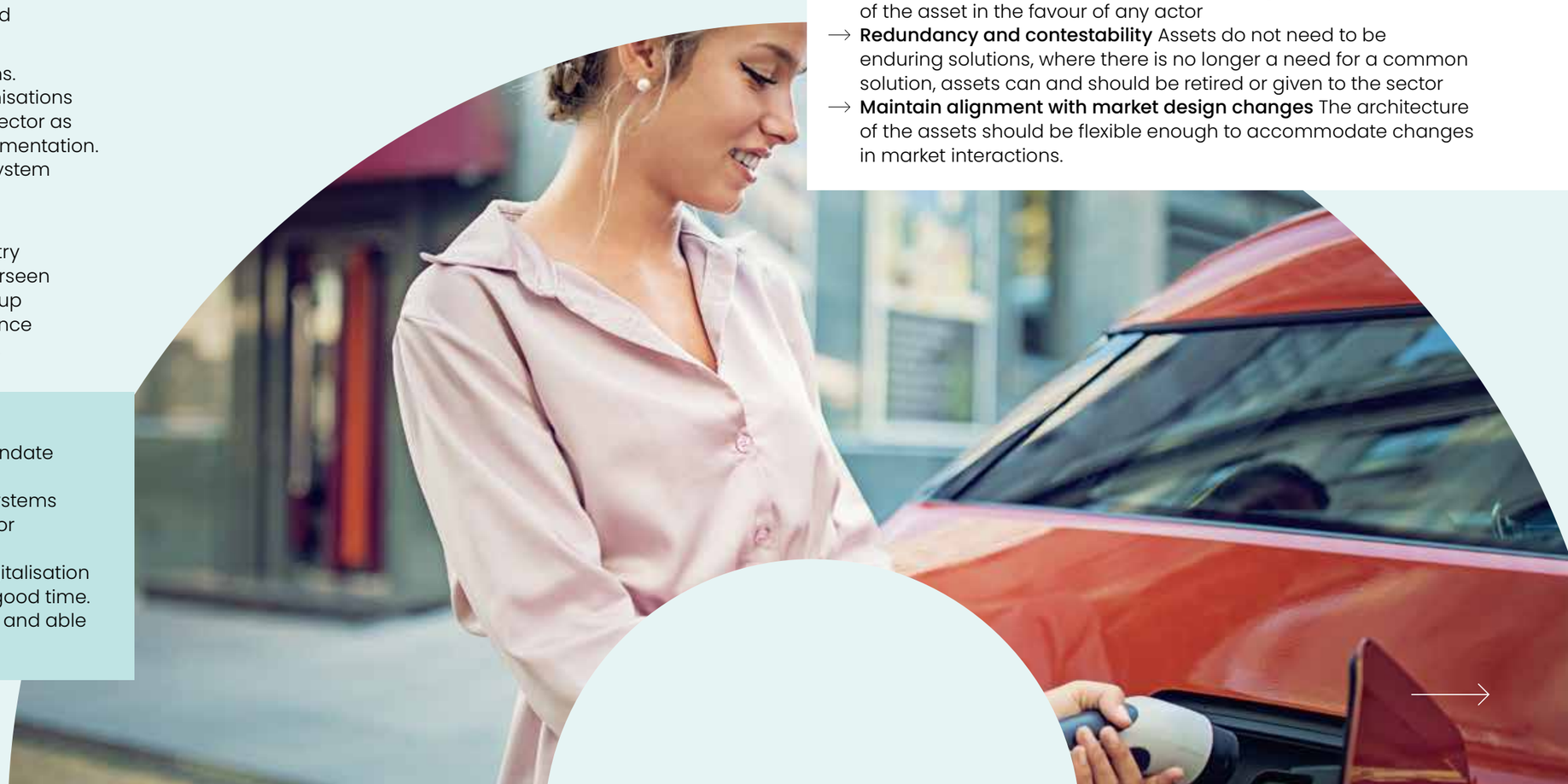
Public Interest Digital Asset Governance

It is necessary to govern the management of Public Interest Digital Assets to ensure that the assets are operated and maintained well and deliver the desired benefits to the sector. More detail is provided in the Governance annex, including details of how the evidence to support decisions will be captured in a knowledge base.

Where a digital asset is deemed to be valuable to the overall system (either temporarily or permanently) the organisation responsible for the asset should be governed in a robust and transparent way to ensure that it is funded fairly, provides the anticipated benefit, and delivers value for money for customers.

There should be governance expectations which include:

- → **Good corporate governance** Robust ownership structure, formal independent board oversight, regular reporting, etc.
- → **Open source and open data** This should be used as default, enabling innovators to use and build on solutions with ease.
- → **Limited in scope** Every common asset should have the thinnest scope possible to achieve the desired outcome whilst leaving space for commercial innovation
- → **Balanced funding** Financial support should be transparent and not result in explicitly or implicitly biasing the operation of the asset in the favour of any actor
- → **Redundancy and contestability** Assets do not need to be enduring solutions, where there is no longer a need for a common solution, assets can and should be retired or given to the sector
- → **Maintain alignment with market design changes** The architecture of the assets should be flexible enough to accommodate changes in market interactions.



Recommendation 3: Implement a new digital governance approach and digitalisation entities — continued

Promoting digital competition

It is vital that we promote digital competition across the energy sector both through proactive, positive interventions and responsive regulatory oversight. The regulator should conduct regular market reviews, which will cover data and digital services and could help to identify existing and emerging digital monopolies. If a potential digital monopoly is identified, the Regulator should take appropriate steps to understand what this could mean for the digital market and whether other appropriate authorities should be involved.

There are several potential interventions that can be used to proactively promote competition and innovation across the energy sector:

- → **Presumed Open Data** The use of Presumed Open and the Open Data Triage methodology helps to ensure innovators can effectively access key data across the energy system. This should be extended to all licenced entities.
- → **Open source Software** Open source solutions can help innovators to compete and reduce the chance of a single solution gaining excessive market power. Open source can also help to deliver interoperability (see Recommendation 2).
- → **Enabling Third Party Investment** Where a physical monopoly exists, there is a risk that a new, distinct digital monopoly unintentionally emerges on top of this, e.g. digital monitoring of physical monopoly assets. In some cases, the physical monopoly operator may not have the right skills or expertise to develop, procure or operate the digital monopoly. Without competition, there may be less innovative solutions and higher costs. By creating frameworks that enable third parties to develop solutions we can enable competition, drive investment, and promote innovation into the sector. This can help to reduce costs and accelerate decarbonisation.

Third party investment example: Network monitoring

- → Where a network operator does not plan to digitally monitor a network asset, third parties should be given the opportunity to do so
- → The third party can independently invest in the equipment and work with the network to install and operate the solution
- → Standards should be in place to ensure cyber security, physical security, and health & safety
- → Basic monitoring should be subject to Presumed Open and Open Data Triage.

It is vital that we promote digital competition across the energy sector both through proactive, positive interventions and responsive regulatory oversight.

* Digital tools which are used to make or largely inform decisions

** Threshold should be based on sector metrics and agreed with the system operator(s).

Algorithm Governance

It is essential that the sector proactively **manages new digital risks** such as the increased prevalence of algorithmic decision making. In addition, there needs to be some level of oversight of the potential of "cascade" impacts across multiple algorithms. Algorithms* which can materially influence the operation of the GB energy system (including downstream algorithms and systems which provide significant inputs) should be registered with the Regulator.

