Digital Spine

Feasibility study

Developing an energy system data sharing infrastructure

September 2023

Developed for:

Department for Energy Security & Net Zero

Contents

Notice:
This report summarises the findings and conclusions of the six-month feasibility study into an energy system digital spine, developed through a stakeholder-led, collaborative, and consultative approach with 100+ cross-sector engagements.

The findings are the view of the consortium and are not official government policy.

Contents

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Executive summary

Developing an energy system data sharing infrastructure

Overview

The digitalisation of the energy sector has grown at pace since the publication of the Energy Digitalisation Strategy in 2021.

Following the Energy Digitalisation Taskforce in early 2022 and its recommendations to develop a ‘digital spine’ for the sector, this feasibility study was commissioned by the government to scope what precisely a digital spine is, and how it might be developed to benefit the energy sector.

The work set out in this document presents the cumulative thinking of the consortium of Arup, Energy Systems Catapult and the University of Bath, along with the numerous individuals and organisations that were consulted in the co-creation of what has now become the concept of a **data sharing infrastructure**.

The feasibility study spanned six months of effort from experts across the consortium and aligned the best knowledge of industry and the energy sector to develop a set of coordinated, cohesive and achievable benefits for citizens, organisations, and the country.

Key findings

Using several energy sector use cases to explore the technical and non-technical requirements of a data sharing infrastructure (Appendix C), the consortium identified the needs for the energy sector to facilitate data sharing and how these needs could be realised through a common approach.

The data sharing infrastructure is made of three key parts: **Prepare, Trust, and Share**. Each component plays a vital role to ensure an ecosystem of data sharing can be realised. These components have been validated through extensive cross-sector stakeholder engagement.

The report outlines the technical architecture of the enabling infrastructure and proposed delivery routes to implement a data sharing infrastructure.

These routes consider existing national and sector programmes, governance requirements, delivery considerations and constraints, and funding.

It is noted there is further work required to ensure a successful design, implementation, and adoption of a data sharing infrastructure. See Appendix O.

Recommendations

Based on the work completed to date, the following three recommendations should be prioritised as a continuation of this study to ensure current momentum is not lost:

1) **Publish a decision:** DESNZ and Ofgem publish a statement of how a data sharing infrastructure will be developed and adopted by the sector.

2) **Develop an MVP**: DESNZ/Ofgem/DSIT, in collaboration with industry and NDTP, supports the development of an MVP.

3) **Form a Task Group**: Ofgem and DESNZ convene and provide a mandate to a group to support the development of a data sharing infrastructure.

These are supported by details of recommendations for eleven core areas of further work required to ensure the successful design, implementation and adoption of a data sharing infrastructure (Appendix O).

The remainder of this document sets out the need for a data sharing infrastructure, what it is, the benefits it would deliver, potential use cases and how it can be developed.

ARUP CATAPULT Energy Systems UNIVERSITY OF BATH

Nomenclature & terminology

Nomenclature

- **API -** Application Programming Interface
- **DPN –** Data Preparation Node
- **DSI –** Data Sharing Infrastructure
- **DSM -** Data Sharing Mechanism
- **ETL –** Extract Transform Load
- **JSON -** JavaScript Object Notation
- **JSON-LD –** JSON for Linked Data
- **LAN –** Local Area Network
- **MVP –** Minimal Viable Product
- **NCSC –** National Cyber Security Centre
- **NDTP -** National Digital Twin Programme
- **RDF –** Resource Description Framework
- **SLA –** Service Level Agreement
- **UI –** User Interface
- **VirtualES –** Virtual Energy System
- **WAN –** Wide Area Network
- **XML –** eXtensible Markup Language

Terms

- **Data producers**: refers to entities that will share their data with other entities via a data sharing infrastructure.
- **Data consumers:** refers to entities that will consume data from data producers using a data sharing infrastructure.
- **Message broker:** software intermediary that facilitates the communication and data exchange between different systems by managing the routing and delivery of messages. Similar to a postal service sorting and delivering mail between senders and recipients. This is done through pub/sub messaging and data streaming.
- **Publish/subscribe (pub/sub) message queue:** messaging pattern where a publisher generates messages for (many) subscribers through a one-to-many data sharing system i.e. one producer sharing to multiple consumers.
- **Tiger team:** A team temporarily dedicated to exploring what the task group should deliver.
- **Task group:** A group orientated to deliver the priorities set out by the Tiger team.
- **Data streaming**: continuous and near real-time transmission and process of data in a sequential and time ordered manner.
- **Container/containerisation:** lightweight, isolated and portable software packages that encapsulate an application along with its dependencies, enabling consistent and efficient deployment across different computing environments.
- **Cross-sector data preparation node:** containerised software application that can be deployed by organisations to prepare their data for sharing through data standardisation, adding security controls and publishing through approved APIs and data brokers.
- **Sector-wide trust framework:** defines, implements and governs the legal and identity rules that ensures regulated and reliable data sharing. Users can set the data licensing and legal terms for data usage through the trust framework. This establishes the user's confidence, right, and legality, where required, to share data between parties.
- **Sector-wide data sharing mechanism:** facilitates data sharing by providing the technology, security and governance means for exchanging data.

Delivery team

Delivery led by three domain experts over six months

The six-month feasibility study has been led and delivered by Arup, in partnership with the Energy Systems Catapult and the University of Bath.

- **Arup:** An employee owned, multinational organisation with more than 15,000 specialists, working across 90+ disciplines, with projects in over 140 countries and the mission to 'shape a better world'. Arup have extensive energy and cross-sector digital expertise.
- **Energy Systems Catapult (ESC):** An independent, not-for-profit centre of excellence that bridges the gap between industry, government, academia, and research. Set up to accelerate the transformation of the UK's energy system and ensure businesses and consumers capture the opportunities of clean growth. ESC are responsible for the Energy Data Task Force (EDTF) & Energy Digitalisation Task Force (EDiT).
- **University of Bath (UoB):** One of the UK's leading universities for high-impact research with a reputation for excellence in education, student experience and graduate prospects. Research from UoB is making an impact in society, leading to positive digital futures, improved health and wellbeing, and sustainable energy futures.

Approach

Feasibility study to define, scope and assess the need and scope of a data sharing infrastructure

Overview

This feasibility study is a crucial step in determining the shape and delivery routes for implementing a sector-wide data sharing infrastructure.

Therefore, to ensure success, over 100+ engagement sessions were undertaken, guided by the principles of being stakeholder-led, collaborative, and consultative.

- **Stakeholder-led:** across every milestone and the various iterations of the data sharing infrastructure definition, those stakeholders who can be directly affected were actively engaged to help shape the definition.
- **Collaborative**: rather than stakeholders being solely recipients of information, they were encouraged to participate in the study. This mindset ensured the engagement sessions fostered a sense of ownership, responsibility, and commitment to the outcomes, leading to stakeholders wanting to be part of the study.
- **Consultative**: validated and extensively tested the definitions by seeking input and feedback. Stakeholders were given the opportunity to express their concerns, raise questions, and provide recommendations.

Aims of the feasibility study

The overall aims of this feasibility study are to:

- Establish the needs case for an energy system 'digital spine' and its benefits to a smart, flexible, decarbonised energy system; and
- Understand the potential scope of an energy system 'digital spine', and the data infrastructure required to deliver it, and the costs of scope options.

The Energy Digitalisation Taskforce (2022) defined two concepts of "***Digital Spine***" and "***Data Sharing Fabric***".

Following stakeholder engagement activities conducted as part of this feasibility study, it was decided to move away from these inherited terminologies. They caused significant confusion and were unhelpful in articulating and communicating the overall purpose.

Instead, to promote broader audience understanding, the concepts are described through three functional steps: **Prepare**, **Trust**, and **Share** (see Section 2.1).

These concepts are collectively referred to as a **data sharing infrastructure**, and together enable a digital infrastructure that allows the exchange of energy data in a secure and interoperable manner.

Continuous stakeholder engagement

Definition of a digital spine

Reviewed and analysed the definition of a digital spine to outline the problems, potential solutions, characteristics, and benefits

Stakeholder engagement

Conducted key stakeholders' interviews to review and improve on the definition of a digital spine

Brainstorming potential use cases and user journeys

Through stakeholder-led engagement sessions, outlined 15 use cases and prioritised 5 priority and day 1 use cases

Outlined constraints and dependencies

Assessed existing codes, licenses, and regulations that impact a data sharing infrastructure

Outlined technical components

Outlined the functional components of a data preparation node, data sharing mechanism and trust framework

Outlined delivery routes

Assessed and recommended potential delivery routes and governance models for the data sharing infrastructure

1

Why is a data sharing infrastructure needed?

Why is it needed?

Summary of how a data sharing infrastructure would support the strategic needs of the energy sector

Overview

The energy industry must undergo significant change to ensure the delivery of an affordable, resilient, net zero energy system.

The future system requires the integration of large volumes of low-carbon and renewable infrastructure with a significant increase of assets and interactions needed. The industry currently suffers from a lack of data sharing which present challenges in the ability to manage the increasing complexities of the future system.

The ability to ingest, standardise, and share data between different actors and customers will be critical in managing this and enabling:

- Lower overall system costs due to efficiencies
- The UK government meeting its strategic and legal objectives around net zero
- A flexible and stable system that can manage the increasing complexities of a net zero system
- An increased pace of innovation to support achieving all the above
- A resilient system with reduced risk of market failure.

Greater value offerings for the customers

As the energy system moves towards net zero the way in which customers interact with the system is set to dramatically change. With current ways of operating this will incur significant costs to customers. Customers need an affordable, trusted, seamless energy experience with the necessary controls and protections that maintain customer experience. A data sharing infrastructure is critical to the robust delivery of these solutions, ensuring delivery of affordable energy to all.

Meet policy objectives

The UK government have set out a net zero strategy and commitment to achieving net zero by 2050. To achieve this the UK must decarbonise its current energy system by 2035, integrating large volumes of low-carbon and renewable infrastructure without compromising energy security or resilience.

The complexity of the future system means that success can only be achieved through greater use of data and technology. Without this, the UK risks failing to meet its commitments.

Flexible and stable system

To achieve an affordable, resilient net zero energy system, a whole systems view must be considered, with numerous actors working in tandem to deliver a flexible and secure network of assets.

To support the delivery of new markets assets owners and operators must be able to easily move their assets between different markets and service providers. All of this can only happen through greater use of data and technology. Without this there is a significant risk of market failure and likely inability to achieve resilience objectives.

Increased pace of innovation

To achieve an affordable, resilient, net zero energy system significant innovation is needed. Innovative solutions that create new commercial structures or introduce more efficient ways to operate the network typically require data from multiple sources.

The current siloing of data and lack of sharing infrastructure means that barriers to entry for innovators are high and innovation cannot happen at the rate it is needed. A data sharing infrastructure would support access to the data needed to drive this

Need for a flexible and a stable system

The industry data sharing challenges identified through stakeholder engagement that a data sharing infrastructure would address

To diversify and decarbonise its energy production, the UK will be heavily dependent on the ability, degree and speed at which different energy datasets can be joined up together so that is can be used between energy market participants.

From enabling timely connection of new low carbon technologies, to optimising millions of existing and new energy and network assets from kW through GW scales; or substantially cutting down wastes in renewable curtailments and under-utilised flexibility to reducing billions of annual network congestion and constraint costs - data from multiple players across the energy systems needs to come together in a way that minimises effort required by all. To enable the scale of data sharing required, the energy sector will need to overcome commercial, legal, cultural, and regulatory challenges.

Three core problem areas have been identified through stakeholder engagement that currently hinder this cross-sector data exchange that needs to take place to facilitate decarbonising the energy system and ultimately achieving net zero.

A data sharing infrastructure would support the industry in addressing these challenges. Additional discussion and context can be found in Appendix B.

Problem: Insufficient data interoperability	Currently, joining and blending datasets remains a manual, inefficient and time-consuming processes that requires extensive, domain-specific knowledge. These processes lead to data silos, resulting in duplicated or misaligned data and information being available in various formats or differing terminologies and standards. The overall lack of data interoperability promotes information silos and information asymmetry and makes it difficult to access and use the data when it is needed.
Problem: No common data sharing practices	Currently, data sharing across the energy sector is managed and carried out on an organisation-by-organisation basis. This has led to limited scalability, increased divergence between datasets and variety of bespoke approaches. The lack of common sector wide data-sharing practices (agreed set of procedures, processes, data licensing, handling conditions, and mechanisms) for sharing data securely between organisations creates a significant barrier to exchange of critical operational, financial reconciliation and price signals needed to enable innovation, provide optionality for future policymaking, and reduce the future system cost.
Problem: No flexible and scalable digital infrastructure	The data sharing infrastructure in the energy sector has been developed in an uncoordinated manner across various entities and domains. Currently, this consists of a landscape of singular initiatives that are implemented ad-hoc, typically through centralised architectures that are usually closed-sourced, taking years of design and development, with high costs. This unstructured approach has led to significant variations in sharing and access to critical systems and data across different parts of the sector, creating high financial and technical barriers to entry and curtailing the overall flexibility and scalability of the system. This leads to the inability to meet the rapidly evolving data sharing needs.

Opportunities arising from a data sharing infrastructure

A data sharing infrastructure goes beyond solving key challenges faced by the energy, presenting significant opportunity to the UK

Increased pace of innovation

A real opportunity to bring energy organisations across traditional boundaries, creating high impact coalitions to undertake mission-critical energy challenges from a whole-system approach for achieving a range of benefits:

- System operator provision of real-time information at fine granularity to optimise whole-system operation
- Flexibility providers e.g., distributed energy resource to offer automated services
- Market operators to enable transparent and cost-reflective energy market/service products to incentivise third parties to contribute to energy balancing and/or system balancing
- Infrastructure owners to achieve a high-level of alignment in investment decision-making to maximise strategic investment planning to reduce connection queues and maximise the utilisation of renewable energy
- Key stakeholders including policy makers to explore what-if scenarios to facilitate decision-making in a highly dynamic environment.

Meet policy objectives

A Major energy market review has been undertaken by the UK Government in the light of skyrocketing energy prices and increased threats to energy security. The review aimed to radically enhance energy security and resilience and deliver affordable low carbon energy for energy consumers for the long term.

The review outlined several reform options to address affordability, security and sustainability challenges.

A research paper on Electricity Market Reform explored the various options in further detail with experts from economists, engineers, policy makers, including:

- Locational marginal prices to indicate congestions in the system
- Market split to decouple electricity from gas prices
- Reform capacity markets to reflect flexibility

All of these reforms are dependent on whole-system, granular information to indicate the surplus or shortage of energy, availability of infrastructure networks, and critically the visibility of flexibility across the whole systems.

See Appendix B.3 for wider impact to policy objectives.

Greater value offerings for the customers

A data sharing infrastructure will:

- Reduce project initiation cost due to reduced data gathering requirements
- Reduce access barriers for less experienced entrants into supply chains through providing access data that are currently not available to them increasing competition, innovation and driving down prices
- Reduced cost to customers through more efficient systems with less network build
- Reduce uncertainty around potential energy and reflexibility resources from customers, network and generation leading to risk reduction
- Enable interdisciplinary research and innovation, enhance visibility and facilitate better integration of research and innovation to industry and policy making.
- Make the UK the first mover, with prospect of providing a blueprint for unlocking the value of data and digitalisation beyond the energy sector.

Need of the sector

Previous studies, consultations, and business cases for a data sharing infrastructure

EDiT Recommendations

EDiT, between 2019-2020, engaged with over 270 organisations to summarise six clear recommendations to support the transition to a future energy system. These recommendations outlined the data sharing infrastructure and governance needed to facilitate the transition to a digitalised energy system.

The joint response from BEIS, Ofgem, and Innovate UK supported many of these recommendations, and proposed to take steps to explore the potential opportunities and risks. This response included recommending commissioning of this feasibility study.

A key recommendation is to 'deliver interoperability' through the development of public interest digital assets. An important part of this is enabling the standardisation, and sharing, of data between different actors within the energy system.

Higher costs for customers

Without a data sharing infrastructure, the integration among various fast-growing numbers of actors, including customers, asset operators, and system operators, will become expensive, leading to significant increases in network congestion and constraints costs over time. This, in turn, can result in a greater reliance on flexible natural gas plants to meet domestic energy requirements, ultimately hindering our net zero goals.

The following reports and publications highlight the clear need for an energy system data sharing infrastructure:

- Smart Systems and Flexibility Plan 2021
- Digitalising our energy system for net zero Strategy and Action Plan 2021
- Energy Digitalisation Task Force 2022
- British Energy Security Strategy – 2022
- Government response to EDiT – 2022

Feasibility study stakeholder engagement

This feasibility study was undertaken with a stakeholder –led culture to ensure the delivery of a data sharing infrastructure meets the diverse needs of sectors. Recognizing this, the team conducted over 100 engagement sessions, reaching out to a myriad of stakeholders spanning energy, government, academia, heat, and other interrelated industries.

These sessions served as platforms for open dialogue, allowing stakeholders to articulate their specific requirements, potential challenges, and expectations.

These engagement sessions validated the needs of the sector, as previously defined in the various initiatives, such as EDiT, concluding an interoperable data sharing infrastructure is required, and requires government intervention for most efficient implementation.

See Appendix A for the list of organisations and activities conducted to understand the needs of the sector.

2

What is the proposed solution?

2.1

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Definition of a data sharing infrastructure

Introduction to a data sharing infrastructure

Overview of the three key components that enable an ecosystem of data sharing

The Energy Digitalisation Taskforce (2022) defined two concepts of "***Digital Spine***" and "***Data Sharing Fabric***".

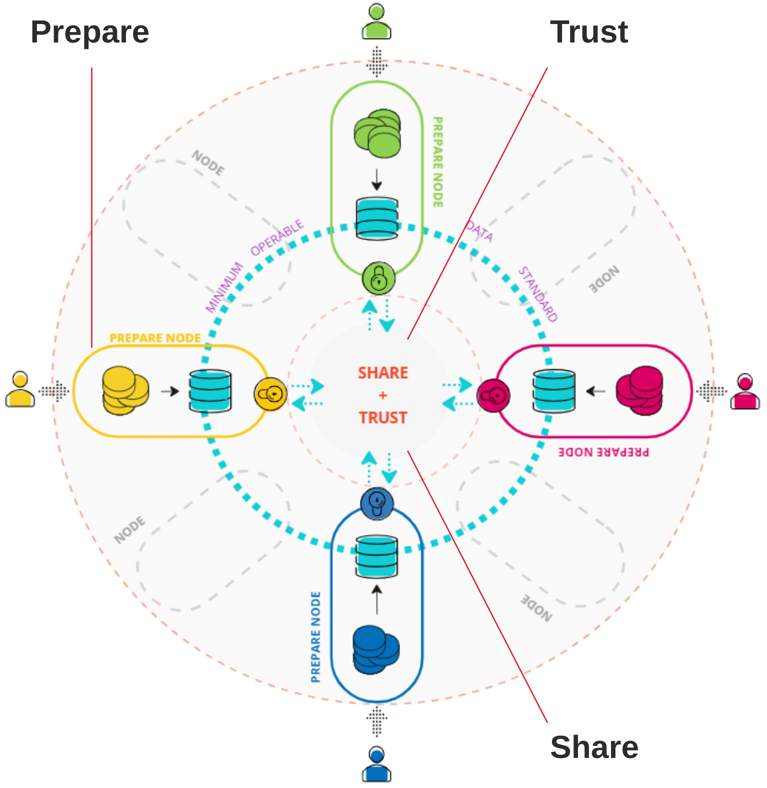
Following stakeholder engagement activities conducted as part of this feasibility study, it was decided to move away from these inherited terminologies. They caused significant confusion and were unhelpful in communicating and articulating the overall purpose of an energy system data sharing infrastructure.