This includes, but is not limited to, algorithms responsible for:

- → dispatching energy from generation or storage assets
- → modulating demand from flexible energy assets
- → requesting or coordinating response from energy assets
- → active network management control
- → maintaining a balanced and stable energy system e.g. frequency, voltage or inertia control.

Organisations that utilise algorithms within the described scope and control of a non-trivial amount of energy assets** should register a minimal set of algorithm metadata and update it on a regular basis, either routinely (e.g. quarterly), where there is a 'major release', where there is a significant growth of assets being controlled or where the algorithm has been decommissioned. The Regulator should provide digital tools to enable organisations to easily submit this data, ideally with as much automation as possible.

Algorithms in scope and in control of a significant amount of energy assets** should register additional information about the development and operational governance of their algorithm or system to provide a more detailed view of the risk profile attached to the algorithm and operator.

Those responsible for operating algorithms should monitor their systems sufficiently to identify and mitigate unusual behaviour to avoid wider energy system failures wherever possible. Where an algorithm has failed, the organisation for operating the algorithm should ensure that there is sufficient data logging, version control and model monitoring to identify the root cause and robustly fix the issue, so it does not occur again. It is recommended that organisations responsible for operating algorithms archive versions of their algorithm source code, record raw input and outputs and store log files for their system for a significant period e.g. rolling 12 months.

Organisations responsible for developing and operating algorithms should also take steps to ensure that their systems are fair and free from bias, robust, and transparent.[15]

→

Recommendation 3: Implement a new digital governance approach and digitalisation entities — continued

Responsive risk regulation dashboard

Digitalisation is a significant opportunity for business model, product, and service innovation, but we need to **prevent customer detriment** and manage emerging risk.

The energy regulator should proactively monitor the sector to identify new emerging risks, especially related to digitalisation, which can be dealt with before they create customer detriment. The regulator should deploy a Responsive Risk Regulation Dashboard which ingests and presents data that can be used to identify issues across markets, business models and individual companies prior to failure. The dashboard should be flexible and able to ingest many types of information including, but not limited to, data sources such as: companies house records, regulatory reporting metrics, company administrative data, customer complaints and reviews, etc. The Dashboard should supplement existing modelling and stress testing that is already undertaken for well understood business models e.g. energy suppliers.

The energy regulator should proactively monitor the sector to identify new emerging risks, especially related to digitalisation, which can be dealt with before they create customer detriment.

Alignment of digital regulation

Government and Regulators should utilise digital and systems thinking approaches to methodically identify, acknowledge, and **manage sector interdependencies** through policy and regulation across infrastructure sectors. This is not only vital to ensure that critical national infrastructure is robust and resilient, but it is also necessary to realise Net Zero across the whole economy.

Digitalisation and the linking of legislation, licences, and codes should be driven by government and should initially focus on the interaction between critical national infrastructure sectors, such as energy and telecommunications. However, there is clear value to using this approach across other closely related areas such as consumer protection, finance, water, waste, and land use. This should be driven by a department with cross regulator remit such as the Better Regulation Executive within BEIS and should be supported by the UK Regulators Network.

The Food Standards Agency

Food safety risks are anticipated through excellent data analytics across all food vectors with a dynamic risk register identifying trends, low to high impact analysis also informing them of risk mitigation and enforcement requirements.

Key tasks

Task	Lead actor	Description
Establish a delivery body for public interest digital assets	Government	→ Define scope, objectives, and terms of reference for Delivery Body → Establish Delivery Body with initial 3-year mandate and funding → Review progress against objectives and industry support
Establish governance principles for public interest digital assets	Government	→ Establish key governance principles for Public Interest Digital Assets
Promote digital energy competition	Energy Regulator	→ Require licenced actors to comply with Presumed Open Data (in progress) → Encourage use of open source solutions in regulated monopoly entities → Integrate third party investment clauses into licences as appropriate
Establish algorithm governance	Energy Regulator	→ Define algorithm metadata fields for non-trivial and significant scale algorithms → Integrate into regulator mechanisms such as the balancing and settlement code → Conduct regular reviews to understand scale of algorithm risk
Develop a dynamic risk dashboard	Energy Regulator	→ Develop requirements for flexible risk dashboard solution → Identify delivery partner to develop initial solution and evolve based on changing sector needs → Use dashboard for dynamic risk assessment and to guide anticipatory interventions
Regulate interdependencies	Regulators	→ Identification of digital interdependency risks → Coordination between regulators of energy and digital infrastructure → Common approaches to customer protection providing a seamless route for redress

Recommendation 4

Adopt digital security measures

Digital security principles and interventions need to be embedded throughout the sector to collectively enable safe digitalisation at scale

Purpose and overview

Digitalisation of the energy system is a fundamental transition that creates many opportunities, but it also presents new risk, not least in the security space. We propose a series of best practice interventions drawn from experts across a range of sectors that collectively improves the security of digitalised systems.

Categorisation	Description
Quick wins	→ **Implement modern password policies** Adopting the National Cyber Security Centre (NCSC) guidance on passwords, including enabling password managers and rolling out multi factor authentication → **Implement merit order of patching based on risk profile** Assess operational risks of systems being compromised and prioritise patch updates (where possible)
Iterative improvements	→ **Map cascade effects of system security zones** Use digital tools to understand where systems have mutual dependencies and create business continuity plans that include where systems cannot be patched → **Increase frequency of regular penetration testing** Prove that robust penetration testing is taking place and action is being taken → **Adopt zero trust and least privilege** Requiring all users and devices, whether in or outside the organization's network, to be authenticated, authorized, and continuously validated
Strategic interventions	→ **Work towards a Just Culture** Enable disclosure of risks and discovered vulnerabilities before they become incidents → **Run drills and threat assessment exercises** Internally and externally run exercises to make sure staff and management know what to do in the event of a cyber incident → **Leverage cross-sector collaboration** Enable a secure information sharing forum where regulated entities can disclose where they are facing common cyber security challenges

The tech sector is often at the bleeding edge of digital change and as such faces a high number of cyber-attacks.

What does good look like?

The tech sector is often at the bleeding edge of digital change and as such faces a high number of cyber-attacks. Tech companies also tend to adopt new technology earlier than other sectors and have IP to protect from theft. The approach of many of the larger tech companies is to run bug bounty schemes, where researchers are rewarded for raising vulnerabilities with the organisation, and establishing disclosure schemes, where a researcher has the right to disclose a vulnerability to a relevant authority in the interest of the users after a fixed amount of time from validation. This openness and acceptance that new and novel challenges will occur periodically encourages them to be more proactive about tackling cyber vulnerabilities rather than attempting to cover them up.

Another sector that demonstrates what good looks like is aviation, safety culture is embedded into everything the sector does and when accidents happen there is full disclosure to the relevant authorities including publication of the audio from the cockpit voice recorder and the telemetry from the systems.

Why this is important

Building trust in organisations is a huge opportunity, two organisations that trust the data they share can operate without fear of making decisions on unreliable data. Organisations that build trust in the security of their data and system can collaborate more closely without fear of information being leaked. Organisations can demonstrate that even in the event they are compromised they can continue operations. This is a logical extension of the Presumed Open principle from the Energy Data Taskforce, security by obscurity and obfuscation is out of date in the modern energy landscape. Increased transparency has huge potential to promote greater optimisation, better system management and faster recovery time.