Instead, to promote broader audience understanding, it is described by the three functional components: **Prepare**, **Trust**, and **Share**, as shown in the adjacent diagram**.**

These concepts are collectively referred to as a **data sharing infrastructure**, and together enable a digital infrastructure that allows the exchange of energy data in a secure and interoperable manner.

The data sharing infrastructure enables and fosters a culture of data sharing in the sector by empowering collaboration within the sector to co-define the rules, and through the enabling infrastructure facilitating the sector to compete on the game.

The **Prepare**, **Trust**, and **Share** functional components are detailed over the following pages.



Prepare: a cross-sector data preparation node

*Previously referred to as a **Digital Spine.*** A node on the organisation's own infrastructure that prepares data into a minimum operable data standard (specific to each data type and use case), and presents it through standard APIs, access and security controls.

There should be one consistent cross-sector version.

Trust: a sector-wide trust framework

Provides the definition, implementation, and governance of the legal and identity frameworks. This establishes the user's confidence, right, and legality, where required, to share data between parties.

There can be more than one of these in the sector.

Share: a sector-wide data sharing mechanism

Previously referred to as a ***Data Sharing Fabric.***

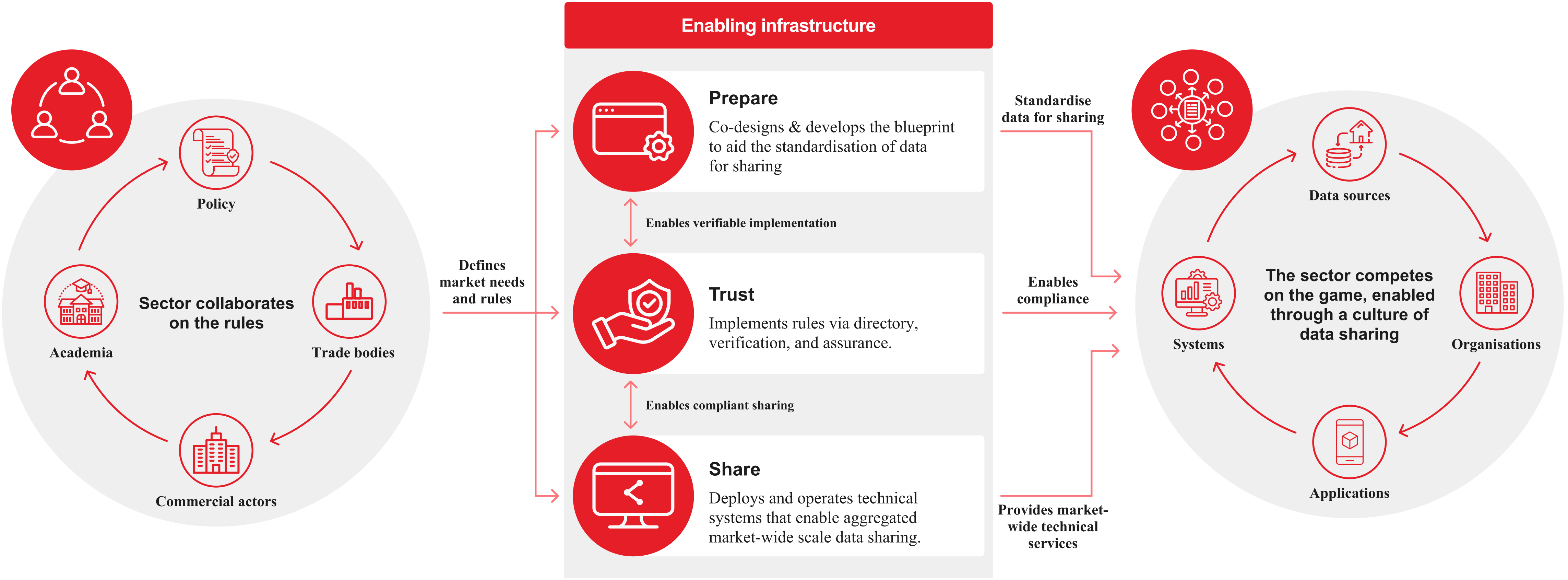
The connectivity layer and technology implementation for the governance of access controls to data.

There can be more than one of these in the sector.

Ecosystem of a data sharing infrastructure

A sector-led initiative with government support to develop and operate a data sharing infrastructure

The diagram shows a data sharing infrastructure in the context of sector actors collaborating on defining data sharing rules; thereby, enabling a market that can compete on providing services to end customers, enabling faster innovation, and supporting the sector meet its net zero targets.



Prepare: a cross-sector data preparation node

Summary of the terminology used in defining the concepts

Cross-sector data preparation node

The **cross-sector data preparation node** allows each organisation across the energy sector to deploy a commonly structured component, referred to as a **data preparation node**, as part of their own IT infrastructure.

This component allows an organisation to:

1. Control and specify the data they wish to share
2. Align and prepare that data to a minimum operable data standard (specific to each data type)
3. Securely present the standardised data to the sector through standard APIs, access controls, and security procedures

These deployed nodes would be able to form a network with organisations across the energy sector, and ultimately across all sectors, all using and presenting data to each other in a consistent approach.

It is considered that there should only be one consistent cross-sector data preparation node to reduce the friction and barriers to cross-sector data sharing.

Addressing a need

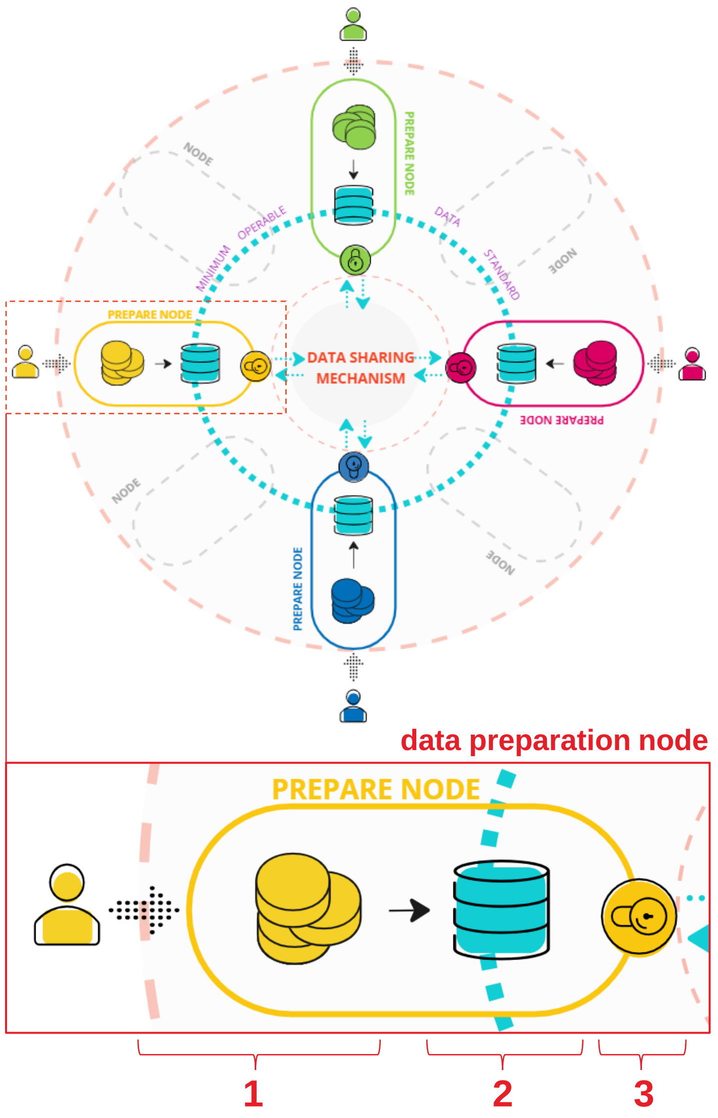
To enable a data sharing infrastructure, the data that is transmitted between two or more actors needs to be prepared and standardised against a set of rules.

These rules can be common standards, ontologies, and taxonomies, or at a basic level common metadata.

In the current operating environment, despite the vast amount of available data, joining and blending datasets remains a manual, inefficient process that requires extensive, domain-specific knowledge.

This challenge can be mitigated by fostering a culture of sharing standardised data. When data is standardised:

- It allows for better collaboration, by enhancing the trustworthiness of the data.
- It helps maintain the integrity of data as it is shared, through common quality standards.
- It can support interoperability which can also reduce overall system optimisation costs. Interoperable data requires fewer translations, lower processing requirements, and is less susceptible to errors, ultimately leading to minimised operational costs.



Trust: a sector-wide trust framework

Summary of the terminology used in defining the concepts

Trust framework

A **sector-wide trust framework** defines, implements and governs the legal and identity rules that ensure reliable data sharing. Users can set the data licensing and legal conditions for data, enabling user's confidence, right, and legality, where required, to share. It includes:

- The process of agreeing to rules for data sharing in the data sharing mechanism,
- An integration of process for enabling organisations to participate through a data sharing mechanism that can implement those rules.
- The technical components required to codify the rules

The development of trust framework is use-case driven, but one trust framework can be applied to multiple use case once implemented if the use cases allow for similar contractual framework and identity management.

Also, It is considered that there can be more than one of these in the sector. For example, a 'network' instance, a 'regulation' instance, and a 'privately' owned and operated instance. These would be designed from the same blueprint, so would be architecturally identical.

This will offer participants the flexibility to define a trust framework that is best suited for their use cases and associated commercial, legal and licensing policies.

Addressing a need

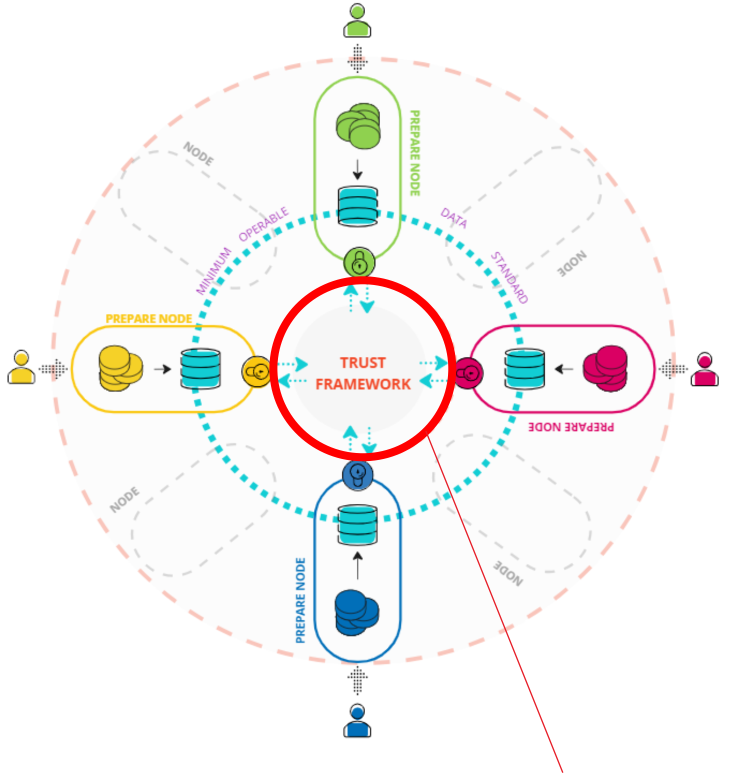
To enable a data sharing infrastructure, an appropriate framework for trust is crucial to facilitate the exchange of data between parties and stakeholders.

Currently, organisations use data sharing agreements. These agreements help reduce risks associated to data sharing by motivating the data producer to ensure the data is accurate, complete, and up-to-date.

They also establish guidelines for data privacy, security, and ownership - which are critical considerations when dealing with sensitive data.

Without appropriate data sharing agreements, there is a risk that parties share incorrect, incomplete, outdated data, which can result in inaccurate simulations and predictions, potentially leading to legal liability, financial penalties and reputational damage for the parties involved.

The trust framework aims to provide a scalable, and a robust solution by providing organisations accurate risk profiles, common user attributes, identity management, and pre-negotiated agreements based on use case needs.



Sector-wide trust framework

Share: a sector-wide data sharing mechanism

Summary of the terminology used in defining the concepts

Sector-wide data sharing mechanism

A **sector-wide data sharing mechanism** facilitates data sharing by providing the technology, security and governance means for exchanging data.

It enables the governance, security, and exchange of data between the organisations. This is delivered by a host of components related to security services, a trust framework, data catalogue, system governance and data exchange via message brokers and APIs.

It allows actors to:

1. Discover data shared by other actors
2. Securely request and pull the data of interest from other actors through their data preparation node
3. Provide governance, and licencing definition and brokerage

Once a request is granted then a stakeholder can securely connect to the data preparation node of the organisation from which they want data, then request and obtain that data, securely with appropriate assurances in place.

Like the trust framework, it is considered that there can be more than one of these in the sector.

Addressing a need

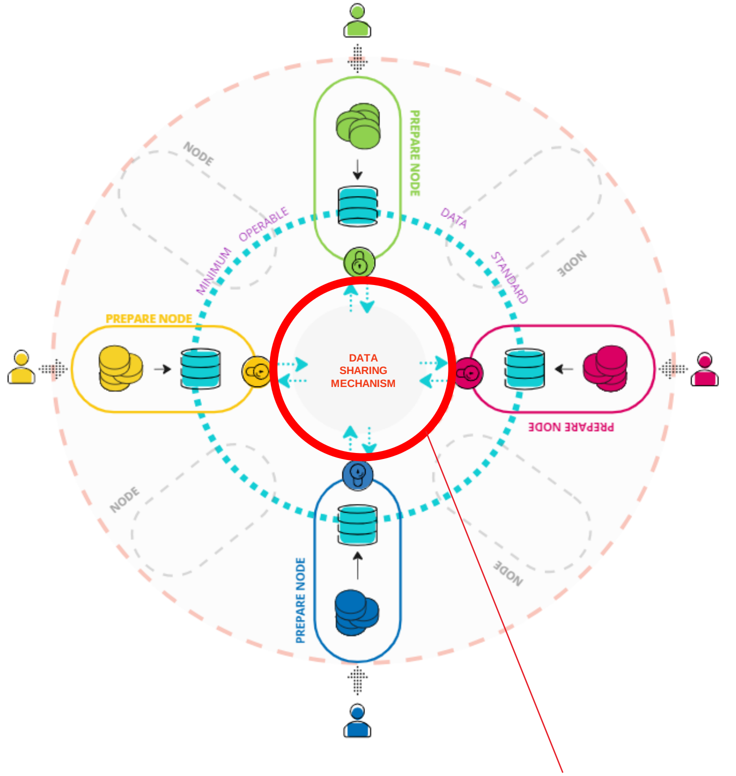
To enable a data sharing infrastructure, an appropriate mechanism is required to ensure secure, reliable, and scalable method for moving data from the producer to the consumer.

The current data pipelines in the energy sector have been developed in an uncoordinated manner. Regulated entities have typically tackled data sharing challenges by implementing vendor-specific solutions, resulting in a range of technologies and approaches being used.

This unstructured approach has led to significant variations in sharing and access to critical systems and data across different parts of the sector, creating high financial and technical barriers to entry for many data systems.

Therefore, establishing an appropriate technology framework, commercial model, and governance structure is crucial for the ongoing evolution of a data sharing infrastructure.

This will ensure that data sharing practices and interoperability initiatives are supported, and that organisations are incentivised to develop and implement supplementary functionality.



Sector-wide data sharing mechanism

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Characteristics of a data sharing infrastructure

Characteristics of a data sharing infrastructure

The high-level characteristics of a data sharing infrastructure

Overview

Based on the problem to be solved and the potential recommended solutions, 12 characteristics were identified for a data sharing infrastructure.

These were identified and validated through research, stakeholder engagement, and sector collaboration.

The provide a view into the essential and non-negotiable aspects for a data sharing infrastructure and consider **people**, **process**, **data**, and **technology**.

The characteristics are summarised over the following pages, with details descriptions given in Appendix B.4.

People and process

The six high-level characteristics identified that consider people and process are:

- Fostering a culture of data sharing
- Hybrid architecture (centralised & distributed)
- Collaborative
- Transparent operations
- Low barrier deployment
- Use case driven

Data and technology

The six high-level characteristics identified that consider data and technology are:

- Data standardisation & interoperability
- Hybrid technology stack
- Secure
- Self-serve platform
- Reliable and performant
- Low integration overhead

People and process high-level characteristics

The high-level characteristics of a data sharing infrastructure

Fostering a culture of data sharing

Fostering a culture is critical to ensuring that the industry and others engage with and adopt a data sharing infrastructure. It helps organisations broaden their thinking beyond traditional business models and individualistic objectives to understand the opportunities presented by data sharing across the sector.

For this to happen, a culture of data sharing must be established. This allows participants to develop the skills and workforce characteristics required to interact effectively with the data sharing infrastructure.

Hybrid architecture (centralised & distributed)

Deployment of a hybrid data architecture, whereby the data preparation nodes can be deployed in a distributed fashion within each organisation's environment (cloud, on-premise, hybrid etc.), but some services associated with the data sharing mechanism (trust framework, security services, data catalogue, message brokers etc.) remains centralised.

A distributed nature will mean that each organisation can retain ownership of their data, but central components can offer services pertaining to trust, security and exchange to maximise usefulness and adoption.

Low barrier deployment

As the development of the infrastructure begins, a low barrier of deployment will be a key measure for assessing different solutions. The solution needs to be grounded in well-understood technologies, which can be easily deployed and maintained.

Preferably, the underlying technology complexity should be abstracted away from the users. Furthermore, accompanying documentation and support will also be available to enable organisations with less mature digital skills and capabilities to engage effectively.

Transparent operations

For organisations and users to develop trust in the data sharing infrastructure and, consequently, adopt it, a collective understanding of the system, its direction, and the reasons behind decision-making must be made clear.

Therefore, communication and decisions will be facilitated through cross-sector engagement, like the engagement during the feasibility study. This approach will ensure that stakeholders appreciate the value being created and understand how they can benefit from it.

Collaborative

The data sharing infrastructure is designed for the sector; hence, any actions and decisions related to the data sharing infrastructure should be taken collaboratively, utilising existing digitalisation initiatives whenever possible.

This approach ensures that maximum value is derived from the delivery of these initiatives, fosters a collaborative culture across the sector, and minimises the risks of failure or the need for future investments to realign potential solutions.

Use case driven development

Use case-driven development supports the design of a system that focuses on what the user needs and, consequently, what the system needs to do, rather than how it is done. This approach ensures the data sharing infrastructure meets user needs and remains focused.