Cyber security is an incredibly deep and technical field; the leadership of regulated and unregulated organisations in the energy sector will need to harness and embrace the necessary cultural change that needs to take place to build trust between actions and actors. There are exciting opportunities within energy that will create new business models, new modes of operation and new innovation, all of which rely on the trust that they will deliver their services securely. Mistakes will happen even with good cyber security practices. Managing resilience is the priority and by recognising where people and processes interact, cascades of failures can be contained and business continuity maintained. A key part of driving this transition will be to establish trust in the new modes of operation under what will most likely be a huge increase in complexity. Organisations can be incentivised to establish these practices through a range of factors; commercial interests, maintaining their reputation, or being dedicated to a positive outcome. These factors all require the organisation to establish trust in their ability to operate in a secure and resilient manner.

→

Recommendation 4: Adopt digital security measures — continued

Key recommendations

This section takes a bottom-up approach to the principles, starting with recommendations to support individual departments' best practice, moving upwards to organisational recommendations and finally to cross-industry recommendations for countering cyber threats. These principles are not predicated on the idea that all threats can always be countered, but that mistakes will inevitably happen and when they do, they can be mitigated effectively.

NCSC guided password policies and MFA

Attacks generally follow a pattern, initial entry, privilege escalation, malicious code injection, extract data or demand money. Individual users are often targeted as the entry point for an attack through compromised credentials, the use of rainbow tables to guess passwords from hashes, or easily guessable passwords. Allowing users to deploy password managers and implementing multi factor authentication reduces the attack surface related to common user entry points.

Merit-order patching

Patching is the process of making malicious reconnaissance expire by removing known vulnerabilities. A merit order of patching according to operational risk will enable organisations to demonstrate they are being proactive with cyber security and that known vulnerabilities are being addressed. Increased frequency of penetration testing will make this process more iterative and address new vulnerabilities over time.

Map cascade effects between security zones

When patch updates are not available for a system with dependencies where vulnerabilities will persist for some time, organisations should use their knowledge to build contingency plans and business continuity if one of these systems is compromised. Again, increased frequency of pen testing will mean that this can be reviewed in the light of new threats emerging.

Adopting zero-trust and least-privilege

The energy sector should adopt zero trust and least privilege, where the interactions between systems, processes and people operate from the minimum trust possible. A physical analogy would be to a public space such as train station, users can enter the concourse with a validated ticket but are not permitted access to the control centre or security. The organisation must understand which systems have dependencies and map out the interactions between people, processes, and systems. Energy organisations will need to increase their proficiency and speed in analysing log files across their estates to identify potential threat vectors and report them.

The energy sector should adopt zero trust and least privilege, where the interactions between systems, processes and people operate from the minimum trust possible.

Work towards just culture

Greater information and transparency can be leveraged to build confidence in the way in which an organisation operates their cyber security with the Regulator and government able to gain visibility over emerging threats and support them accordingly. Just Cultures exist to prevent issues being allocated to a person (or group of people), rather than to a core problem. Ultimately allocating blame is counterproductive as complex systems require multiple people interacting with a set of processes that in most cases no one person has visibility over.

It is of the upmost importance that if a critical flaw or vulnerability is discovered in the energy system operation then the organisation can report it and be supported fully to tackle and fix it before it becomes an incident. NCSC and BEIS need to create a secure platform by which all actors can share discovered vulnerabilities and cyber threat activity to ensure that information flows across the sector to further build resilience and anticipation of potential threats. The purpose of this platform will be for an expert panel to advise on the best course of action to tackle known and emerging threats for the whole industry rather than individual organisations working in siloes. This way, issues can be tackled proactively before they become incidents which must be disclosed under the Network and Information Security (NIS) directive.

To differentiate this group, it will also be necessary to assess where these challenges have knock-on effects on other participants in the digitalised energy system. The Centre for the Protection of National Infrastructure (CPNI) has already achieved success by facilitating information sharing in the physical security space, once trust is built up these groups as extremely effective. It is likely that multiple organisations across energy (particularly those operating similar functions, such as network operators or suppliers) will encounter similar threats and types of attacks.

Case study: Aviation just culture

Just Culture has been adopted by many organisations within the aviation industry and has been expanded into other sectors like medicine. The manifesto for Just Culture sets out five points to support a culture where if decisions are made in line with skills and experience then there continues to be accountability when things go wrong, but individual blame is reduced to ensure full investigation. However, deliberate actions that cause harm are not tolerated. The Just Culture emphasises the need for issues to be raised without fear before they become incidents and an understanding that a whole-systems approach should be taken to allocating accountability.

Recommendation 4: Adopt digital security measures — continued

Drills and red team tests

Training only goes so far in raising awareness. Within organisations, cyber security, or more widely, business continuity drills should take place involving as many people within the organisation as possible. The idea is to embed the communication lines and expected responses to a cyber security incident, as well as uncovering what the challenges with the current process. Knowledge and competence must be built up over time through practice and application to be embedded in culture.

Organisations should conduct cross sector exercises in collaboration with the NCSC, Ofgem and CPNI, where drills are run across systems and processes that multiple energy sector participants are active in. These activities have been conducted successfully in the past under the direction of the NCSC and should be adopted more regularly. The objectives should be to stress test the responses to emerging threat vectors, highlight ways in which energy system participants can be supported to improve their cyber security and build up greater collaboration between organisations working in energy.

Cross sector collaboration

The energy industry should embrace collaboration, share knowledge of emerging threat vectors and build trust between themselves, with customers and with regulators, to ensure they are as prepared as possible for the digital transition. Standards such as PAS 1878 and PAS 1879 [11] have already emerged to make devices compatible with demand side response services out of the box, which is a strong step forward, but the pace needs to accelerate. There is a huge open source community working on cyber security, the energy sector should be engaging with these groups working in threat research to examine their own estates and develop solutions for identified challenges. In addition, legal protection will also be required for external researchers or organisations that discover cyber security issues within energy and critical national infrastructure to facilitate a culture of transparency and access to support.

Training only goes so far in raising awareness. Within organisations, cyber security, or more widely, business continuity drills should take place involving as many people within the organisation as possible.

Key tasks

Task	Lead actor	Description
A minimum level of basic cyber security	Sector	→ The sector should review cyber security protocols and ensure they 'excel at the basics' in accordance with NCSC guidelines, NIS directive and ISO 27001
Trust protocols	Sector	→ The sector should adopt a zero trust and least privilege to minimise cascade risk across critical systems. This principle needs to be embedded throughout the sector through standards and regulation for regulated entities
Just culture	Sector	→ Government and the Regulator should foster a culture of transparency and enhanced disclosure for cyber security risks
Stress testing and security exercises	Sector	→ Create a 'Red Team' within regulatory entities that is monitoring and designing drills and cross-sector cascade stress testing

Recommendation 5

Carbon monitoring & accounting

Carbon emissions from energy production, storage and delivery need to be measured at source with data reported and shared in a standard format.

Purpose and overview

Implementing effective carbon* monitoring and data flow has the potential to fundamentally change the energy sector. By creating true visibility of standardised carbon emissions, it will be possible to provide clear signals to participants across the system so they can understand exactly what is needed to reach Net Zero. This will ensure that actions that reduce carbon can be incentivised and help to drive investment in smart solutions which maximise reductions. Carbon data will also help the sector to understand where to upgrade infrastructure and invest in low carbon energy assets.