Additionally, a use case driven approach facilitates incremental development, enabling early realisation of value through the delivery of the use cases, and provides tangible information to help participants understand the opportunities presented.

Data and technology high-level characteristics

The high-level characteristics of a data sharing infrastructure

Data standardisation & interoperability

A data sharing infrastructure will be a critical vehicle for achieving interoperability of energy data. This entails developing a data preparation node that enables organisations to provide their data in a way that incentivises and facilitates its use. This approach ensures that the data is described in a manner that supports search and discovery.

Without standardisation and interoperability at its core, the data sharing infrastructure would be redundant and could potentially lead to market failure due to misaligned data sharing.

Hybrid technology stack

To ensure the widest adoption, the development of the blueprint data sharing infrastructure should be open-source, but any given implementation for specific components e.g. the trust framework, may not be.

The technology implementation for the MVP data preparation node will be built using an open-source software technology stack. This will foster collaboration, eliminate risks of vendor lock-in, and enhance accessibility by lowering barriers to entry. It will also commercially incentivise actors to develop their own modules and components to drive further innovation.

Secure

A data sharing infrastructure will provide trusted, secure, and resilient sharing of data. Therefore, it will adhere to and align with international security standards and best practices. This approach will secure and protect the data, minimising vulnerabilities and building trust and confidence among participants.

Finally, as the program progresses, core housekeeping practices, regular testing, and resilience mechanisms will be included as part of the wider governance of the data sharing infrastructure.

Self-service platform

Adopting a self-serve platform design will help foster a data-driven culture that promotes collaboration and empowers organisations to provision and consume data for decision making. This approach will result in a data sharing infrastructure that provides organisations with the appropriate components and techniques to prepare, trust, and share their data.

The implementation should abstract technology complexity away from the users, enabling a self-serve data environment in which individuals can quickly and independently obtain data in an accessible way.

Reliable and performant

To minimise the risk of failure, development of mistrust, and potential disengagement, data sharing infrastructure will prioritise performance and reliability while accommodating a variety of use-cases. Any development will incorporate requirements related to reliability and performance into the design, such as scalability, performance, availability, and fault-tolerance.

The design will consider requirements for design patterns (e.g., event-driven architecture), asynchronous data sharing, and considerations around the user journey and experience.

Low integration overhead

The data preparation node will be easily deployable and will seamlessly integrate with organisations' existing data pipelines, platforms, and data stores. This is crucial as a solution that requires significant change will create barriers to adoption.

Furthermore, organisations with mature IT capabilities can use their incumbent tooling to prepare their data, then publish through the data preparation node’s APIs. The node forms the blueprint for data preparation and organisations may choose to use their internal tooling to achieve this.

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How to deliver a data sharing infrastructure

3.1

Use cases and user journeys

Summary of findings from over 100+ engagement sessions

Main observations emerging from sector wide engagement

Meeting common objectives

A consistent theme observed through the stakeholder engagement activities was consensus around the ability of a data sharing infrastructure to effectively enable key policy objectives, such as:

- **Energy equity and affordability:** enabling energy that is affordable to consumers, keeping bills affordable, assisting vulnerable customers and reducing fuel poverty.
- **Energy security**: ensuring the UK is on a path to greater energy independence, ensure reliability of energy resources.
- **Support net zero**: supporting the economy through the net zero transition.
- **Economic security**: supporting growth, innovation and competition.

Emerging themes

Through the exploration of the use cases and stakeholder engagement activities, several observations and themes have emerged:

- A data sharing infrastructure should be equally a technological and a governance initiative, so that it can respond to the complex challenges around sharing of data.
- A data sharing infrastructure that was confined to the energy sector only would significantly risk the creation of further siloes across sectors and future abortive work.
- A data sharing infrastructure as an ecosystem for data sharing across the energy sector should be as simple as possible. It should avoid creating a barrier to entry for data providers, particularly in the requirement alignment to standards, and for actors with lower digital capability and reporting.

The value of a data sharing infrastructure

Through stakeholder interviews it was observed that the stakeholders found it difficult to clearly articulate the value of a minimal level data sharing infrastructure in relation to the problems they are trying to solve.

It was observed that stakeholders focused on the end functionality needed to solve a specific problem.

For this reason, it is considered challenging to achieve and understand the proof of the benefit of a data sharing infrastructure if it is measured at a single use case level, or on a use case by use case basis.

The value of a data sharing infrastructure is realised by solving common challenges faced across several use cases.

It is therefore recommended that a holistic approach for benefits is used, which considered whether it is better to solve each possible use case across the energy sector requiring data sharing in isolation or whether it is more effective to enable the missing foundational capability across the sector as a whole.

Potential use cases and functional requirements

Stakeholder-led approach to defining use cases, technical and delivery requirements

Stakeholder engagement

In total, 15 potential use cases were identified through stakeholder engagement, and market research.

They aimed at finding potential use cases that helped with the definition of a data sharing infrastructure and met the overarching policy objectives.

The 15 initial use cases were prioritised through three steps:

1. Eligibility criteria
2. Stakeholder preferences
3. Assessment against ‘additional considerations’

These steps prioritised five use cases. Details of these steps are given in Appendix C.4.

The detailed use case analysis is in Appendix C.4.1.

Day 1 use cases

Five use cases were selected and prioritised for further research. These were divided into two categories:

- **Day 1 use cases** – those use cases for which a data sharing infrastructure could bring immediate value. See Appendix C.5.1 for the detailed user journeys for each use case.
  - Use cases: *Vulnerable consumers identification, LAEP & coordination of local decarbonisation planning, and electricity flexibility.*
- **Strategic use cases** – those use cases that provide the future strategic potential of a data sharing infrastructure. Two use cases were identified in this category. See Appendix C.5.2 for the detailed user journeys for each use case.
  - Use cases: *Electricity market reforms – nodal pricing, and sector coupling.*

The day 1 use cases were detailed further to understand the clear definition of how they would use a data sharing infrastructure to achieve a particular goal.

See Appendix C.5 for further details.

Functional requirements

In addition to identifying potential use cases, the stakeholder engagement also highlighted the functional requirements for a data sharing infrastructure.

The functionalities were broken down into three considerations:

- **MVP functionality**: common capability for users to carry out the data exchange across all use cases.
- **Extended functionality**: Potential capability, such as use case specific needs, that could be addressed to ensure better/effective sharing of data
- **Enablers**: Governance and process for users to exchange and access data effectively**.**

Appendix C.2.1 details the user journey of the nine steps a user takes when interacting with the data sharing infrastructure. A summarised on the next page.

Appendix L details worked examples of two use cases interacting with a data sharing infrastructure to outline the differences between the MVP and the extended functionality.

Describing a data sharing infrastructure through a user journey

Outline of nine steps a typical user will undertake when interacting with a data sharing infrastructure

Interacting with the data sharing mechanism can be described through a nine-step user journey, which is based on the user needs identified in Appendix C.

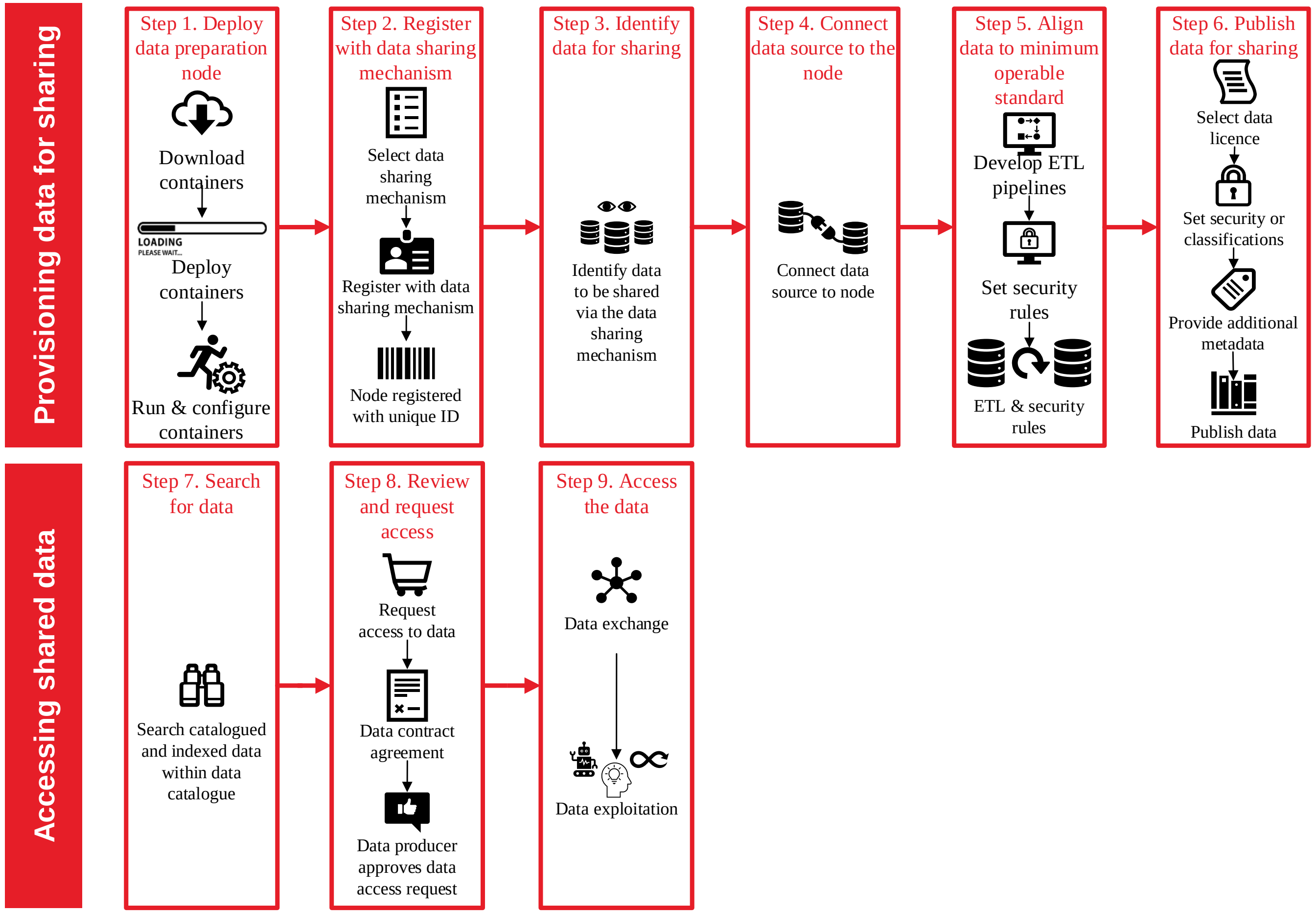
The nine steps are summarised in the adjacent diagram.

1. **Deploy data preparation node**
2. **Register with data sharing mechanism**
3. **Identify data for sharing**
4. **Connect data source to node**
5. **Align data to minimum operable standard**
6. **Publish data for sharing**

Activities pertaining to provisioning data for sharing. These are the activities an organisation will perform to prepare and publish their data for sharing

7. **Search for data**
8. **Review and request access**
9. **Access the data**

Activities pertaining to a data consumer accessing the data provisioned by a data producer in step 1-6



Detailed descriptions of the steps are in Appendix G.1.

3.2

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Technical components of a data sharing infrastructure

Technical requirements of a data sharing infrastructure

The technical requirements and functionality of the data sharing infrastructure and the minimum viable product (MVP)

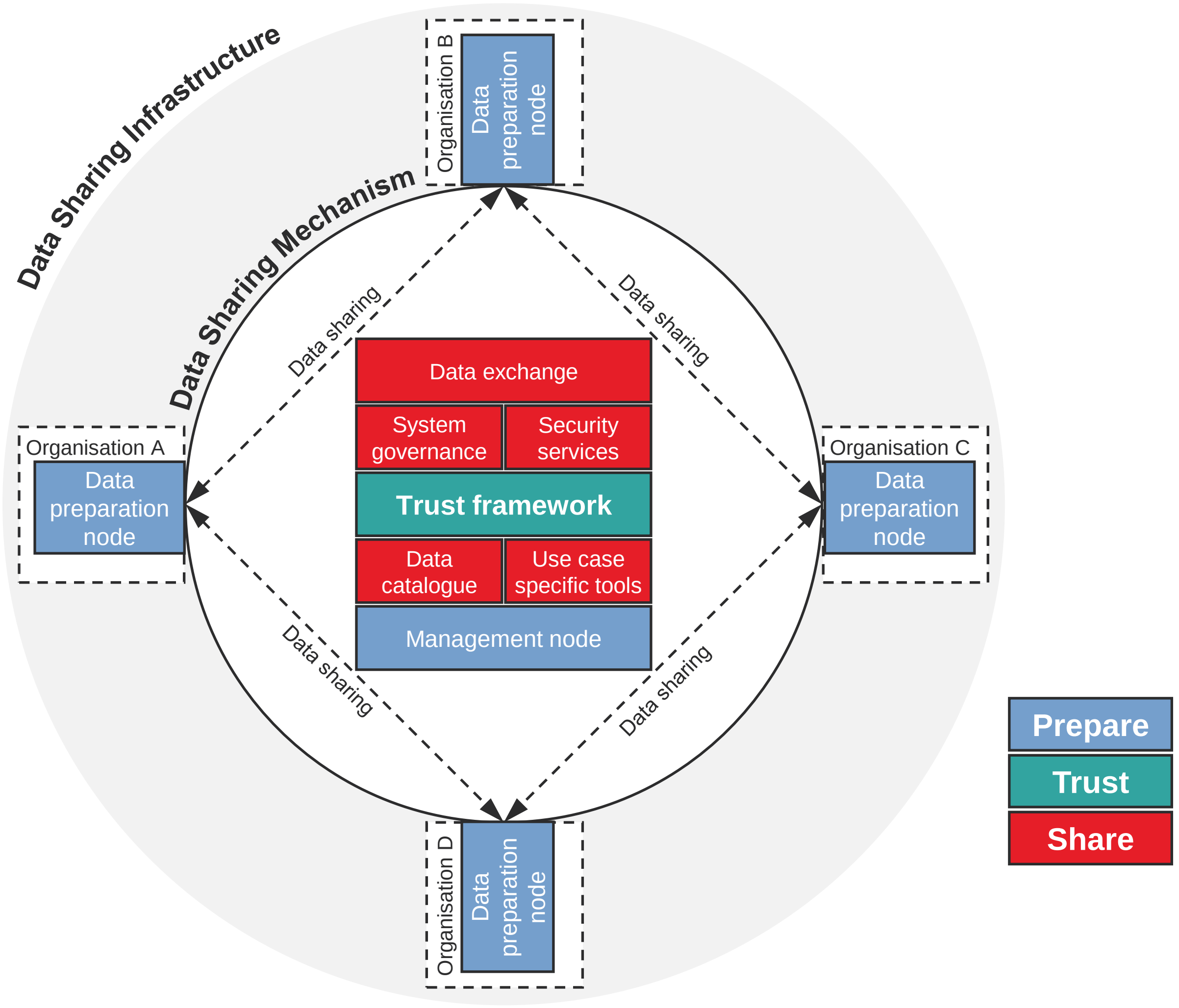
As summarised in Section 2.1, a data sharing infrastructure is an approach to enable data sharing across a sector amongst several organisations or participants. It consists of three components:

- **Prepare** - A cross-sector data preparation node
- **Trust** - A sector-wide trust framework
- **Share** - A sector-wide data sharing mechanism

To enable the secure, interoperable and effective sharing of data, these three components need to deliver a variety of functionalities and services.

The constituent functionalities and services are summarised on the following pages, alongside a technical user journey to describe a user's interaction with a data sharing infrastructure.

Further details on the technical requirements are given in Appendix G.



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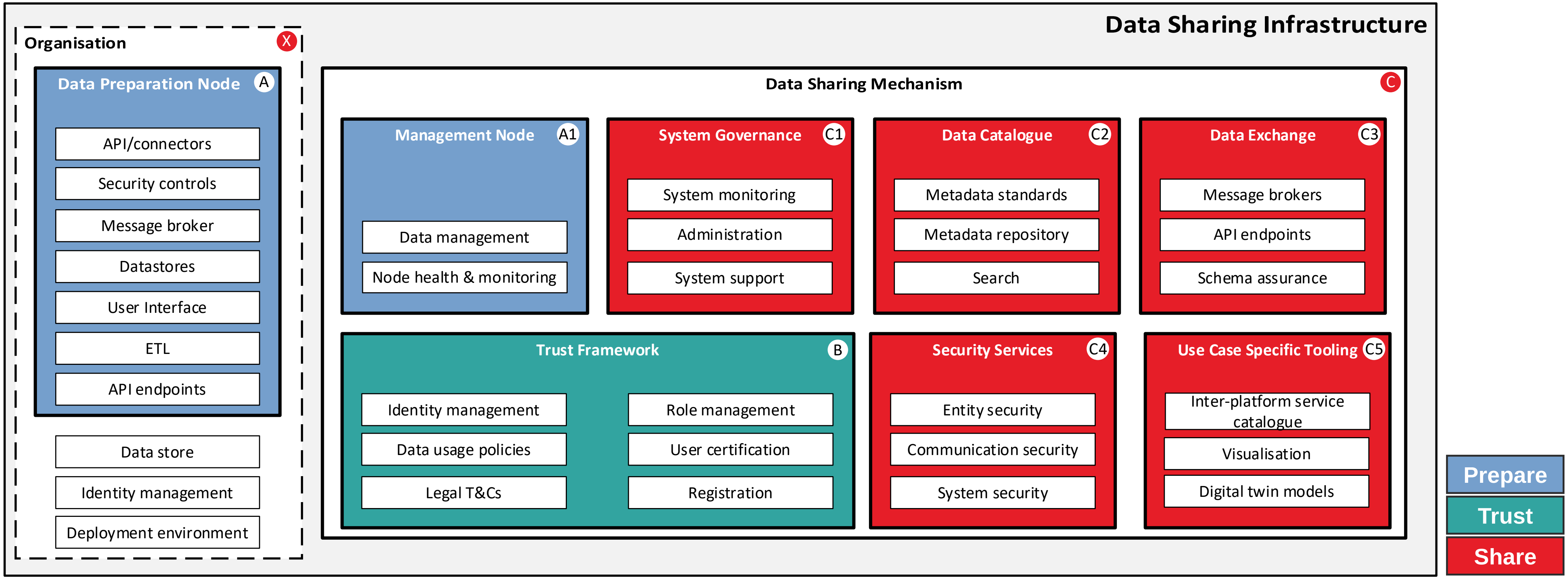
Functional components of a data sharing infrastructure

Diagram of the functional components of a data sharing infrastructure

A data sharing infrastructure consists of several functional components. Each of these components are detailed on the next page using the numbers in the diagram below.



Functional components of a data sharing infrastructure

Description of the functional components of a data sharing infrastructure

The following functional component descriptions correspond with the numbers on the diagram on the previous page.

Further details on the technical requirements of the data sharing infrastructure are given in Appendix G.

X. Organisation: Organisations deploying a node will require a deployment environment (cloud, on-premise, hybrid) to deploy the node.

Their datastores will need to connect to the node for the transformation and publishing of data, and they will need identity management services for internal security authentication and authorisation for their users.

A. Data preparation node: The containerised application node with a set of components to enable the standardisation and publishing of data.

A high-level design is provided in Appendix G.1.

A1. Management node: Performs health & monitoring for data preparation nodes across a data sharing infrastructure and performs data management e.g., reference data management.

B. Trust framework: Provides the technology and legal functions to ensure assurance and compliance when exchanging data between nodes and actors.

This includes the technology elements such as identify management, role management, registration portal, and the legal elements such as data usage policies, legal conditions, and certifications.

C. Data sharing mechanism: provides a range of security, governance, cataloguing and data exchange services to enable sharing of data between nodes.

C1. System governance: Governance of the data sharing mechanism including administration, monitoring of data and system use, and system support.

C2. Data catalogue: Provides the metadata repository to host metadata in required standards to enable search by organisations.

C3. Data exchange: Provides the tools to facilitate the transmission of data between nodes. This includes API endpoints and message brokers i.e., data streaming and publish-subscribe sharing.

Schema assurance is also used to validate and check for schema conformity when data is published and consumed across the nodes.

C4. Security services: Security controls and techniques to facilitate the secure sharing of data across nodes. This includes entity security, communication security and system security.

C5. Use case specific tooling: tools and applications offered by the data sharing mechanism to deliver specific use-cases e.g. digital twin models marketplace to share digital twin models, and visualisation and analytical tools, and an inter-platform service catalogue for additional interoperability services.

3.2.1

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Enabling a cross-sector data sharing ecosystem

Blueprints: enabling a cross-sector data sharing ecosystem

How a data sharing infrastructure can enable a cross-sector data sharing ecosystem

Approach

The development of data sharing infrastructure within the energy sector can be done in two complementary ways to enable a cross-sector infrastructure:

- **Blueprints:** The template or design pattern of the data sharing infrastructure components. These would include the architectural diagrams, specifications, processes, and standards that need to be adhered to for anyone to build any of the components of the data sharing infrastructure in a compliant way that is interoperable with other instances of the blueprints.
- **Development of components:** The technical implementation of those blueprints through the creation of components. It can represent demonstrating the technology readiness level of a data sharing infrastructure, provide the market with an ‘early adopter’ of the solution and in the long run represent the implementation of an ecosystem of interoperable components underpinned by the blueprints.

Setting the data sharing infrastructure up in this way ensures successful development of an energy sector data sharing ecosystem that can knowledge disseminate with future cross-sector data sharing ecosystems.

Blueprints

Blueprints for a data sharing infrastructure will be broken down into its functional parts.

It is considered that, at a minimum, the blueprints will comprise of the data preparation node (prepare), trust framework (trust), and data sharing mechanism (share).

This feasibility study identified functional requirements for the data sharing infrastructure (see Section 3.1).

Whilst the functional requirements identified were underpinned by energy sector use cases and user requirements, they were developed with the intention of being sufficiently generalisable that they could be adopted by any sector looking to develop a data sharing infrastructure.

This was done with the intention of supporting cross sector collaboration, interoperability of data sharing, and delivery of maximum value from the effort expended.

Development of components

Developing the components provides the implementation for a data sharing infrastructure by delivering the functional capabilities outlined in the blueprints. This represents the development of capability to build a data sharing infrastructure around a chosen use case, such as electricity flexibility, that can demonstrate usefulness for the sector.

The components could be developed as part of the organisation which is also delivering the blueprints. These components can then be iterated and validated against the design specification for a specific use case.

The development and implementation of the components may be different for each one; for example, the data preparation nodes will have an open-source delivery, but other components such as the trust framework may not.

The aim is to develop the components by using the blueprints. This will create the required capability for adoption. Coupled with this is the aim to accelerate the technology readiness level of the capability across the sector, and in the future, across other sectors.

Cross-sector data sharing ecosystem

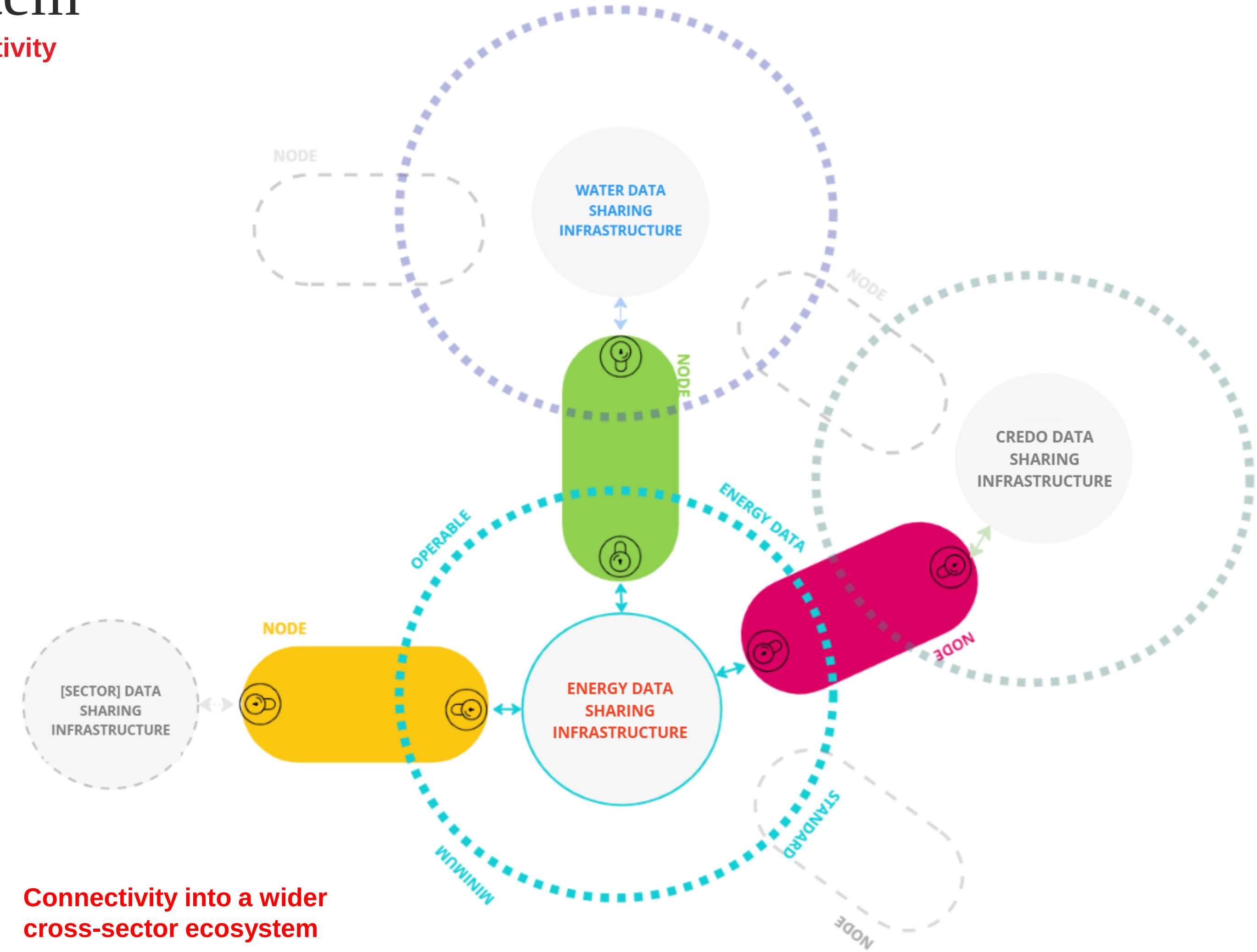
A data sharing infrastructure could facilitate cross-sector connectivity

As the data sharing infrastructure blueprints are developed and validated, the energy system data sharing infrastructure can grow to be part of a wider connectivity ecosystem spanning across multiple sectors (such as water) or other connected digital twin ecosystems (such as CReDo).

Its distributed implementation across each organisations enables the consistent cross-sector data preparation node to connect and share data through multiple data sharing mechanisms, enabling a wider system-of-system connectivity.

To achieve this, the blueprint of the **cross-sector data preparation node** should be managed and maintained by an appropriate national-level entity, and then consistently used by each sector to provide the blueprint of their sector-specific implementation.

This blueprint approach provides flexibility to accommodate sector-specific needs and requirements, on top of a common architecture design. See Appendix I for further details on governance.



Connectivity into a wider cross-sector ecosystem

3.3

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Delivery and governance requirements

3.3.1

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Delivery pathways for a data sharing infrastructure

Delivery pathways of a data sharing infrastructure

An overview of the high-level delivery assessment undertaken to determine the recommended delivery routes

A pathway is defined as a selection of options for the implementation and steady-state phases for all three aspects of the data sharing infrastructure.

Through stakeholder engagement, and subsequent prioritisation, four delivery options were identified for the implementation phase and five delivery options were identified for the steady-state operation phase. These delivery options are summarised to the right, with descriptions for each given in Appendix H.1.1.

Each of the functional components were evaluated against these potential delivery options, using various socio-technical criteria, to determine which pathways are most likely to be successful. See Appendix H.2.

There are potentially many different pathways to deliver a data sharing infrastructure, each with its own benefits, disbenefits, and considerations. The consortium selected a set of plausible of candidate pathways for further analysis. The highest scoring pathway outlined on the next page, with further details given in Appendix H.3.

Additional work is required to assess the viability of a pathway and select a delivery route that aligns with sector policy requirements. Potential delivery routes, considering delivery pathways, and governance is outlined on Section 3.5, and Appendix K.

Implementation phase

The delivery lifecycle encompasses the series of stages and processes involved in bringing the functional components from conception to implementation.

It typically begins with requirements gathering and analysis, followed by design and development, testing and quality assurance, and deployment.

The identified delivery routes include:

- **Option 1A:** Independently-led industry consortium
- **Option 1B:** Publicly-led development
- **Option 1C:** Technology provider builds it
- **Option 1D:** Directly procure an existing solution and/or services from an organisation with relevant experience

Steady-state operation phase

Once the functional components has been deployed and all major development and implementation activities are completed, it enters the steady-state.

During this phase, the focus shifts from active development to maintenance and support activities to ensure the functional component operates smoothly, meets performance expectations, and remains reliable for its users. This phase involves activities such as monitoring, bug fixing, performance optimisation, security updates, and user support.

The identified delivery routes include:

- **Option 2A:** Solution given to an energy sector strategic entity
- **Option 2B:** Solution given to a national-level strategic entity
- **Option 2C:** Solution given to an energy sector operational entity
- **Option 2D:** Create a commercial agreement to support operation, maintenance, and further development of the solution
- **Option 2E:** Solution owned and operated by a private entity

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High-level assessment of the potential delivery options

Summary of the high-level assessment of the potential delivery options for the three functional components of a data sharing infrastructure

High-level assessment results

The adjacent table summarises the results of the high-level assessment, with the details of each assessment given in Appendix H.

The cells highlighted in the table are the delivery option with the highest score for each of the lifecycle phases and functional components. From this high-level assessment it was observed that there is not a single option that applies to all functional components within a lifecycle stage.

The highest scoring pathway, a selection of options for different functional components, has been developed further in Appendix H.3 to understand the operating model, delivery timelines, and potential costs.

The proposed governance models for each lifecycle phase is given in Appendix I.2.

Phase	Delivery option	Functional components		
		Data preparation node	Data sharing mechanism	Trust framework
Implementation	**Option 1A:** Independently-led industry consortium	●	●	
	Option 1B: Publicly-led development			
	Option 1C: Technology provider builds it			
	Option 1D: Directly procure an existing solution and/or services from an organisation with relevant experience			●
Steady State operation	**Option 2A:** Solution given to an energy sector strategic entity		●	●
	Option 2B: Solution given to a national-level strategic entity	●		
	Option 2C: Solution given to an energy sector operational entity			
	Option 2D: Create a commercial agreement to support operation, maintenance, & further develop the solution			
	Option 2E: Solution owned & operated by private entity			

The assessment conducted are the view of the consortium, and further stakeholder engagement, considerations and needs review is recommended (see Appendix O).

Highest scoring implementation pathway for each functional component

A delivery pathway for the implementation of a data sharing infrastructure

Prepare: Data preparation node

An **independently-led industry consortium** (**Option 1A**) is the highest scoring option.

Justification

An independently-led industry consortium has the benefit of selecting partners who are likely to share knowledge and bring their own skillsets to offset any gaps.

This option scored highly for the right skillset, social value (due to their ability to distribute learnings), adoption (by ensuring high stakeholder engagement to capture industry views), and mitigating monopoly risk (through their ability to design and set up tools to prevent vendor lock-in).

See Appendix H.2.1 for more details.

Trust: Trust framework

An entity responsible for the data sharing mechanism **directly procures an existing solution** and/or services from an organisation with relevant experience (**Option 1D**) is the highest scoring option.

Justification

This option scored highest in terms of timeline, cost, skillset, and governance because of the organisation's ability to leverage previous similar projects in the energy sector.

An existing framework will provide a common ground for stakeholder engagement to ensure high adoption for feature development, and high alignment for outlining the trust and assurance guidelines.

See Appendix H.2.3 for more details.

Share: Data sharing mechanism

An **independently-led industry consortium** (**Option 1A**) is the highest scoring option.

Justification

An independently-led industry consortium has the benefit of selecting partners who are likely to share knowledge and bring their own skillsets to offset any gaps.

The consortium can be flexible to adopt to changing regulatory landscape and government requirements; therefore, has scored highest when assessed against all four options.

However, a key risk associated with this option is the longer time required for the consortium to reach agreements for collaborative work, mitigating monopoly risks, and ensuring the incorporation of industry views.

See Appendix H.2.2 for more details.

Highest scoring steady-state pathway for each functional component

A delivery pathway for the steady-state operation of a data sharing infrastructure

Prepare: Data preparation node

Solution given to a national-level strategic entity (**Option 2B**), such as the NDTP, to be responsible for the blueprints for its cross-sector remit.

Justification

The 'prepare' node has a cross-sector adoption requirement, Therefore a national entity is necessary for proper governance because of its ability to access relevant stakeholders and ensure broader cross-sector adoption. A sector-specific will not have the responsibility or mandate to engage other sectors; whereby, a national entity can have said responsibility.

See Appendix H.3.1 for more details.

Trust: Trust framework

Solution given to existing energy sector strategic entity (**Option 2A**) because the trust framework is a specialised functional component which requires extensive sector-specific engagement.

Justification

This option is assumed to be closely linked to the 'share' component; therefore, long-term operations should also align with the entity operating the data-sharing mechanism.

This component will not rely on vendor-specific technology, making it easier for the sector entity to manage long-term operations and maintenance.

See Appendix H.3.3 for more details.

Share: Data sharing mechanism

Solution given to existing energy sector strategic entity (**Option 2A**).

Justification

A sector-level organisation is necessary due to sector-specific needs and requirements. This includes sector-specific ontologies, CNI security, and use case specific tooling.

This component will require high stakeholder engagement for BAU activities to ensure high adoption across the sector.

Ensuring high adoption is a key need to realise major benefits the data sharing infrastructure can enable.

See Appendix H.3.2 for detailed outlines of the operating model, and timelines.

Other considerations for evaluating potential pathways

A delivery pathway for the data sharing infrastructure

Overview

In addition to the proposed delivery pathway there are additional delivery reflections to be considered.

A decision on these will inform the requirements for procurement and underpin the implementation and steady-state operating model and future success of the data preparation node.

These reflections are:

- **Build or Buy:** The design and delivery of the data standardisation infrastructure from first principals or the use and customisation of existing solutions to act as the foundations. See Section 3.3.3 for review of existing initiatives.
- **Public or Private:** The provision of ownership of the data preparation node to a public or private organisation. See Section 4.1 for review for potential government intervention
- **Open or Proprietary:** The data preparation node could either be open source and freely available in design or proprietary such that it is owned by one organisation only. See Section 2.2 for considerations on ensuring wider accessibility.

Cost considerations

The cost ranges for the various functional components of a data sharing infrastructure are considered a class 5 estimate, with uncertainty range of +100% or -50%.

The cost ranges summarised are derived from and correlate with open data available from previous government-funded projects, and the consortium's experience from previous completed similar digital projects.

Therefore, the costs range contains uncertainty, and are a value judgement that is subject to change as new information becomes available. Further details assessments are needed to reach a class 1 or 2 estimate.

Such historical prices provide an initial estimate, but further detailed cost estimate are dependent on the following requirements:

- Delivery pathways
- Detailed outline of the MVP technology
- Scale of implementation
- Use cases

The MVP implementation of the **data preparation node**, encompassing the, sharing, or transformation of data, is expected to be **£1m-£3m**, depending on the complexity of design, procurement pathway, and future improvements. While the potential steady state costs can cost **£2m-£4m per year**.

The MVP implementation of the **trust framework**, to ensure security, and compliance, is anticipated to cost **£2m-£6m**, reflecting the complexity of enabling scalable, and codifying the various legal terms and conditions, identity management, and security controls. While the **steady-state costs** would be **minimum £2m per year.**

The MVP implementation of **data sharing mechanism**, the engine that facilitates seamless data sharing, is estimated to be **£10m-£20m**. While the **steady-state costs** would be **minimum £18m per year.**

Therefore, the overall investment for implementing an MVP of an energy sector data sharing infrastructure is projected to be **£13m-£29m.** While the **steady-state costs** would be **minimum £22m per year.**

These costs do not account the income generated from licensing, exporting technology, and other enabling innovation.

3.3.2

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Governance of a data sharing infrastructure

Governance of a data sharing infrastructure

Characteristics of the overall approach for data sharing infrastructure governance routes

Overview

Governance of a data sharing infrastructure needs to clearly define the overarching outcomes it wants to achieve by setting itself a specific remit and set of functions.

For a data sharing infrastructure to enable the exchange of energy data in a secure and interoperable manner through the provision of a minimum layer of digital infrastructure, it is considered that the best suited structure is one that brings:

- **Transparency and openness** – brings visibility to its operation to enable trust and adoption across different market's participants.
- **Accountability** – provides clear definition of responsibilities and party responsible for each governance function and avoid conflicts of interest.
- **Legitimacy** – assures the endorsement of a data sharing infrastructure as a sector wide common digital infrastructure.
- **Responsiveness** – enables adaptation to future challenges, opportunities and stakeholder needs.

Further details are given in Appendix I.

Governance models

Several potential governance models were identified, and then evaluated and tested with cross-sector stakeholders (see Appendix A.1).

Models were developed for the implementation and steady-state operation phases of a data sharing infrastructure, as it is considered that separate governance approaches are required for the two lifecycle phases because of their distinct requirements.

These lifecycle stages are outlined over three distinct time horizons, representing the necessary time required to establish capabilities and potentially enact primary legislation to create new sector wide entities:

- **Implementation (2024-2026)**
- **Interim-state (2026-2030)**
- **Steady-state (2030+)**

The implementation (2024-2026) time horizon is summarised on the next page

The interim-state (2026-2030) and steady-state (2030+) time horizons are detailed in Appendix I.2.