Categorisation	Description
Quick wins	→ **Mandate Dynamic Carbon Reporting** Ensure the carbon data that is collected is reported in line with settlement periods
Iterative improvements	→ **Mandate Dynamic Carbon Monitoring** Require carbon emitting energy generators to deploy hardware sensors to monitor emissions and report it in line with settlement periods → **Require Separate Emissions and Offsetting Reporting** Independent reporting of emissions and offsetting for energy sector entities including suppliers
Strategic interventions	→ **Adopt Carbon Data Open Standards** Cross industry agreement on carbon measurement and reporting standards will enable like for like comparisons of impact

Carbon reduction is a global mission; the UK has already shown leadership by being the first major economy to set a legally binding Net Zero target.

What does good look like?

Carbon data will provide government, companies, and consumers with the information that is needed to understand the potential impact of their carbon footprint and develop wider economic carbon policies. This could have global impacts with other governments and countries being able to follow the UK's lead toward a Net Zero future.

The increased ability of domestic and non-domestic meters to measure consumption at a half-hourly level provides a huge amount of insight into the energy consumption of the UK as a whole, but on a carbon basis it still falls short of the whole picture. This can move forward by matching carbon emissions (and other pollutants) to energy consumption per settlement period and detaching the measurement of carbon emissions from carbon policy to understand actual carbon emissions. Carbon policy (or lack thereof) currently dictates the type of measurement of carbon but collecting more accurate data and having access to better information regarding the true carbon emitted means changes in policy become easier to justify.[16]

Why this is important

Carbon reduction is a global mission; the UK has already shown leadership by being the first major economy to set a legally binding Net Zero target. We now have an opportunity to become a world leader in carbon monitoring, data capture, and accounting. Accurate carbon metrics are key to supporting carbon innovators to deliver Net Zero and provide a solid foundation for future carbon policy.

Improving the granularity and timeliness of carbon emissions data

Carbon reporting is a laborious task characterised by a lack of data, many assumptions, and manual processing. The lack of fundamental data means that the results can be less reliable and therefore customers are unable to understand if their actions increase or reduce carbon emissions and industry innovators carry the risk that their 'carbon reduction' claims may be false. This issue was also identified in the recent Smart Systems and Flexibility Plan 2021 published by BEIS and Ofgem.[2]

Standards exist for the measurement and accounting of carbon emissions (scope 1, 2 and 3, GHG corporate standards[17]) but calculations are often based on averages, estimates or static figures. Organisations that are part of an emissions trading scheme commonly monitor carbon emissions, however, this data is typically only reported at an annual level.

* Carbon is used as a term throughout this section, but is also applicable to other greenhouse gases (GHGs)

Recommendation 5: Carbon monitoring and accounting — continued

Carbon capture and offsetting transparency

With the emergence of carbon capture in multiple forms, the transparency of the carbon life-cycle is going to become increasingly important. The transparency of the carbon flows will have impacts on customers' products marketability, veracity, future labelling and auditing.

Many organisations use carbon offsetting to mitigate the emissions created through their normal operation. For energy suppliers, this often takes the form of purchasing Renewable Energy Guarantees of Origin (REGO) certificates which enables the supplier to advertise a 'green tariff', even if the renewable energy was generated at a different time to when it was consumed. Government are currently reviewing this process.[17]

There are a range of other offsetting approaches across wider industry. One of the major challenges is that the impact of offsetting is often applied before carbon emissions are reported. This means that there is little room for review or challenge for the assumptions for both the emissions and offsetting impact. The lack of transparency makes it more challenging for customers to understand the impact of products and services and harder for low carbon innovators to justify their value.

Standardising carbon measurement and data

It will be impossible to evidence we have hit Net Zero without common measurement. Net Zero is an economy wide issue, but the energy sector needs to take a lead and provide a solid foundation of data to inform and galvanise action across other industries. It is essential that data is in a format that can be widely understood and minimise friction when sharing between organisations.

There are a range of other offsetting approaches across wider industry. One of the major challenges is that the impact of offsetting is often applied before carbon emissions are reported.

Key recommendations

In order to effectively determine and monitor the energy system progress towards Net Zero, it will be necessary to implement a set of changes to increase the visibility, veracity, velocity and transparency of carbon measurements across the system. This will include the ability to examine what offsets have been made to justify any claim of being zero-carbon.

Mandate dynamic carbon monitoring and reporting

To **improve the granularity and timeliness of carbon emissions data**, Government should mandate that carbon data that is collected today should be reported at a more granular level, ideally aligned with settlement periods. In some cases, this may be commercially sensitive so it may be appropriate for an independent third party, such as the Future System Operator,[19] to collect and aggregate data prior to publishing.

In addition, the Regulator should consider requiring hardware-based emissions monitoring for all carbon emitting energy generation. There are a multitude of sensors available from low-cost environmental IR sensors to industrial grade specific emissions spectrometry. These should be deployed with the specific intention of measurement above the granularity of the current grid balancing settlement period, i.e., half hourly under current market design.

As broad a spectrum of greenhouse gases should be monitored as appropriate, dependant on their source. This includes, but is not limited to, carbon dioxide, carbon monoxide, methane, nitrous oxide, HFCs, PFCs, nitrogen fluorides and sulphur fluorides. This breadth of data collection is a fundamental requirement to establish a more accurate carbon emission estimate for the energy sector. Government should also consider simultaneously requiring particulate matter monitoring (e.g. PM10 and PM2.5) from carbon emitting generation to provide optionality on future air quality legislation.

Where an organisation uses static emissions values by fuel type or system averages, they should be expected to use 'reasonable worst case' values rather than optimal or average. This creates the incentive for generators to implement true monitoring and encourages carbon efficiency improvements in equipment to reduce worst case values.

Political and economic benefits

COP26 proposed more rigorous carbon standards, with the United Nations Director General proposing global standards. The UK is a preeminent standard setting leader and in its role as COP26 chair should support this work.

Companies that are claiming to be progressive should be able to benefit from the marketing and customer preferences for those that want lower carbon products and services, but this requires much more robust measurement that exists currently

Recommendation 5: Carbon monitoring and accounting — continued

Require separate emissions and offsetting reporting

It is essential to **increase offsetting transparency** by requiring that carbon emissions data is reported separately from emissions offsetting and REGO purchases. The industry must accept that carbon emissions are part of the energy system no matter what methods are used to mitigate them. Greater transparency will also ensure that policy makers have the right tools to enact carbon policies and understand the role of offsetting in our road to Net Zero.

Adopt carbon data open standards

It is critical we **standardise carbon measurement and data** to ensure that this critical information can flow seamlessly across the economy. It is key that common interfaces for carbon data are developed and enforced to ensure interoperability across the wider supply chain. There are numerous groups developing solutions for this such as Cloud Carbon Footprint and Open Footprint, and there are many commercial entities integrating carbon monitoring and accounting into their tools.

Government should monitor the developing carbon data standards space and consider using one of the emerging open solutions as the basis for an economy wide carbon data standard.

Key tasks

Task	Lead actor	Description
Mandate dynamic carbon monitoring	Energy Regulator and Industry	→ Require carbon emitting energy generators to deploy hardware sensors to monitor emissions, initially via generator licence and then Balancing and Settlement Code
Mandate dynamic carbon reporting	Energy Regulator and Industry	→ Require carbon emissions and carbon intensity of energy to be reported before the application of carbon offsetting
Require separate emissions and offsetting reporting	Energy Regulator and Industry	→ Require carbon emissions and carbon intensity of energy to be reported before the application of carbon offsetting
Adopt carbon data open standards	Government	→ Monitor development of carbon data standards → Adopt industry carbon data standard when one is of sufficient maturity to be used

Government should monitor the developing carbon data standards space and consider using one of the emerging open solutions as the basis for an economy wide carbon data standard.