Summary of implementation (2024-2026) governance

The below activities are detailed further in Appendix I.

- Through the delivery of an implementation phase described in Section 3.2, a ***Data Sharing Infrastructure Task Group*** would be established (see Appendix I.2). This would have the appropriate secretariat, terms of reference and funding mechanisms to develop the data sharing infrastructure blueprints, and technical MVP.
- During this period, the relevant roles and responsibilities of the ***Data Sharing Infrastructure Task Group*** can be handed over to the ***Energy Data Sharing Infrastructure Operator*** as and when that entity becomes technically capable to take on the responsibility.
- Concurrently Ofgem could, through the RIIO3 process, update the digitalisation licence condition (9.5) to compel licensees to engage with the data sharing infrastructure and create guidance around the use of the blueprints to develop capability (as done with Data Best Practice).

  This amendment to the licence condition could have a date from when it applies to align with ED3 licence conditions, so all networks have the same amount of time to be 'ready' for the requirements.

Implementation phase governance (time horizon: 2024-2026)

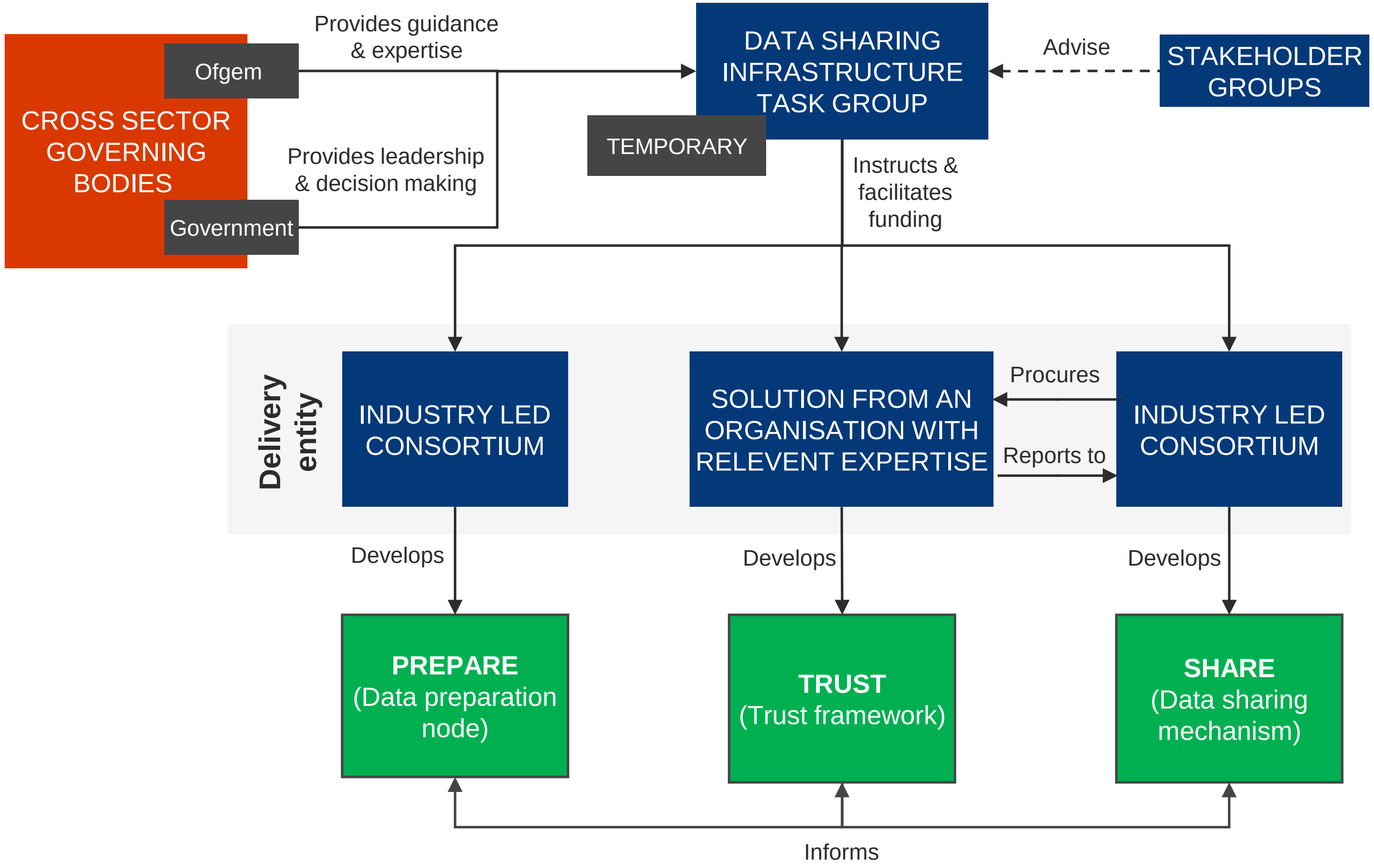
Governance of a data sharing infrastructure during implementation

The diagram outlines the proposed governance of a data sharing infrastructure during the implementation phase. The proposed approach is for a co-development of both the data preparation nodes and data sharing mechanism, and the direct procurement of a trust framework solution from an organisation with relevant experience.

This approach enables government and industry to select and deliver a high priority use case, either taken from those detailed in the use cases, or elsewhere. The governance shows two possible consortiums, one focussing on the development of a data preparation node, and the other on the development of the data sharing mechanism. These delivery entities are interchangeable, depending on the delivery route selected.

During implementation it is recommended that there is a ***Data Sharing Infrastructure Task Group*** established with the specific remit to fund and accelerate the development of the data sharing infrastructure on behalf of the energy sector. This should be in support of the objectives of the National Digital Twin Programme, and to drive adoption.

Further details are given in Appendix I.



3.3.3

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Alignment with other data sharing infrastructure initiatives

Alignment with other data sharing infrastructure initiatives

High-level review of existing digitalisation initiatives and their interaction with an energy system data sharing infrastructure

Complementary initiatives

A review of the existing energy sector and cross-sector digitalisation initiatives highlighted the close alignment to, and agreement with, the objectives of establishing an energy system data sharing infrastructure.

These initiatives including the following:

- Energy networks data sharing portals
- Ofgem's future of distributed flexibility
- OneNet
- CReDo (Climate Resilience Demonstrator, DT Hub)
- Market Wide Half Hourly settlement programme
- Smart Meter Data Repository
- Smart Meter Internet of Things
- Energy Data Visibility Project

It was concluded that four of the existing energy sector and cross-sector initiatives have very close alignment with the functional requirements of the proposed data sharing infrastructure. These are summarised in the adjacent boxes.

Further details on all initiatives are in Appendix J.3.

National Digital Twin Programme (NDTP)

NDTP is directly run by the UK Government, in collaboration with industry and academia. Telicent were commissioned to deliver the technology aspects of the Isle of Wight demonstrator using their 'CORE' platform.

One feature of CORE is an open-source tool on an organisations own IT infrastructure to ingest raw data, cleanse and transform it to a specific standard. This is functionally like the data preparation node.

Virtual Energy System

The Virtual Energy System aims to enable the creation of an ecosystem of connected digital twins of the entire energy system of Great Britain. This has functionality like a data sharing mechanism and has many common high-level components.

A data preparation node would provide the sector with the correct tooling to enable preparation and standardisation of data, which could then be shared through the Virtual Energy System.

Open Energy

Open Energy provides a data catalogue, trust framework, and governance model to facilitate secure data sharing and access controls through a 'broker' model.

Open Energy could allow organisations to register their identities and connect to a data preparation node through the Open Energy Trust Framework, where specific actors may already have the correct permissions to enable them to consume data from a data owner's data preparation node.

Automatic Asset Registration

The automatic asset registration programme (AAR), is a NZIP-funded feasibility study, aiming to support the development of an automated secure data exchange process for registering small-scale energy assets and collecting and accessing their data.

The data intended to be captured and sharable through AAR is of high value to the flexibility use case detailed in Appendix C4. The AAR would be a key data provider in an energy sector data sharing infrastructure

3.4

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Routes to enabling a data sharing infrastructure

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Routes to enable a data sharing infrastructure

Summary of routes available to the government for intervention

A route is defined as a selection of a pathway, a governance structure, and a review of existing related programmes nationally and in-sector.

Establishing a data sharing infrastructure involves evaluating a spectrum of routes, each offering advantages and potential challenges. These routes are designed to address diverse sector and policy needs.

Importantly, they are not fixed choices. Government or sector can transition between these routes, although the costs of switching varies.

Deciding on the most suitable route involves a nuanced evaluation of factors like adoption, vendor lock-ins, scalability, integration complexity, and the potential switching costs associated with each route and when a switch takes place.

While there are many pathways for the delivery and governance of the data sharing infrastructure, the six options summarised in the adjacent box and detailed on the subsequent page were considered to account for the and represent the majority of the pathways.

Further details are given in Appendix H, Appendix I, Appendix J, and Appendix K.

Two categories of possible routes

There are two categories of possible routes, each with three options:

1. **National and sector specific programme alignment driven by government**

   These routes focus on the delivery of the enabling infrastructure through a collaboration of national and sector programmes, enabling effective cross-sectoral knowledge dissemination, optimal use of government funds, and reduces the risk of duplication.

   These routes are focused on aligning existing initiatives discussed in Section 3.3.3.

2. **Sector specific procurement of relevant capabilities required to deliver a data sharing infrastructure MVP**

   These routes focus on the delivery of the enabling infrastructure through a sector-specific lens, enabling greater oversight by the sector entities, and industry partners.

   These routes are focused on selecting one of the pathways outlined in Section 3.3.1 while evaluating the need to aligning existing initiatives.

Route 1 - National and sector specific programme alignment driven by government

- **Route 1A:** Government encourages alignment of on-going programmes
- **Route 1B:** Government assigns staff to ensure alignment of on-going programmes
- **Route 1C:** Government assembles a “tiger-team” to align programmes to define long-term governance

Route 2 - Sector specific procurement of relevant capabilities required to deliver an MVP

- **Route 2A:** Government funded innovation of a data sharing infrastructure
- **Route 2B:** Government mandates a sector strategic entity to deliver a data sharing infrastructure
- **Route 2C:** Government assembles a “tiger team” to roadmap enablement of a mandated task group to oversee delivery of a data sharing infrastructure

National and sector specific programme alignment driven by government

Further details of each route are given in Appendix K

Route 1A: Government encourages alignment of on-going programmes

A no-regret scenario. Government reviews the outcomes of this feasibility study and acknowledges the core components of the data sharing infrastructure can be fulfilled by the Virtual Energy System, Open Energy and the National Digital Twin Programme. It encourages those programmes to collaborate, with their buy-in, to implement the energy sector data sharing infrastructure.

- **Virtual Energy System and Open Energy** collaborate to develop the data sharing mechanism and trust framework
- **CORE as part of the National Digital Twin programme** provides the data preparation node

In this route industry is given ownership of developing, testing, and implementing the data sharing infrastructure, but has government acknowledgement that encourages these programmes to collaborate, but the programmes are not mandated or procured to do so.

Route 1B: Government assigns staff to ensure alignment of on-going programmes

Government acknowledges the role of the NDTP to support the energy sector in developing the data sharing infrastructure.

A tiger team (~2-4 people) is formed by DESNZ/Ofgem to provide the programme/project leadership and management for accelerating the development of the MVP of the data sharing mechanism and its integration with CORE/NDTP. This team can support the programme in removing financial, technical, and governance hurdles.

This team could sit within DESNZ/Ofgem or be seconded into the NDTP team. Irrespective of their location, they would maintain strong alignment, communication, and collaboration between NDTP and this team.

A key difference between route 1B and 1C is the lack of long-term governance. The tiger team in this route will focus on delivering the MVP for the sector.

Route 1C: Government assembles a “tiger-team” to align programmes to define long-term governance

This route considers NDTP and energy sector collaborating, and, in parallel, becomes a first mover to explore sector-specific implementation instance. Thereby, government recognises the need for a task group to support future governance requirements.

Government assembles a “tiger-team” to understand and scope:

- How the energy data sharing infrastructure task group would work in practice. For example, the roles and responsibilities, size, membership, decision making powers, ability to procure (this aligns with an area of further work identified by the digital spine feasibility study)
- The technical integration of NDTP and VirtualES. It would oversee/conduct a detailed study into the technical architecture with the support of the relevant programmes.
- Understand and deconflict any sector-specific requirements or work required to enable the data sharing infrastructure. For example: technical requirements relating to regulatory obligations, conflicts between existing in-sector initiatives.

Sector specific procurement of relevant capabilities

Further details of each route are given in Appendix K

Route 2A: Government funded innovation for a data sharing infrastructure

Government, through innovation funding (e.g., NZIP, SIF, NIA), directly procures the relevant organisations required to deliver a data sharing infrastructure, as outlined in the delivery routes and holds responsibility for its successful delivery.

To support the delivery of the data sharing infrastructure, government assembles an advisory group of sector and government subject matter experts to evaluate, inform, and support the development of a data sharing infrastructure.

Procurement could happen individually for each aspect of the data sharing infrastructure or as a whole.

See Appendix H for the proposed delivery pathway, and summary of other delivery options to enable data sharing infrastructure.

This route does not consider existing initiatives but focus on procurement of an MVP as a competitive tender process.

Route 2B: Government mandates a sector strategic entity to deliver a data sharing infrastructure

Government mandates existing sector programme(s) to deliver the whole enabling infrastructure.

The most likely example of this would be the government supporting ESO to deliver the Virtual Energy System. The support can come in forms of:

- Assembling an advisory group of sector SMEs. i.e., brings different actors together for feedback on technology and data.
- Financial support from existing innovation pots or other means.
- Debottlenecking regulator challenges, where feasible.

Government leaves the delivery, testing, and implementation to the programmes with minimal oversight on day-to-day operations, but retains control of the IP for public good, and future commercial benefits.

This route leverages existing initiatives funded by the sector, for sector needs, and assumes government procures aspects of the data sharing infrastructure that are not yet designed.

Route 2C: Government assembles a “tiger team” to roadmap enablement of a mandated task group

Government assembles a “tiger team” to roadmap the enablement of a mandated task group. The roadmap will detail the governance structure, roles and responsibilities, and ways of working requirements.

The task group formed with industry subject matter experts delivers the MVP functionalities. It can, for example, mandate Virtual Energy System by ESO or directly procures the required technology, ensuring delivery meets the requirements as identified in this study, while also, implementing a sector level governance structure for further development and innovation. The two parallel paths:

- Assemble a “tiger-team” to understand and scope:
  - How the energy data sharing infrastructure task group would work in practice.
  - What the tasks of the task group would be.
  - Understand and deconflict any sector-specific requirements or work required to enable the data sharing infrastructure
- Assemble a “task group” to select a ‘pathway’ to deliver the data sharing infrastructure, as outlined in Appendix H.

Potential funding mechanisms

Summary of potential funding mechanisms available to the government for the development of a data sharing infrastructure

There are several funding mechanisms that are available for the government to use to develop an MVP of a data sharing infrastructure.

These routes could include:

1. Innovation funded
2. Treasury funded
3. Price control re-opener funded
4. Industry funded (non-regulated entities)

Routes 1 and 2 are ultimately derived from government funding. Routes 3 and 4 are is borne by consumers and industry respectively.

Route 4 requires further sector engagement to understand the industry's willingness to fund or invest in the development of a data sharing infrastructure.

Innovation funded (e.g., NZIP/SIF/NIA)

Innovation funding could be used to develop an MVP. Each fund has specific eligibility criteria, and varying timescales, oversight/governance requirements, and expectations.

Using innovation funding could result in the sector considering a data sharing infrastructure as “innovation”, rather than a key sector enabler.

Industry funded (non-regulated entities)

Government and Ofgem could engage with industry partners to find a way of funding the development of a data sharing infrastructure as part of an organisation’s development or capital expenditure.

While this route reduces cost to the government, it also reduces the ability to provide coordination and oversight to the development of a data sharing infrastructure.

Price control re-opener funded

'Reopeners exist to respond to changing needs of the energy system. If DESNZ and Ofgem collectively decide there is a new need and publish a policy decision stating as such, then a re-opener window could be triggered to provide funding to action this policy decision.

This mechanism likely presents the fastest route of funding that maintains government oversight and control.

Treasury funded

Using the evidence of the feasibility study, government could develop a business case for the development of the MVP of a data sharing infrastructure.

This business case would be complimented by wider government priorities for net zero, data and digitalisation. It would also provide a sector specific implementation of the NDTP integration architecture.

This route is least certain of those highlighted and is likely the slower options to release funding.

4

Next steps

4.1

Need for government intervention

Opportunity for government intervention

Overview of the opportunity for government intervention and considerations required to assess its viability

Overview

The delivery of the resulting solution will require a combination of governmental, industrial, trade bodies, and academic collaborations.

While a collaborative approach emphasises participatory decision-making, co-creation, and collective ownership of the infrastructure, enabling diverse perspectives, innovation, and agility in implementation, it often involves establishing multi-stakeholder committees, or working groups to ensure effective coordination and representation of all stakeholders, which can be challenging for any one stakeholder to undertake.

Therefore, an initial push or encouragement from Government is required to align the dispersed actors.

It is currently considered that government involvement will be crucial, due to government's ability to prioritise public interest, to provide security and trust, to drive standardisation and interoperability, and to ensure long-term stability.

By taking a proactive role, government can support and fast track the creation of a robust data sharing infrastructure.

Intervention considerations

Intervention should be appropriate and flexible, growing or reducing as required to meet the needs of the challenge.

In principle, government intervention should only be considered if the industry requests assistance, and there is a clear need for sector alignment and coordination.

The users of a data sharing infrastructure could be from any sector and organization; therefore, an initial request from the industry to the government could be to bring together actors and provide an environment for open decision-making, fostering a culture for data sharing.

Additionally, long-term governance is expected to require regulatory intervention to maintain a minimum level of engagement, as operations become steady state.

Observed experiences of other energy projects which have attempted transitioning from an innovation project to a business-as-usual service, suggests that a level of policy or regulatory intervention is needed to ensure organisations that are part of or creating digital infrastructure for the energy sector are engaged appropriately.

Cost recovery

Data sharing infrastructure is a modern governmental service for public good, and as such, a cost recovery route will be required to pay for the implementation, ongoing operation and maintenance of a data sharing infrastructure.

The cost recovery route could involve, for example, a licensee or a consulting service charge that the energy infrastructure operator charges for the use of the data sharing infrastructure, or its blueprint. This will ensure recovery of public funds, remove any dependency on public funding and ensure sustainability of service in the long term.

The need for a data sharing infrastructure has been evidenced by all major stakeholders in the energy sector; therefore, users to pay and adopt this service will not be a risk for this implementation.

Further assessment is required to outline a detailed operating model.

Challenges government intervention could address

Overview of the opportunity for government intervention and challenges it could address

Overview

Government intervention has the opportunity to support enacting the changes required to the existing system to address critical challenges associated with data sharing in the energy industry.

Addressing these challenges is critical to ensuring the development of a resilient, net zero energy system. This includes mitigating risks of market failure posed by the current digital and data systems. More details on market failure mechanisms can be found in Appendix M.

At a minimum, it is considered that government intervention could address the following challenges to support trusted, interoperable data sharing across the industry:

- Insufficient data interoperability
- Lack of common data sharing practices
- Lack of open-source foundations
- Lack of flexible and scalable digital infrastructure
- Data monopolies
- Lack of skills and capabilities

Insufficient data interoperability

Tackle insufficient data interoperability by facilitating establishment of standards, mechanisms, or enacting policy or regulatory changes.

Lack of common data sharing practices

Tackle the lack of common data sharing practices by establishing best practices, encouraging collaboration and partnerships, and creating regulatory frameworks to determine minimum requirements for sharing data, security and privacy.

Lack of open-source foundations

Tackle the lack of open-source foundations through instigating the development of open-source tools and owning the definition of requirements to do so.

Lack of flexible and scalable digital infrastructure

Tackle the lack of flexible and scalable digital infrastructure by instigating a sector-wide governance framework and developing open-source tools to support the smaller players in the sector.

Data monopolies

Tackle impact of data monopolies controlling markets and creating barriers to entry and innovation through enacting regulatory requirements and enabling safe secure sharing of data through supporting development of required infrastructure.

Lack of skills and capabilities

Tackle the lack of skills and capabilities which are required as the sector continues the transition to being increasingly digitally enabled by engaging with, supporting and funding the academic community and other skills development programmes.

Evidence of the need for government intervention

Learnings from the feasibility study to support the assessment of the viability of intervention

Scale and coordination

Sector-wide transformations often require large-scale changes that affect multiple companies, industries, or stakeholders. Achieving this level of scale and coordination often requires significant resources, coordination, and cooperation among various stakeholders to set the rules of the game; therefore, it requires government to incentive, and foster a culture of collaboration.

The government policy decisions to decarbonise the electricity sector by 2035 mandates the sector to transform quickly, which is challenging because, while industry can certainly initiate and drive transformation to some extent, government support is often crucial to support a faster transformation because no one actor in the industry will have the legitimacy or authority to make the required decisions needed to support a sector-wide transformation. This indicates government intervention is required to drive key mechanisms that will support this transformation including a data sharing infrastructure.

Industry drawbacks

To date, the industry has not been able to get it done.

Energy sector operates through a process set by licenses and codes that each actor adheres to. While these regulations help reduce the risks of market failure or monopoly, they don't foster a culture of fast-paced collaboration and innovation, required to meet net zero.

No single actor in the industry has the authority or legitimacy to align the whole sector, and previous initiatives haven't yielded the appropriate results because the groups or initiatives lacked the necessary authority or funds to make the required decisions.

Additionally, industry actors are siloed within their own domains, making it difficult for them to track the long-term vision of a sector-wide transformation. They may face pressures to prioritize short-term gains or encounter investment challenges. For example, the time taken for a sector to align towards a standard can span several years, creating a critical bottleneck to realize the multitude of standards required for a decarbonized energy sector.

Given the lack of progress to date it suggests that industry will not be able to do this alone and government intervention is required to drive it forwards.

Sector engagement feedback

The consortium undertook over 100+ engagement sessions to understand the scope and need for a data sharing infrastructure. These sessions while helpful were needed because of the lack of a sector-wide stakeholder group that can feedback on a proposed solution, increasing the overall time spend on developing or implementing the solution. Through the engagements to date (Appendix A), two common themes have emerged of which one was a clear need for central intervention:

- **Scope boundaries:** The stakeholders engaged repeatedly asked about the extent of what should be in and out of scope indicating needing a common, centralised view of the solution.
- **Need for central intervention:** Most stakeholders stated a clear need of central intervention and direction in ensuring that a future data sharing infrastructure construct can become a sector wide tool/service and achieve the market cohesion and coordination needed to decarbonise the sector. Some stakeholders stated a clear need for a regulatory mandate of a data sharing infrastructure, or some parts of it. All stakeholders raised the need of clear policy intervention to ensure a data sharing infrastructure adoption and oversight.

Mitigating market failure

Considerations of market failure for developing a data sharing infrastructure

Overview

The Energy Digitalisation Taskforce recommended the need for a data sharing infrastructure. It considered that their absence would result in a loss of 'optionality' in how the future energy system is developed.

In the context of a data sharing infrastructure, the following types of market failures are considered:

- **Provision of information**
- **Absence of an interoperable way to share**
- **Lack of structural trust**
- **Data monopolies**
- **Increasing complexity of the energy markets**

Detailed descriptions of each market failure mechanism are given in Appendix M.

Governance considerations

The energy market already is already familiar with the sharing of operational data related to system operation or financial flows within the energy retail market.

For example, organisations such as RECCo or ElectraLink facilitate data transfer with market participants to discharge their licence obligations. The codes are then governed by a strong framework that has iterated over time to deliver for the market needs.

The agreement of these types of frameworks is a core function of a governance mechanism that overcomes a common market failure, which is a lack of information.

The five prioritised use cases suggest that information provisions for each is lacking and may represent an information provision market failure. Therefore, the level of governance required for such a solution should reflect the technical maintenance and core functions of a data sharing infrastructure. A decentralised and distributed approach to governance, reflecting the proposed distributed technological implementation will mitigate the described market failure risks (e.g., digital monopolies developing).

See Appendix M for more details on governance requirements.

Avoiding duplication across industry programmes

Another consideration for government is the efficient use of resources allocated to define, develop, and operate a data sharing infrastructure.

Coordinating multiple programmes, such as NDTP, VirtualES, or Open Energy that receive funding from government should be priority of government to ensure effective uptake of policy outcomes, avoiding conflicting objectives, and ensure interoperability between programmes.

To mitigate risks from duplication of activities across programmes government should ensure coordination, collaboration, and careful resource allocation to optimise and maximise the impact of the publicly funded initiatives.

Section 3.3.3 outlined certain programmes that have received government support, and Section 3.4 outlined potential relations among of those programmes for consideration in determining next steps.

4.2

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Proposed next steps

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Emerging recommendation themes

Themes of recommendations identified through the feasibility study

Through the delivery of this feasibility study and the stakeholder engagement activities, several recommendation themes have emerged. These can be summarised in three categories, and directly translate to the recommendations detailed on the next page.

- Government to provide clarity to the sector
- Develop the technical capability
- Facilitate appropriate governance

Government to providing clarity to the sector

To make use of the momentum gathered through this feasibility study, there are opportunities and no regrets actions that can be taken by government that will provide clarity to the sector on the direction of travel for the development of a data sharing infrastructure.

With existing initiatives already establishing and developing technical capabilities in this space, it is important for government to provide clarity on what it hopes to achieve. Providing a statement of what government's plans are, noting sequencing, rough timetable and expectations for engagement, would give the wider energy sector an opportunity to engage with the development. It would also establish where effort is, and is not, worth making for a wide range of market participants.

Developing the technical solution

In order to test the concept of the data sharing infrastructure government should take forward a minimum viable product (MVP) to test the technical implementation.

This should consist of taking forward the technical architecture detailed in Appendix G, which has identified strong alignment with the NDTP.

This, alongside existing industry initiatives, provides a large opportunity to coordinate existing work and further government areas of focus set out in the Digitalisation Strategy 2021.

Facilitating appropriate governance

The implementation of a data sharing infrastructure requires appropriate governance. In order to set that up the boundaries of what is expected of that governance regime should be tested and developed.

The creation of a task group, seeking to develop an appropriate governance mechanism for a data sharing infrastructure within the energy sector should be a priority of government when developing the MVP.

Areas of further work

Appendix O highlighted 11 areas for further work that have been identified through this feasibility study. These areas can be grouped into three categories:

- **Developing the technical solution**
  - Development of technical components
  - Security framework
- **Facilitating appropriate governance and skills**
  - Integration of existing initiatives
  - Data Sharing Infrastructure Task Group
  - Detailed analysis of delivery and governance
  - Foster a culture of data sharing
  - Trust framework
  - Knowledge dissemination activities
- **Developing standards and blueprints**
  - Data sharing infrastructure detailed blueprints
  - Management of standards
  - Detail review of licenses, codes, and legislation

Accelerating the development of a data sharing infrastructure

Recommendations to collaboratively enable the data sharing infrastructure

1) Develop an MVP

Develop the technical solution by DSIT/DfBT/DESNZ support a development project where the MVP of a data sharing infrastructure is developed, built, and tested.

Work with the existing initiatives that are functionally like the component parts of a data sharing infrastructure to accelerate the development of the MVP. These are the Integration Architecture (National Digital Twin Programme), Open Energy, and Virtual Energy System.

No-regret actions (0-6 months)

- Host technical alignment meetings with existing initiatives (NDTP, VirtualES)
- Select a use case to develop the MVP

Other actions (6-12 months)

- Select and implement a funding route for the development of the MVP
- Allocate staff to the coordination of the MVP

2) Establish a Task Group

Facilitating appropriate governance by DESNZ & Ofgem to convene and provide a clear mandate and funding to a **Data Sharing Infrastructure Task Group**

The Task Group's objective is to support and accelerate the development of data sharing infrastructure.

No-regret actions (3-12 months)

- Set up a "tiger team" of dedicated resources to determine the priorities of the task group
- Select and implement a funding route and priorities determined by the tiger team

Other actions (6-18 months)

- Conduct the 11 areas of further work that support acceleration, articulated in Appendix O.
- Prepare a pathway to standing up a Task Group

3) Publish a decision

Government to providing clarity to the sector by DESNZ and Ofgem publishing a statement of how a data sharing infrastructure will be developed and adopted by the sector.

Decision outlines the scope of the government, industry, and potential national programmes.

No-regret actions (0-12 months)

- Create a plan that government can test with industry stakeholders.
- Publish a call for input on creating a data sharing infrastructure and associated governance.

Other actions (18-24 months)

Update the digitalisation licence condition (9.5) to compel licensees to engage with the data sharing infrastructure.

Consortium recommendations

Recommendations to collaboratively enable the data sharing infrastructure

Developing the MVP

It is the position of the consortium that the most sensible path to developing the data sharing infrastructure is to combine the initiatives noted within the feasibility study:

- NDTP/Telicent's CORE solution is a match to the needs identified for the **Prepare** component.
- Virtual Energy System demonstrator has a significant alignment with the **Share** component.
- Open Energy has relevant expertise to implement the **Trust** component.

There is currently a critical window of opportunity to coalesce these programmes to enable a rapid MVP. While other initiatives may exist, they are less well developed and aligned, and their selection for an MVP would delay acceleration of delivery. Joining these programmes will not be without challenges. It is suggested that government funds a technical alignment study to avoid losing momentum gained to date. This study will evidence technical alignment between the programmes, and continue sector engagement, while a delivery pathway to an MVP is selected by government.

Once aligned, Ofgem/DESNZ mandates ESO to deliver a data sharing infrastructure by collaborating with NDTP. The MVP development can be funded through the RIIO ED2 reopener mechanism – which provides opportunities for appropriate government oversight.

Governance

DESNZ/Ofgem can ensure appropriate oversight for the technical alignment study by contracting SMEs to represent public needs. For MVP development, an advisory team is assigned to collaborate with NDTP.

In addition to the development of the MVP, a concurrent workstream resolving issues of governance should be undertaken. Doing so supports the energy sector in building a sector-specific implementation of a data sharing infrastructure and resolve issues of who manages and operates any instances of it for public good. This workstream also helps map out the governance of the 'blueprints' of a data sharing infrastructure within the energy sector. We are of the opinion that this should take the form of a 'tiger team', who detail what the task group should undertake as its priorities and scopes.

The 'tiger team' can be wholly comprised of civil servants and is broadly defined as a short-term team that defines the scope of the task group. This can be funded as normal activity for DESNZ and/or Ofgem, or as an extension to this feasibility study. The funding model for the activities of the task group is less certain and is dependent on the work completed by the tiger team. It is likely also subject to a call for input or consultation on the expectations of the task group. A logic flow of this approach is set out on the next page.

Resources consideration

The development of the data sharing infrastructure will require many resources with a board set of skill. Therefore, further work is required to determine the resources required to undertake the programme.

It is assumed that the government's input in the discovery phase will be to support the creation of a plan for alpha phase. This plan will outline, using agile principles and stage gate reviews, class 2 cost estimates, resource requirements, and terms of reference for the 'tiger team' to fulfil their remit. Additionally, it will provide an outline of the long-term governance and operating models.

The 'tiger team' will also serve as the PMO to support the integration of various programs. They will be responsible for submitting a terms of reference for the 'task group' to the government to unlock further funding for the development of the MVP and establishing the task group. Therefore, they will have the remit and the ability to request additional funds at various stage gate reviews, as defined in the alpha plan.

Timelines of the consortium recommendations

Recommendations to collaboratively enable the data sharing infrastructure

It is proposed that the government funds the Discovery/Alpha phases through an appropriate mechanism. The exact funding routes for Beta/Live will be determined in Alpha.

Implementation → **Steady-state**

Discovery (0 – 3 months) → **Alpha (3 – 6 months)** → **Beta (6 – 18 months)** → **Live**

- **Government funds further work recommended by this feasibility study**
- **Government funds further work recommended by the plan for the Alpha phase**
- **Sector and government converge to unlock further funding for MVP and Task Group as part of the outcomes from Alpha phase & 'call from input'**
- **Steady state operations, and funded at this stage through licenses, price control, subscriptions, etc**

Publicly share the feasibility study
DESNZ/Ofgem share the entire feasibility study to the wider sector for review and feedback

Government buy-in acquired
Signals government's active role in implementing the data sharing infrastructure

Technical alignment
Government funds SMEs, NDTP, and VirtualES to technically align & define MVP

Data sharing infrastructure team
SMEs, NDTP, and VirtualES present findings of the alignment. This outlines a plan for the Alpha phase to implement an MVP, and requests funding.

Design the governance
A "tiger team" is formed by DESNZ/Ofgem to define the governance requirements for long-term implementation, and the funding routes for the MVP and governance.

Design the MVP
An MVP is wireframed for the chosen use case by the team.

Call for input
A sector-wide call for input is prepared and initiated by DESNZ/Ofgem to test the MVP wireframes, and the plan for the governance, including funding mechanisms.

Mandate a Task Group
A task group is mandated to implement a data sharing infrastructure, and support defining the future energy orchestrator role

Built the MVP
The MVP is developed, tested, and a blueprint of the data sharing infrastructure is published for all sectors to consume

New use cases
The orchestrator iteratively adds new use cases and specific tooling.

Governance defined
The energy orchestrator is mandated, and their terms of reference defined to ensure further development for use case specific needs

Cross-sector blueprint
MVP for the core functionalities is available cross-sector.

Appendix

Contents

Appendix

Appendix A

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Stakeholder engagement

Learnings from stakeholder engagement

An overview of the 100+ engagement sessions completed during the feasibility study

Overview

This appendix presents a summary of the 100+ engagement sessions completed throughout the six months period of the feasibility study.

It outlines:

- The approach to stakeholder engagement
- Interviews conducted during the feasibility study
- Wider stakeholder engagement activities

Key learnings

Stakeholder engagement has been key to the development of a data sharing infrastructure, from defining the concept of the infrastructure to informing delivery routes.

The user research conducted during the use case development, and the insights gathered from each engagement, led to the prioritisation of five use cases. These use cases were selected due to their potential to address both government policy priorities and industry goals.

For each prioritised use case core technical functionalities were defined. These functionalities guided the definition of a functional architecture for a data sharing infrastructure (see Appendix G). This architecture was then extensively tested and developed by engaging with priority stakeholders.

The use cases and technical functionalities also informed the approach to determine potential delivery pathways (see Appendix H).

Further information on use cases is given in Appendix C.

A.1

Approach to stakeholder engagement

Stakeholder engagement

Approach to identify, capture knowledge, engage, and disseminate stakeholder views

Overview

Realising the objectives of a data sharing infrastructure, and ensuring its long-term success, requires extensive stakeholder engagement and buy-in.

This feasibility study aimed to establish the need case and feasibility for an energy system data sharing infrastructure. To approach taken was stakeholder-led, consultative, and collaborative, ensuring the ensuring the outcomes of this feasibility study, and the proposed data sharing infrastructure, meet the need of the stakeholders.

The study adopted a user-centred and agile approach to capturing and disseminating emerging findings. For each of the feasibility study activities and phases, key stakeholders to engage with were identify that:

- Can best contribute to that phase of the feasibility study, based on the requirements of the activity
- Most benefit from the knowledge and information generated through this study.

Principles

The proposed framework for engagement and knowledge sharing has four key principles to build participation.

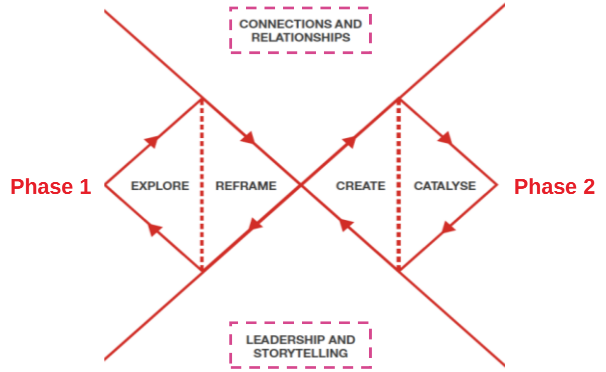
- **Put stakeholder first:** Start with developing an understanding of the stakeholders using a data sharing infrastructure and their needs, strengths, and aspirations.
- **Communicate visually and inclusively:** Help stakeholders gain a shared understanding of the problem, ideas, and value.
- **Collaborate, co-create, and collectively develop, extend and upgrade:** Work together, in the open, and get inspired by what others are doing. Be modular and interoperable to enable quick and efficient iterations to respond to errors and changes in technologies, markets and behaviours
- **Iterate, iterate, iterate:** Adopt a continuous improvement approach, helping to spot issues early, avoid risk, and build confidence in a data sharing infrastructure.

A double diamond process

The feasibility study approach is aligned to the British Design Council 'Double Diamond' process, where the study goes through two phases of divergent thinking and converging around recommendations.

Stakeholder engagement and knowledge sharing are core enabling activities throughout this process:

- **Phase 1 - scope & stakeholder engagement:** these enabling activities will inform the exploration of the use cases and framing of a data sharing infrastructure.
- **Phase 2 - feasibility & delivery:** these enabling activities will allow the creation and assessment of potential solutions toward a best delivery route.



Double diamond process

Approach

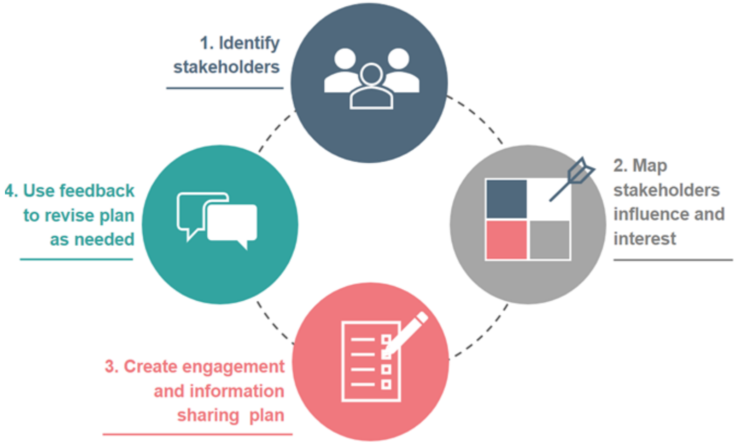
How stakeholders were engaged and identified

Overview

As a future key component of national digital infrastructure, it is important for a data sharing infrastructure to be developed by the energy sector for the energy sector.