Recommendation 6

Embed a digitalisation culture

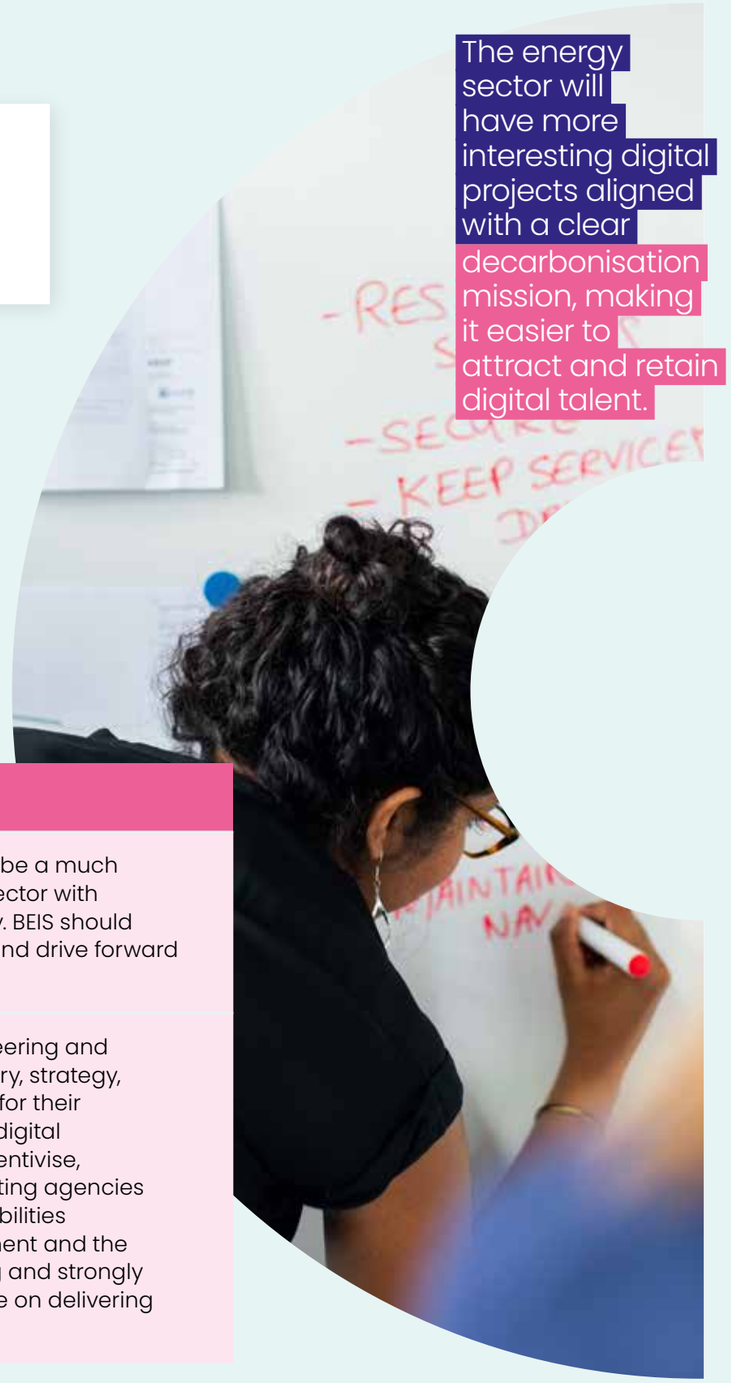
A digitalisation culture needs to be embedded throughout the energy sector by promoting digital leadership, valuing digital assets, and focusing on whole system user experience.

Purpose and overview

Throughout the consultation that the Taskforce has undertaken, the most common theme has been the need for a much deeper digitalisation culture throughout the energy sector. There are numerous examples of good practice that rival sectors with greater digital history, however this often sits in silos within companies. For the future, digitalisation must become a 'business as usual' part of any energy company which will require significant cultural change across the companies and the bodies in the sector.

While actions can be taken to deploy greater digital assets, without leadership and digital skills being valued throughout the system, people and embedded attitudes will at best decelerate progress, and in some instances stop it entirely.

Categorisation	Description
Quick wins	→ **Promote digitalisation leadership** There needs to be a much greater emphasis on digital skill throughout the sector with leaders expected to have data and digital literacy. BEIS should consider recruiting a Chief Data Officer to assist and drive forward digitalisation throughout the organisations work
Iterative improvements	→ **Value and investment in digitalisation** The engineering and digital worlds have different approaches to delivery, strategy, and investment. Energy companies are not rated for their digital assets nor are their valuations inclusive of digital capabilities. Ofgem can take a leading role to incentivise, educate and inform companies, investors, and rating agencies of the increasing value of digital assets and capabilities → **Focus on whole system user experience** Government and the Regulator should promote whole systems thinking and strongly encourage industry to coordinate and collaborate on delivering consistent user experiences where possible



The energy sector will have more interesting digital projects aligned with a clear decarbonisation mission, making it easier to attract and retain digital talent.

What does good look like?

If implemented, this recommendation will create a dynamic sector where digital technologies are not only deployed more successfully, but also create tangible value for customers and improve profitability for companies involved. In addition, companies will see rising valuations which will enable them to attract more investment and deliver returns for shareholders.

The energy sector will have more interesting digital projects aligned with a clear decarbonisation mission, making it easier to attract and retain digital talent. This will initiate a virtuous cycle by creating an internal talent pipeline that ensures the next generation of leaders will have digital skills and expertise and will therefore be able to deliver future digitalisation needs.

Why this is important

The energy sector is at a pivotal time of change as we attempt to ready the sector to thrive on new low carbon energy sources and vast amounts of renewable energy balanced by flexible assets across the country, under most circumstances. Digitalisation is no longer a nice to have but a truly essential part of the puzzle if we are to deliver a decarbonised, reliable, and cost-effective system in good time.

Developing digital leadership

Digitalisation requires leaders to understand the value of digital, be able to eloquently articulate this and secure funding to deliver it. However, many leaders in the energy sector are not well versed in digital transformation, this means they risk missing opportunities or struggle to justify investment for them. In a sector with a need for rapid digitalisation to enable future operations, this is a significant systemic risk.

Resolving the culture clash

There are some key challenges facing a digital future trying to integrate into an engineering culture centred around assets with extremely long lifespans. Current decision making and procurement is guided by long term investments with strong evidence and deterministic outcomes while the world of digital is iterative, dynamic, and requires continuous short-term investments. In addition, digital transformation is rarely best delivered through traditional procurement but on-going partnerships with digital native collaborators.[19]

There is also a need to address the regulatory valuation, investment culture, and rating agencies in their approach to valuing to support digitalisation. Currently it is one that is dominated by the value of physical assets with high upfront long term capital costs. Neither the investment nor valuation regime creates the right environment for investment in digitalisation.

Recommendation 4: Adopt digital security measures — continued

Improving sector wide user experience

The fragmentation of the energy sector means that customers are forced to interact with multiple organisations when they install new energy assets, often being required to register their device with multiple entities and piece together a patchwork of technical elements to realise the desired solution. Similarly, innovators must work with multiple organisations when developing and scaling up new products and services, especially if they want to operate nationally.

Each of the energy sector organisations involved in the chain may be focused on delivering a good experience for their stakeholders but if this is done in isolation, the ultimate outcome for customers or innovators is poor. This reduces engagement and slows innovation which impacts our ability to deliver Net Zero.

Key recommendations

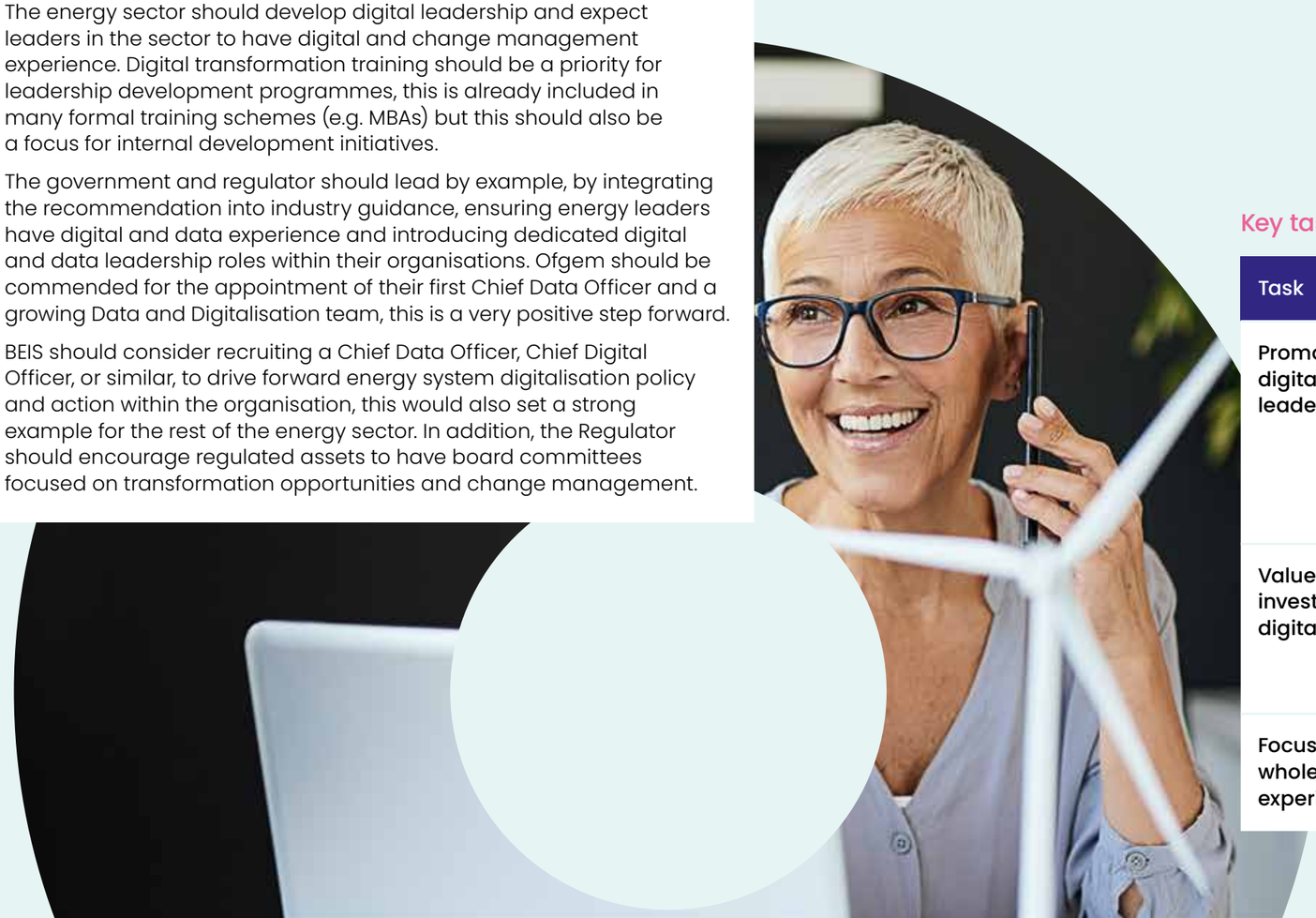
The sector should take steps to foster a digitalisation culture by ensuring that leaders have the right skills and experience, and that digitalisation and the integration of digital systems is valued appropriately.

Promote digitalisation leadership

The energy sector should develop digital leadership and expect leaders in the sector to have digital and change management experience. Digital transformation training should be a priority for leadership development programmes, this is already included in many formal training schemes (e.g. MBAs) but this should also be a focus for internal development initiatives.

The government and regulator should lead by example, by integrating the recommendation into industry guidance, ensuring energy leaders have digital and data experience and introducing dedicated digital and data leadership roles within their organisations. Ofgem should be commended for the appointment of their first Chief Data Officer and a growing Data and Digitalisation team, this is a very positive step forward.

BEIS should consider recruiting a Chief Data Officer, Chief Digital Officer, or similar, to drive forward energy system digitalisation policy and action within the organisation, this would also set a strong example for the rest of the energy sector. In addition, the Regulator should encourage regulated assets to have board committees focused on transformation opportunities and change management.



Industry should also consider the needs of downstream industry users, such as those creating value out of data assets (e.g., data scientists and AI practitioners).

Valuing and investing in digitalisation

All parts of the sector need to recognise the difference between energy infrastructure and digital infrastructure investment characteristics and requirements to **resolve the culture clash**. The sector should move toward more agile investment processes which support digital investment, particularly through the network regulatory model.

Regulation should further incentivise, promote, and value digital assets as part of the overall value of the regulated assets. In addition, the Regulator should consider briefing the rating agencies who need to regard digital infrastructure as valuable component of the company's asset base; recognising the potential for it to make organisations more future fit, operationally efficient, and resilient.

Furthermore, the sector should recognise the value of digitalisation for critical industry and corporate functions, such as legal and financial processes. Streamlining these areas through digitalisation can drive significant time and cost savings for relatively small investments in digital solutions.

Improving whole system user experience

Government and the Regulator should **improve sector wide user experience** by promoting whole systems thinking for digitalisation, this should be part of the Energy Digitalisation Body's mission. Government and the Regulator should strongly encourage industry to coordinate and collaborate to deliver consistent user experiences where stakeholders are likely to utilise the same interface or process across organisations, for example distribution network connections. Industry should also consider the needs of downstream industry users, such as those creating value out of data assets (e.g., data scientists and AI practitioners) and should consider how these users can be involved in the design of digital solutions.