It is therefore important to ensure that stakeholders across the energy industry are informed, consulted, and actively involved in the project from its onset.

The stakeholder engagement will be planned, iterated, and delivered through four steps throughout the study:



Stakeholder engagement approach

1. **Identify stakeholders:** Using the extensive knowledge and connections of the consortium partners, stakeholders across energy and within other relevant sectors (e.g. transport, heat, local government, charities) were identified.

   Relevant individuals and actors were identified across each group based, on the activities and objectives of this feasibility study.

2. **Map stakeholders influence and interest:** Stakeholders were mapped according to their individual and/or organisation level of influence and interest using a power-interest matrix.

   This considered their influence during development and future implementation, adoption and usage of a data sharing infrastructure. This enabled prioritisation of stakeholder engagement and knowledge sharing efforts.

3. **Create and iterate engagement and information sharing plan:** Plans for engagement and knowledge sharing were developed and iterated. The approaches will vary throughout the different phases and requirements of this study.

   This included identifying who we need to interact with, and when and how. This detailed view was updated and iterated throughout the project.

4. **Use feedback to revise the plan as needed:** The plan was iteratively incorporate feedback and emerging findings and stakeholder lists, ensuring our engagement and knowledge dissemination and information sharing activities and channels are as effective as possible.

Stakeholder mapping and engagement activities

Understanding stakeholders through the power-interest matrix

Stakeholder mapping

The power-interest matrix is a common approach to categorising the identified stakeholders based on the intersection of their power and interest.

It divides stakeholders in four stakeholder categories:

- **High power, high interest:** These stakeholders are key players and are critical to the project's success. They are likely to be decision-makers and we will work closely with them.
- **High power, low interest:** These stakeholders will be actively engaged but their involvement in the project can be minimised. It is important to manage them cautiously to minimise negative feedback.
- **Low power, high interest:** These stakeholders are likely to be impacted by influencing stakeholders. They need to be involved and consulted and can often be very helpful for detail requirements.
- **Low power, low interest:** These stakeholders will be kept informed about the project but they require little engagement.

The categorisation of these stakeholders can change as the programme progress; therefore, it needs to live and regularly reviewed.

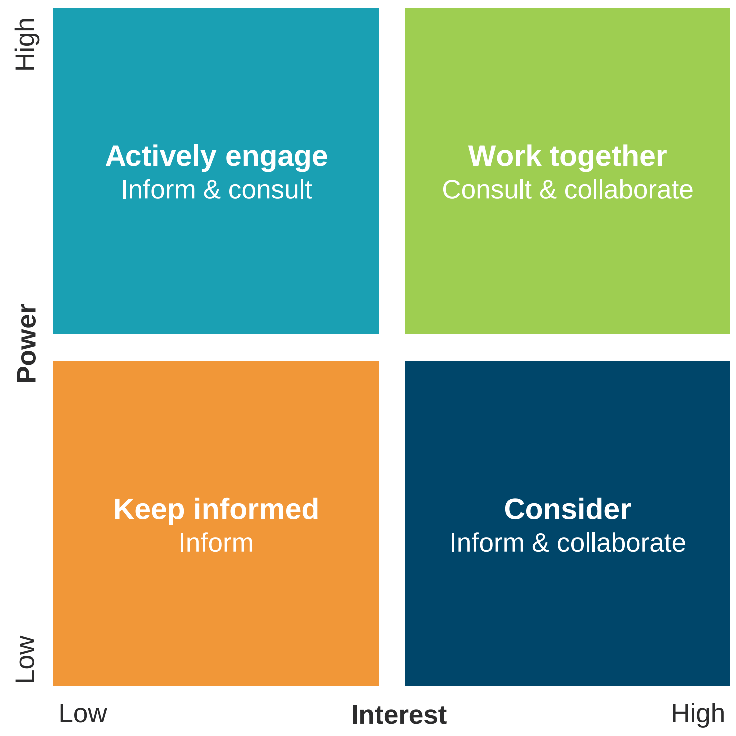
Stakeholder engagement activities

A variety of consultative and collaborative stakeholder engagement and knowledge capture methods were used throughout the feasibility study.

These methods include:

- Interviews
- Workshops
- Conference, events, and industry forums
- Wider stakeholder presentations & webinars
- High priority stakeholder feedback

Further details on the stakeholders engaged throughout each phase of the feasibility study are outlined in Appendix A.1, with details on the conferences, events, and webinar given in Appendix A.2



Based on Mendelow's Matrix (1991), the matrix is based on stakeholder's power or influence and their level of interest.

A.2

Interviews conducted during the feasibility study

Initial definition

Stakeholder interviews conducted during this phase

Defining a data sharing infrastructure

To determine an initial definition of a data sharing infrastructure, as established in Appendix B, the consortium conducted both internal and external engagements through either 1-2-1 interviews or group interviews.

Externally, high-priority stakeholders were engaged on a singular basis to allow to better capture the diversity of feedback. Their early feedback helped test the initial definition.

Overall, during this phase, over 10 engagement sessions were held with a diverse range of organisations.

Summary of the organisations engaged (A - Z order)

- CReDo
- DESNZ
- CMCL
- Data sharing working group / Digital Twin Hub
- ENA data and digitalisation steering group (DDSG)
- International Energy Agency
- National Grid ESO
- Ofgem
- Icebreaker One
- Telicent
- UK Power Networks

Use cases development

Stakeholder interviews conducted during this phase

Understanding how users interact with the solution

During the development and refinement of use cases, as described in Appendix C, user research was conducted to understand how users might interact with a data sharing infrastructure.

This aimed to identify:

- User needs around access and sharing of data
- Current barriers and issues encountered when sharing or trying to access data
- Potential opportunities, things that work well and things that would enable those needs to be met.

It allowed the identification of the key ways in which data provider and data consumer might interact with a data sharing infrastructure.

Over 60 individuals from 20 organisations were engaged through either 1-2-1 interviews or group interviews with a set of individuals within an organisation.

Summary of the organisations engaged (A - Z order)

- Advanced Infrastructure
- Association for Decentralised Energy
- Citizen Advice
- DESNZ
- Electron
- Elexon
- ENA data and digitalisation steering group (DDSG)
- Energy UK
- Flexitricity
- Innovate UK
- Jaguar Land Rover
- National Energy Action
- National Gas Transmission
- National Grid ESO
- Ofgem
- Octopus Energy
- SP Energy Network
- SSE
- SSEN
- Stonehaven
- UK Power network

Technical feasibility and requirements

Stakeholder interviews conducted during this phase

Defining the MVP functionalities

Following the development of use cases, the consortium started defining a functional architecture for a data sharing infrastructure, as detailed in Appendix G.

This architecture was tested with key stakeholders, who provided feedback for further development.

It allowed the testing of hypotheses with stakeholders quickly, garnering valuable feedback that allowed the quick iterations on the functional architecture.

Engaging over 10 stakeholders' organisations with a functional architecture ensured the social aspects of the implementations were considered early on, helping to enable a wider adoption of the proposed tool without writing a single line of code.

Summary of the organisations engaged (A - Z order)

- Amazon Web Services
- CReDo
- CMCL
- ENA data and digitalisation steering group (DDSG)
- IBM
- Icebreaker One
- International Energy Agency
- National Digital Twin Programme
- National Gas
- National Grid ESO
- Ofgem
- Palantir
- Telicent
- UK Power Networks

Delivery routes feasibility and requirements

Stakeholder interviews conducted during this phase

Assessing delivery routes

To assess delivery routes of a data sharing infrastructure, a five steps approach was defined, as detailed in Appendix H.

Industry experts were engaged through interviews and workshops, at each step, to provide continuous validation and feedback on the proposed routes, as well as to help identify areas for improvement and guide future enhancement.

Summary of the organisations engaged (A - Z order)

- Data sharing working group / Digital Twin Hub
- DESNZ
- ENA data and digitalisation steering group (DDSG)
- IEA
- Icebreaker One
- National Grid ESO
- National Digital Twin Programme
- Ofgem
- SSEN
- UK Power Networks

A.3

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Wider stakeholder engagement activities

Wider stakeholder engagement

Summary of the conferences, events, workshops, and webinar held

Overview

Thorough the feasibility study, the consortium engaged with the energy sector, and other sectors, to present the developing thinking on a data sharing infrastructure and receive feedback in open forums.

These engagements ranged from webinars and conferences to workshops and sharing sessions with specific organisations.

Conferences, events and industry forums attended

These activities were in addition to the interviews and engagements detailed in Appendix A.1.

Date (2023)	Activity
22 March	ENA Data & Digitalisation Steering Group
31 March	Social value workshop, University of Bath
20 April	Industry webinar (see next page)
20 April	Data sharing working group / Digital Twin Hub
21 April	ENA Data & Digitalisation Steering Group
11 May	All Energy Conference, Glasgow
16 May	Utility Week Live conference, Birmingham
19 May	ENA Data & Digitalisation Steering Group
23 May	Digital Twin Hub Gemini Call
06 June	Ofgem FSNR Workstream 5
12 June	Data sharing working group / Digital Twin Hub
16 June	ENA Data & Digitalisation Steering Group
21 July	ENA Data & Digitalisation Steering Group

Social Value workshop

On 31 March, the consortium hosted a social value workshop at the University of Bath with different actors in the energy sector. The collaborative workshop focused on understanding the social value impacts and outcomes of the data sharing infrastructure concept, particularly through fostering a marketplace for entrepreneurship and inspiring and upskilling future researchers and workforce to meet net zero targets.

The workshop took participants through two main parts, focusing on lessons in digital transformation in other sectors, followed by 'What would the ideal thin-layer of data/digital infrastructure look like?'

The social value of the data sharing infrastructure is further explored in Appendix N.

Participants included:

- National Grid Electricity Distribution
- National Grid ESO
- National Gas
- UKRI
- Clean Energy Prospector
- Propflo
- Halo Software
- Amazon
- Palantir
- OFGEM
- DESNZ

Industry webinar

Sharing our developing thinking with stakeholders across the energy sector and wider.

Wider industry webinar

On the 20th of April, the consortium hosted an industry-wide webinar to gather understanding of use case preferences. This presented the opportunity for us to outline the key activities conducted during the feasibility study and to directly engage with energy-sector and wider stakeholders.

During the webinar feedback was gathered on:

- The developing thinking on the definition of a data sharing infrastructure.
- The initial use cases and the extent to which they would help demonstrate the value of a data sharing infrastructure.

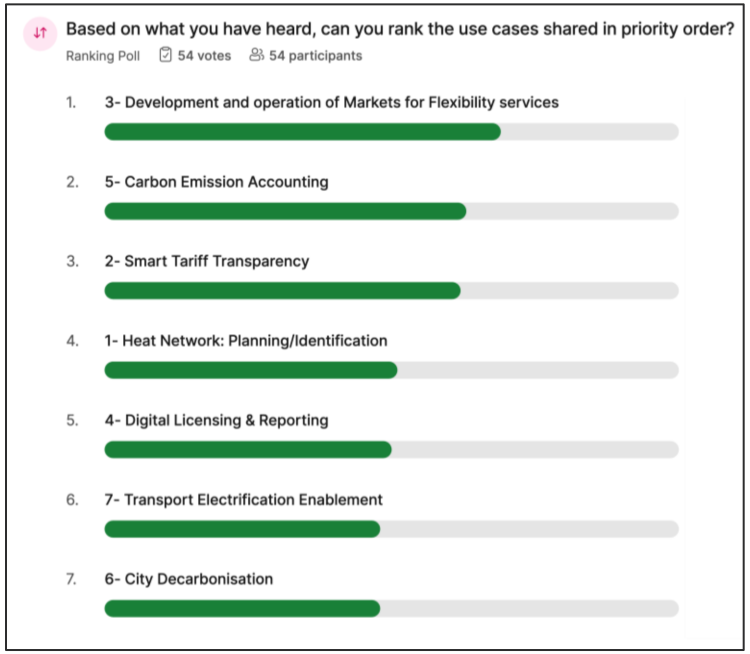
The audience were provided with the opportunity to ask questions and to participate in interactive polls through an online platform.

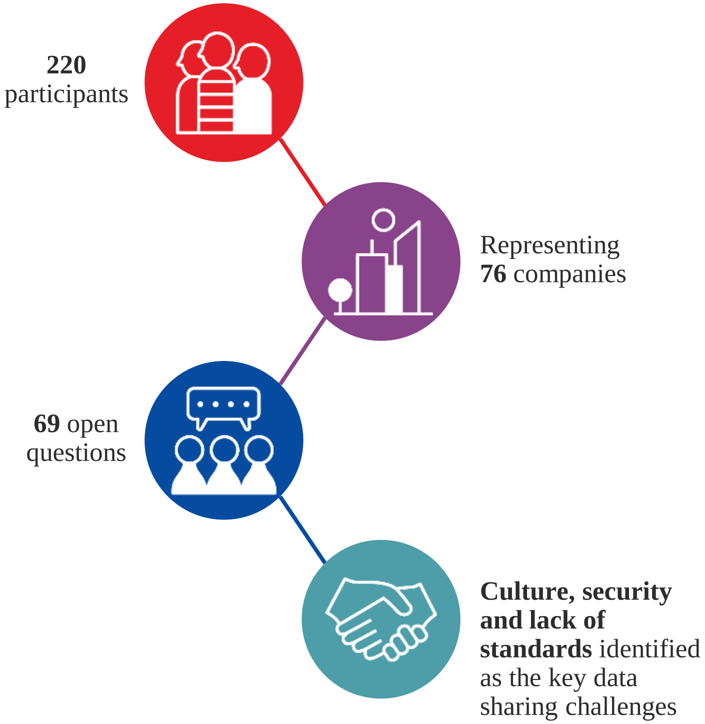
The participants were asked what are the main challenges they face today with data sharing, how they would describe a data sharing infrastructure, and how they would rank our use cases in order of priority.

Summary of the feedback received from attendees

When asked about the main challenges participants face with data sharing today, lack of standards, culture and security where highlighted.

Participants were asked to rank, in order of priority, the use cases presented to them. As it can be seen below, there were no clear favourite(s) to take forward.





Numbers and insights from the webinar

Organisations that attended the webinar

Summary of the organisations that attended the webinar

A – Z of organisations

- 1Spatial
- Aecom
- Albany University
- Arup
- Baringa
- Bath University
- Birmingham City University
- BSI Group
- BUUK
- Cambridge University
- CMCL Innovations
- Correla
- Crown estate
- DESNZ
- Digital Catapult
- DNV
- Edinburgh University
- ElectraLink
- Elexon
- Energy Networks
- Engage Consulting
- Engineering and Physical Sciences Research Council
- Enoba Tech
- ESB Networks
- Energy Systems Catapult
- ESRI UK
- Eurofins Digital Testing
- Exeter University
- Flock Associates
- Frazer-Nash Consultancy
- Fujitsu
- Future Energy Associates
- Grayce
- GTC UK
- IBM
- Icebreaker One
- IES
- Imperial College
- Institutions of Civil Engineers
- International Energy Agency
- IOTICS
- ITM Power
- JCB
- Kainos
- Legal Aid Agency
- Metis Digital
- Microsoft
- National Composite Centre
- National digital twin programme
- National Gas
- National Grid ESO
- OFCOM
- OFGEM
- ORE Catapult
- Oxfordshire County Council
- Palantir
- Piclo
- RAE
- Regen
- Restoration and Renewal
- Satellite Application Catapult
- SGN
- Smart DCC
- Smart Energy
- Smarter Grid Solutions
- SP Energy Networks
- SSE
- Sygensis
- Telicent
- TP Bennett
- University of Birmingham
- University of Lincoln
- Wild Pear CIC
- Zühlke

Appendix B

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Defining a data sharing infrastructure

Defining a data sharing infrastructure

Review of potential constraints and dependencies for a data sharing infrastructure

Overview

The purpose of this appendix is to provide further details on the characteristic of a data sharing infrastructure, and the problems it seeks to solve.

It considers:

- The problem which needs to be solved by a data sharing infrastructure
- The potential solution options to address those problems
- The high-level characteristics of a data sharing infrastructure
- The outline data types and categories to be shared through a data sharing infrastructure.

Key findings

The establishment of a data sharing infrastructure within the energy sector is considered important to facilitate the diversification and decarbonisation of energy production by overcoming the following problems:

- Insufficient data interoperability
- A lack of common data sharing practices
- No flexible and scalable digital infrastructure

A range of solutions such as data standardisation, a common sharing infrastructure, and the importance of security and trust, were considered to tackle these problems.

High-level characteristics were identified for the essential and non-negotiable aspects for a data sharing infrastructure. These consider people, process, data, and technology.

B.1

The problem to be solved

Energy Digitalisation Taskforce high-level definition

Summary of the problem statement summarised by the Energy Digitalisation Taskforce (EDiT) and high-level definition of a data sharing infrastructure

Context

An energy system and ecosystem that is profoundly different from the one that exists today is needed to achieve the objectives outlined in the British Energy Security Strategy, Energy Digitalisation Strategy, and Smart Systems and Flexibility Plan 2021.

As summarised by the Energy Digitalisation Taskforce (EDiT), to deliver on these strategies and plans the future energy system needs to "*manage hundreds of millions of interactions and assets every year, each interacting, engaging, and delivering value to customers and the stakeholders*".

The exchange of data is a critical enabler to delivering this future energy system. The ability to ingest, standardise, and share data between different actors and customers across the energy system will enable:

- Customers to access complex, blended products that drive consumer value
- Asset operators to view and respond to signals to dynamically manage their assets
- System operators to maintain a stable system
- Infrastructure owners to plan and manage their asset at low cost while maintaining service to customers

EDiT recommendation

With the increasing number of assets and actors, the future energy system will be more expensive and complex without an interoperable data sharing infrastructure that facilitates the seamless exchange of data. Importantly, this data sharing infrastructure will need to be socio-technical in nature – considering people, process, data, and technology.

EDiT engaged with over 270 organisations to summarise six clear recommendations to support the transition to a future energy system. These recommendations outlined the data sharing infrastructure and governance needed to facilitate the transition to a digitalised energy system.

The joint response from BEIS, Ofgem, and Innovate UK supported many of these recommendations, and proposed to take steps to explore the potential opportunities and risks. This response included recommending commissioning of this feasibility study.

A key recommendation is to "deliver interoperability" through the development of public interest digital assets. An important part of this is enabling the standardisation, and sharing, of data between different actors within the energy system.

What is a data sharing infrastructure?

EDiT defined two core concepts that are components of a proposed energy system data sharing infrastructure:

- **Digital spine:** A thin layer of interaction and interoperability across all players which enables a minimal layer of operational critical data.
- **Data sharing fabric:** The governance, administrative and technological solution for managing access to, and sharing, data across organisations.