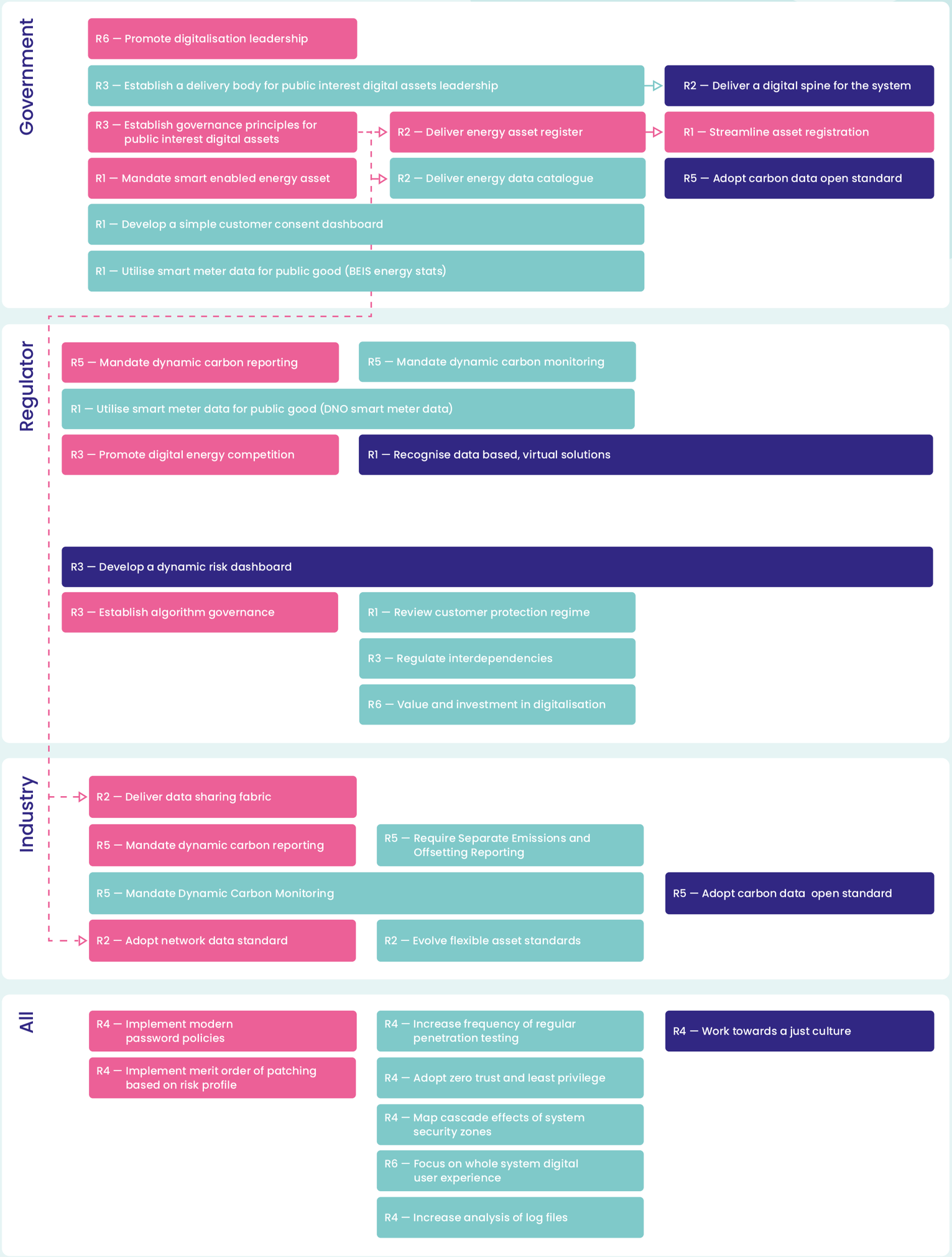
Key tasks

Task	Lead actor	Description
Promote digitalisation leadership	Government	• Government and the Regulator to set expectations for energy sector leaders to have digitalisation expertise • Government to consider appointment of a Chief Data/Digital Officer for Energy • Industry to integrate digital transformation into leadership training schemes
Value and investment in digitalisation	Sector	• Regulator to review regulated asset value assessment and route to investment in digital assets • Rating agencies to include digital assets in company value
Focus on whole system user experience	Sector	• Government and the Regulator to promote whole systems thinking and consistent use experience where possible

Delivery

The recommendations and tasks outlined in this report are all based on the sector needs and are all a priority for the delivery of a Net Zero compatible energy system. However, it is recognised there are many actions and there is limited resource available; there is a need to prioritise action in the near term. In addition, there are some dependencies between tasks that need to be considered.

In the diagram below we have prioritised tasks for Government, Regulator, Industry, and Sector. This considers the ease of delivery as well as the potential impact to maximise speed of progress.



Conclusions

The digital transformation

It is agreed that digitalisation of the energy system is not just a ‘nice to have’ but a core requirement in ensuring that we can accelerate the journey to Net Zero; that our new decarbonised system works effectively; and importantly rewards customers for their actions. Stability and resilience of the future system cannot be achieved without deep digitalisation built on the availability of more accurate and timely data. Generators, storage operators and supporting services will require much more textured information flows to ensure that they can respond to the dynamics of a more integrated system.

While digitalisation is deeply embedded in many sectors, the energy sector is behind the development and deployment curve. However, this presents an opportunity to build on and benefit from the experiences and lessons from other sector’s digitalisation journeys. By drawing on best practice from these sectors, risk and uncertainty are significantly reduced in implementation.

We also recognise that digitalisation poses new risks and we have considered consumer detriment, system stability and, importantly, security, and have addressed the challenges posed by greater interoperability of a much more complex system.

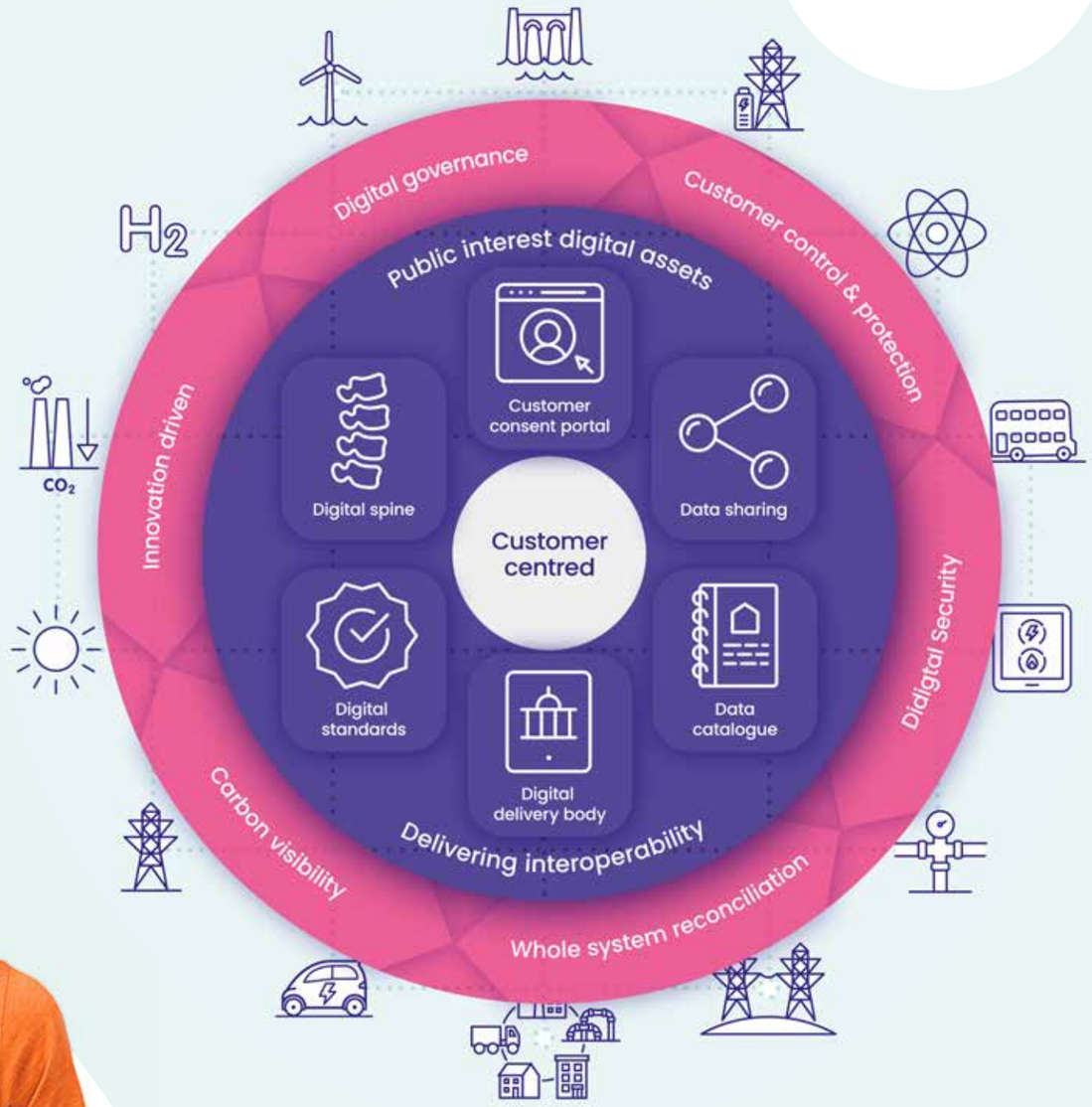
Digitalisation of the energy system is not just a ‘nice to have’ but a core requirement in ensuring that we can accelerate the journey to Net Zero.

As stated, we have aimed to propose approaches to deliver our four key drivers:

- → **Exciting tailored customer propositions** Enabling Net Zero compatible products and services which provide customers with compelling, personalised offers that deliver outcomes the customer values – and are of value to the whole system
- → **Accelerating decarbonisation** Creating a digitalised energy system that supports and encourages rapid decarbonisation across energy vectors and energy user needs
- → **A stable and resilient system** Developing a system which continues to deliver high levels of stability for end customers, whilst using digitalisation to create additional resilience through more accurate forecasting and dynamic responses
- → **Whole system optimisation** Making the best use of all energy assets across vectors and locations. Using digital tools to guide strategic investment in new infrastructure which deliver an ideal overall solution.

We have put strong boundaries on our work to ensure that the recommendations are focused only on the most crucial and fundamental requirements for whole system digitalisation. In concluding the work of this Taskforce, the recommendations address the following key areas.

Overview of our recommendations outputs



Conclusions: The digital transformation — continued

The customer journey
Giving customers control through explicit consent, easing their pathway to interact with the system through automated asset registration and enabling new innovative business models to tailor new products and services to customer needs.

The system actors
Providing a digital spine that enables all the relevant players to get the right digital and data visibility of the operational capabilities of the system enabling them to become much more productive and responsive to the changing and more dynamic needs of the future system.

New public interest digital assets
To facilitate the interoperation of the new system, there is a requirement for a set of limited new public interest digital assets that serve the whole system to enable interoperability, data sharing, data visibility, asset visibility and new standards which cannot sit in commercial organisations.

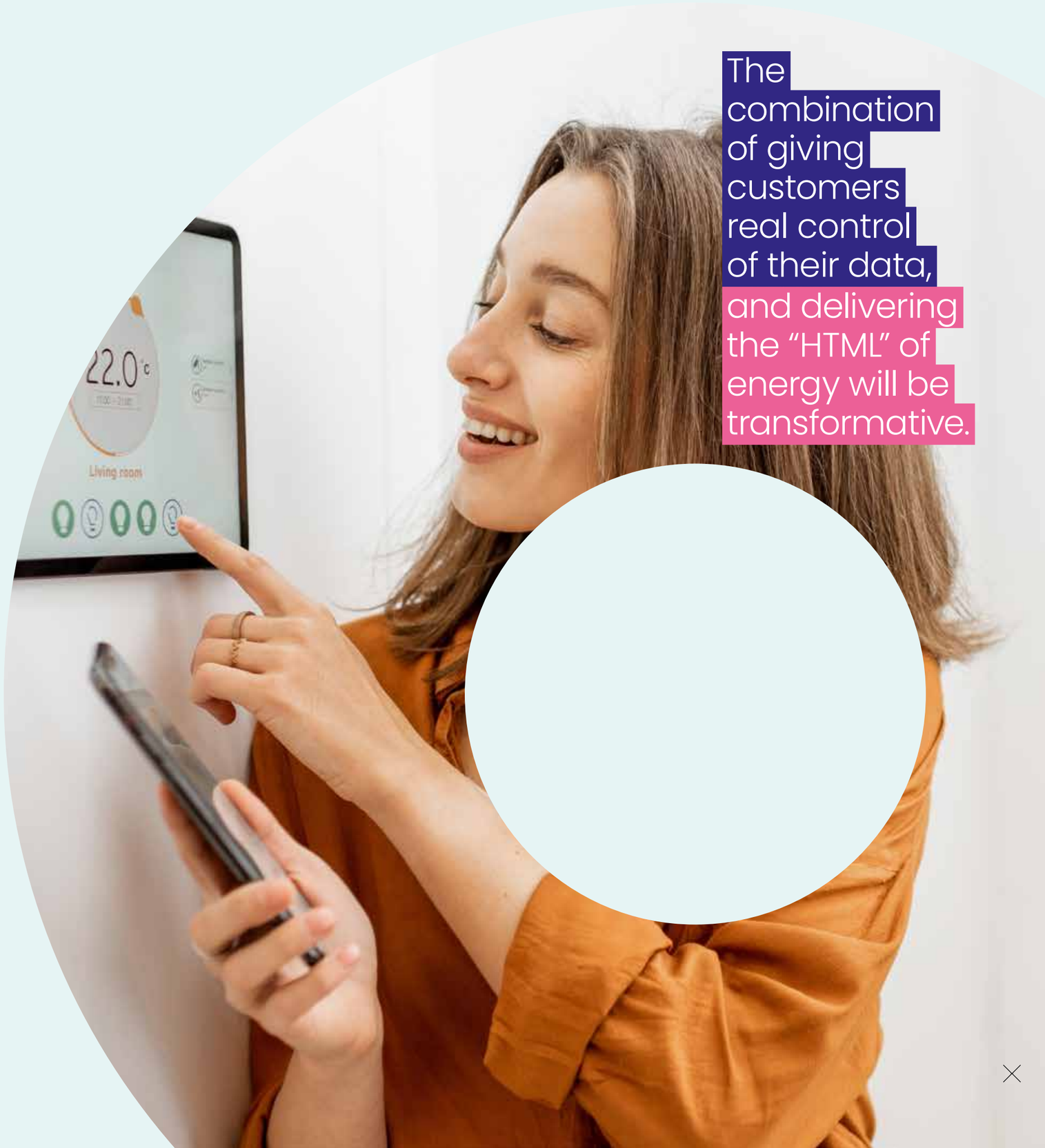
Addressing the security risks
Security is a key issue across our future energy system and our proposals, integrating some very important housekeeping practises while recommending regular testing and resilience mechanisms.

A new delivery body
To develop the Public Interest Digital Assets and to drive this agenda forward, Government needs to establish a small, independent, time limited delivery body to ensure that these tools are designed and delivered in the public interest.

In the energy sector, we are just starting the digital journey. The recommendations that have been set out in this taskforce will provide the foundation for a modern, digitalised, decentralised, and decarbonised energy system. How successful the sector is at capturing this opportunity will depend on its ability to be agile in devising solutions, to react quickly to technological or market changes, to ensure that all consumers are treated fairly, and to proactively identify and rapidly address areas of customer detriment.

These recommendations are just the beginning, everyone across the sector will have a role to play in the Digital Transition.

New and improved digital governance
There are requirements for new governance principles to manage any concentration of data and digital assets, to gain oversight of dynamic algorithms and to manage customer or system detriment.



The combination of giving customers real control of their data, and delivering the “HTML” of energy will be transformative.

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