Through the stakeholder engagement activities conducted during this feasibility study, it was observed that this inherited terminology was causing confusion and was unhelpful in communicating and articulating the overall purpose of a data sharing infrastructure.

Therefore, for the purpose of this report, and to promote broader understanding, this inherited terminology is instead linked to the functional descriptions of these concepts

These are collectively referred to as a **data sharing infrastructure, and** is detailed in Section 2.1.

Key problems a data sharing infrastructure could help solve

Summary of the problem to be solved by a data sharing infrastructure

Insufficient data sharing to reach net zero

To diversify and decarbonise its energy production, the UK will be heavily dependent on the ability, degree and speed at which different energy datasets can be joined up together so that is can be used between energy market participants.

From enabling timely connection of new low carbon technologies, to optimising millions of existing and new energy and network assets from kW through GW scales; or substantially cutting down wastes in renewable curtailments and under-utilised flexibility to reducing billions of annual network congestion and constraint costs - data from multiple players across the energy systems needs to come together in a way that minimises effort required by all.

To enable the scale of data sharing required, the energy sector will need to overcome commercial, legal, cultural, and regulatory challenges.

Through engaging industry stakeholders, three core problem areas have been identified that currently hinder this cross-sector data exchange that needs to take place to facilitate decarbonising the energy system and ultimately achieving net zero. These problems are expanded in more detail over the subsequent pages.

Problem: Insufficient data interoperability

Currently, joining and blending datasets remains a manual, inefficient and time-consuming processes that requires extensive, domain-specific knowledge. These processes lead to data silos, resulting in duplicated or misaligned data and information being available in various formats or differing terminologies and standards.

The overall lack of data interoperability promotes information silos and information asymmetry and makes it difficult to access and use the data at the right there when it is needed.

Problem: No common data sharing practices

Currently, data sharing across the energy sector is managed and carried out on an organisation-by-organisation basis. This has led to limited scalability, increased divergence between datasets and variety of bespoke approaches. The lack of common sector wide data-sharing practices (agreed set of procedures, processes, data licensing, handling conditions, and mechanisms) for sharing data securely between organisations creates a significant barrier to exchange of critical operational, financial reconciliation and price signals needed to enable innovation, provide optionality for future policymaking, and reduce the future system cost.

Problem: No flexible and scalable digital infrastructure

The data sharing infrastructure in the energy sector has been developed in an uncoordinated manner across various entities and domains. Currently, this consists of a landscape of singular initiatives that are implemented ad-hoc, typically through centralised architectures that are usually closed-sourced, taking years of design and development, with high costs. This unstructured approach has led to significant variations in sharing and access to critical systems and data across different parts of the sector, creating high financial and technical barriers to entry and curtailing the overall flexibility and scalability of the system. This leads to the inability to meet the rapidly evolving data sharing needs.

Problem: insufficient data interoperability

Key problem to be solved

Context

Despite the vast amount of available data, joining and blending datasets remains a manual, inefficient process that requires extensive, domain-specific knowledge. These processes lead to data silos, resulting in duplicated or misaligned data and information being available in various formats or differing terminologies.

The lack of publicly agreed identifiers for assets, infrastructure, and network topology data has further complicated matters, making it challenging to connect datasets to known reference points.

Therefore, to achieve interoperability in the current environment, coordination of working groups across different layers and sub-divisions of the sector is necessary, including outside of traditional industry structures.

While regulatory obligations have compelled some degree of data sharing, the lack of mature standards and ontologies, or their failure to be deployed in tandem, has resulted in uncoordinated approaches to implementation of data interoperability.

What is the opportunity?

New technologies and services will require data to be provided on an automated basis; therefore, alignment and interoperability between terms, values, and data structures is essential. Achieving this alignment requires overcoming several challenges, including establishing common identifiers and data models, building effective governance and regulatory frameworks, and developing new approaches for integrating and analysing data.

To effectively adopt and manage data and technology standards, a coordinated and organised approach is necessary. This may involve evaluating existing standards and collaborating on implementation strategies, as well as identifying areas where new standards are required. Furthermore, reconciling and integrating asset and network identifiers into existing datasets poses a significant challenge that requires a streamlined and accessible process.

To maximise the value of data, it is essential that users can easily join and blend data from multiple sources or domains.

This requires ensuring that data is understandable and reusable for a wide range of users.

Why is it important?

A cohesive approach to data sharing can present significant opportunities. By maximising the utility and transportability of data, users can easily combine datasets from across the sector for more comprehensive analyses and use cases.

Improved interoperability can also reduce overall system optimisation costs. Interoperable data requires fewer translations, lower processing requirements, and is less susceptible to errors, ultimately leading to minimised operational costs.

Having data that can be easily integrated with other datasets provides policymakers, network operators, and service providers with a clearer view of the entire system operation. This enables better decision-making and optimization of the energy system.

Problem statement

How might we….

coordinate and manage the adoption of standards and shared terminology to make data more easily joinable and understandable?

Problem: no common data sharing practices

Key problem to be solved

Context

Data sharing in the industry has typically been conducted through bilateral agreements, often through regulated entities, without a standard framework for governing data access requirements, such as authentication and authorisation services. As a result, ad-hoc, bespoke processes using spreadsheets, CSV files, or email as the transfer medium have been implemented to satisfy data sharing demands. This has led to limited scalability and increased divergence between datasets. Bilateral agreements and processes also hinder data interoperability as terminology and data structures are developed in isolation.

More recently, digitalisation programmes have led to the creation of more suitable data sharing capabilities, typically through the provision of centralised data portals. This improves the availability of data but requires alignment of sharing/governance procedures.

The rise of distributed generation and smarter, flexible consumption patterns necessitates automated data transfer to enable programmatic access to data and services. Whilst APIs enabling access to distributed data are emerging, a more coherent approach to data architecture, storage, and access is required to enable wider and consistent data sharing.

What is the opportunity?

Enhance the accessibility of data and align data sharing practices across the industry by creating a shared data architecture and governance structure.

It should be scalable, enabling default data sharing among multiple sources, and eliminate the need for additional bilateral agreements and systems.

Data users and organisations need to be able to access data through common procedures and governance processes to minimise complexity and enable automation.

Why is it important?

A standardised approach to data sharing methodologies will reduce the uncertainty and minimise duplication of effort for organisations managing, serving, and ingesting data in the sector.

This can be achieved by clearly defining roles and responsibilities, which also enhances accountability and enables greater interoperability between network participants.

Aligning access control procedures and cybersecurity requirements can result in a more secure and resilient system, ensuring that organisations are implementing adequate measures to safeguard the data.

Problem statement

How might we….

Establish a shared data architecture and governance structure to improve the efficiency, alignment, and automation of data sharing practices across the industry?

Problem: no flexible and scalable digital infrastructure

Key problem to be solved

Context

The data sharing infrastructure in the energy sector has been developed in an uncoordinated manner across various entities and domains.

Regulated entities have typically tackled data sharing challenges by implementing vendor-specific solutions, resulting in a range of technologies and approaches being used. This unstructured approach has led to significant variations in sharing and access to critical systems and data across different parts of the sector, creating high financial and technical barriers to entry for many data systems.

Recent digitalisation programmes have also been implemented on an ad-hoc basis, typically through centralised system architectures. Closed-source, bespoke solutions have made it difficult and expensive to adapt to changing needs.

Centralised systems have typically been deployed via a ‘big-bang’ implementation, taking years to design and deliver, with high costs to maintain and evolve.

This approach also requires regulated entities for implementation and ongoing management.

What is the opportunity?

The sector must align on fundamental system requirements and provide clear technical approaches for systems integrators and service developers.

Any proposed solution must complement the data interoperability and architecture strategy to create a resilient, flexible, and scalable technology framework.

Regulated entities demonstrate varying levels of maturity in their digitalisation journeys, supporting them in transforming their existing services to integrate with future data sharing infrastructures will be key to unlocking the wider benefits of whole system operation.

The energy sector needs a flexible and scalable digital infrastructure to minimise operational costs and harness innovation.

Why is it important?

Establishing an appropriate technology framework, commercial model, and governance structure is crucial for the ongoing evolution of a data sharing infrastructure.

This will ensure that data sharing practices and interoperability initiatives are supported, and that organisations are incentivised to develop and implement supplementary functionality.

The defined solution must be flexible and scalable to meet the rapidly evolving needs of the digital systems that will underpin the energy transition.

Problem statement

How might we….

define and deploy a common technology framework to enable data sharing across the energy sector?

B.2

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Potential solutions

Solution scope considerations

Summary of the potential solutions to address the key problems to be solved by a data sharing infrastructure

Scope considerations of potential solution

The solutions in this appendix set out a broad spectrum of approaches for addressing the following problems:

- Insufficient data interoperability;
- No common data sharing practices;
- No flexible and scalable digital infrastructure.

How these are best addressed, and the resulting potential minimum viable solutions, will be a key driver in the definition of a data sharing infrastructure scope and its functions.

It is important to consider that other elements might be needed to fully respond to a problem, and that a data sharing infrastructure might iterate and evolve in the future according to a changing landscape of challenges and needs.

The adjacent diagram outlines the scope considerations for potential solutions to the data sharing infrastructure,

Building an initial understanding of the solution space enables the identification of key parameters and considerations for the technical requirements given in Appendix G and assumptions to be tested against the exploration of use cases and needs Appendix C.

Problem	Scope consideration	Description
Problem: Insufficient data interoperability	**Data standardisation**	Specific technical approach to data standardisation should be a key component of what the data preparation node can deliver for organisations that aim to deploy a node.
	Data governance	Functional governance of the 'direction' taken by a data sharing infrastructure, i.e., prioritisation of what data standardisation could be adopted and developed will be a key component of the governance.
Problem: No common data sharing practices	**Common sharing infrastructure (i.e. network of nodes)**	Exchange of data between market participants is a key component in how a data sharing infrastructure is defined/implemented. Solutions should reflect interoperability of different approaches for data sharing.
	Security & trust	Considerations around the secure and governed exchange of data. This includes implementation of security controls, access permissions, data licensing, handling conditions, and legal T&Cs.
Problem: No flexible and scalable digital infrastructure	**Hybrid technology stack**	Developing a solution where the blueprint and data preparation nodes are open-source but specific implementations (e.g., trust framework), to drive innovation across the sector.
	Governance	The concept of ownership or custodianship for open-source implementations will need to be considered and reflected in what the data sharing infrastructure sets out to achieve.

Solution scope considerations

Summary of the potential solutions to address the key problems to be solved by a data sharing infrastructure

Other scope considerations of potential solution

In this feasibility study the potential solutions were evaluated against a full scope implementation as well as a minimum viable solution.

The exchange of data between market participants is a key objective of a data sharing infrastructure. While there is a need for a common, industry-wide method of exchange that promotes standardisation and cohesion of practices, there are also other factors to consider, including:

- The ***legal framework*** setting the rules for the sharing of the data.
- The ***regulation and policy framework*** ensuring the implementation outcome.

The feasibility study considered the extent these components will need to be part of a data sharing infrastructure solution.

Legal framework

Alongside the interoperability of data, it will be key to ensure the legal interoperability of the data exchange itself.

This means having a common data licencing framework that defines how data can be shared and used.

The overarching licencing model developed will need to ensure interoperability so that players can participate within the same legal parameters and accountabilities and be suitable for the data sharing infrastructure architecture.

This will enable data sharing practices to move beyond the use of one-off, non-standardised bilateral agreements.

This will facilitate the volume of data multi-party data exchange needed for net zero. This may also emerge from Ofgem's Data Best Practice guidance.

Regulation and policy framework

In line with the UK net zero 2050 commitments and several government strategies (such as the national data strategy, the export strategy), the data sharing infrastructure looks to enable a future decarbonised smart and flexible energy system by providing the minimum digital infrastructure and controls that support such vision.

It will be necessary to have a policy and regulatory framework that defines how a data sharing infrastructure should be used and in which cases this or certain elements might be mandated (e.g., exchange of data X because it is considered critical national infrastructure information).

Possible solutions to: insufficient data interoperability

A spectrum of three potential solutions to address this problem

A: Comprehensive data standardisation

Data preparation nodes perform comprehensive transformation and translation of an organisation's data to conform with the agreed data exchange standards.

This means that organisations will be able to take their current data and legacy data, which may be scattered across various applications and data stores and in multiple raw formats, then publish it through the data preparation nodes using various out of the box connectors and APIs and translate it into multiple agreed formats. The mechanism for doing consisting of various Extract Transform Load (ETL) pipelines and data cleansing techniques, allowing for a complete standardisation of that data.

The conversion into specific data exchange standards and ontologies will remain flexible i.e., it can convert to multiple required standards such as the Common Information Model (CIM) or Information Exchange Standard (IES), to enable interoperability with different use cases.

This solution undertakes comprehensive transformation and processing of data for multiple data standards with the data preparation nodes.

B: Minimum data translation and standardisation

Data preparation nodes perform the minimal translation of formatted data into relevant data exchange standards for sharing across the network.

Organisations will be expected to develop some of their own tooling and connectors to connect some of their datastores (perhaps for more bespoke applications and datastores). The data will be expected to have undergone a degree of formatting where some data quality errors have been corrected before publishing to the data preparation nodes. The data is then passed to the node where it is translated into specified data exchange formats, depending on the nature of the interface and request.

Whilst the nodes may be unable (at least for the MVP) to perform full transformations, including comprehensive data quality checks, and contain multiple out of the box connectors and APIs to pull in various data from multiple bespoke datastores and in different formats, over time, actors or third parties across the sector may develop modules to enable this.

This could be through a marketplace where these modules are developed under a governance framework with actors across the sector.

C: Validation only, no translation or standardisation

Data preparation nodes validate against specified standards, but do not perform any transformation or translation of the data.

The required data standards will be dictated by the nodes, with accompanying documentation pertaining to the appropriate data schema and models. Organisations will then be expected to perform the transformation of their data into the required standard by using their own applications and ETL components, before it is offered for exchange using the data preparation node.

Whilst the nodes will not perform the data standardisation through an ETL component, it may not necessarily preclude the nodes from performing other potential functions, for example providing the security labelling for the data, or validating the schema before it is shared.

This solution minimises the technical complexity of the data preparation node connectors, as it receives fully formed and standardised data for any given data exchange format (e.g., CIM, IES) from participating organisations.

Possible solutions to: no common data sharing practices

A spectrum of three potential solutions to address this problem

A: Centralised architecture

Deployment of a centralised, common data sharing infrastructure where all the components, including the data preparation nodes, and data exchange is conducted centrally.

A centralised platform will mean that the locality (and potentially custodianship) of the data will reside on a central platform, and with a central governance entity.

Organisations would be expected to use secure APIs to publish their data into the central platform for ingestion, where the necessary data standardisation and transformations will occur. Furthermore, the platform would also be used to conduct other potential functions on behalf of the users, including adding security permissions to the data. All data will be stored and brokered for exchange within the centralised platform; there will be no option to exchange data through decentralised peer-to-peer sharing.

This approach aligns with the traditional methods of pushing data into a monolithic and centralised platform, where different transformations and aggregation of the data is performed, then shared with relevant parties.

B: Hybrid architecture (centralised & distributed

Deployment of a hybrid data architecture, whereby the data preparation nodes can be deployed in a distributed fashion within each organisations' environments (cloud, on-premise, hybrid etc.) but some services associated with the data sharing mechanism (trust framework, security services, data catalogue etc.) remains centralised.

A distributed nature will mean that each organisation can retain ownership of their data. This will enable them to conduct their own transformation (maybe using their own incumbent ETL component), set security permissions, and data licencing and handling conditions to their data, prior to publishing to a central data sharing mechanism platform. This doesn't preclude the option to conduct decentralised data sharing through peer-to-peer data exchange directly between the nodes.

A more central data sharing mechanism can conduct functions related to security services, governance controls around data licensing and handling conditions (through the trust framework), data cataloguing and message brokering. Appropriate governance entities can also oversee and ensure the appropriate use and implementation of it and wider data sharing infrastructure.

C: Fully distributed architecture

Deployment of a fully distributed data sharing infrastructure, where all the technology components are owned and managed by the participants across the sector. This means that there will be no centralised functions for the trust framework, data catalogue, security services, described in data sharing mechanism.

Like **solution B**, the distributed nature will mean that each organisation can retain ownership of their data within their own organisational boundary. However, this solution also places the development and implementation responsibility for the governance, trust, security, access protocols and software with the organisations. This is different to **solution B**, as there are no dedicated entities responsible for the development and maintenance of the data sharing infrastructure and its constituent components.

This solution may potentially offer the greatest accessibility for components such as the data preparation nodes, as the entire implementation and development is completely distributed across the sector. However, the lack of central entities to develop, coordinate and govern the technology may lead to slower implementation, and challenges associated with coordination efforts.

Possible solutions to: no flexible and scalable digital infrastructure

A spectrum of three potential solutions to address this problem

A: Proprietary technology stack and blueprint

A data sharing infrastructure is implemented through the development of proprietary, closed-source technologies, accepting the possibility of vendor lock-in.

This will most likely consist of commissioning a vendor to develop a data sharing infrastructure (or procure it if a COTS product is available). The vendor will then assume ultimate responsibility for the infrastructure, provisioning, security, patching, updating and providing service support for data sharing infrastructure services, including the data preparation nodes.

Having a primary vendor means that service support from them could be offered as part of the licencing agreements. Security aspects, including penetration testing, will also be provided by the vendor.

However, vendor lock-in could potentially limit the compatibility of a data sharing infrastructure - perhaps with other technologies and cloud platform providers. Furthermore, the cadence of iterations and updates to the technology will be down to the vendor to determine, which may be slower than the industry requires it.

This could also restrain the industry from adopting new technologies or solutions because of the licensing agreements with the vendor or technology choices.

B: Hybrid technology stack and blueprint

Foundational components of a data sharing infrastructure are offered as an open-source blueprint for the sector to adopt and implement.

This means that the development of the blueprint for a data sharing infrastructure is open source, any given implementation for specific components e.g., the trust framework, may not be.

However, the technology implementation for the MVP data preparation node will be built using an open-source software technology stack. This will foster collaboration within the wider energy community, eliminate risks of vendor lock-in, and enhance accessibility by lowering entry barriers associated with costs

This may offer commercial incentives for organisations and start-ups across the sector to develop useful components for a data sharing infrastructure to address specific needs and functionalities that are outside the scope of the foundational blueprint components.

This may also lead to the emergence of a marketplace of providers creating new components for a data sharing, thereby accelerating specific use cases for data sharing and the standardisation required.

C: Open-source technology stack and blueprint

A data sharing infrastructure is implemented through an exclusively open-source technology stack. This means that all the components have an open-source implementation, and any future developments for additional components and modules are also required to be open-source with no associated propriety elements.

An open-source solution would mean that components such as the data preparation nodes become an open asset as in **solution B**, as part of the licensing agreements.

However, participants wishing to develop additional modules or applications for a data sharing infrastructure will have to comply to open-source governance, licensing and implementation.

Whilst this would mean that the entire data sharing infrastructure would remain fully accessible for everyone to use, it may lead to slower delivery and implementation due to fewer commercial incentives for the sector.

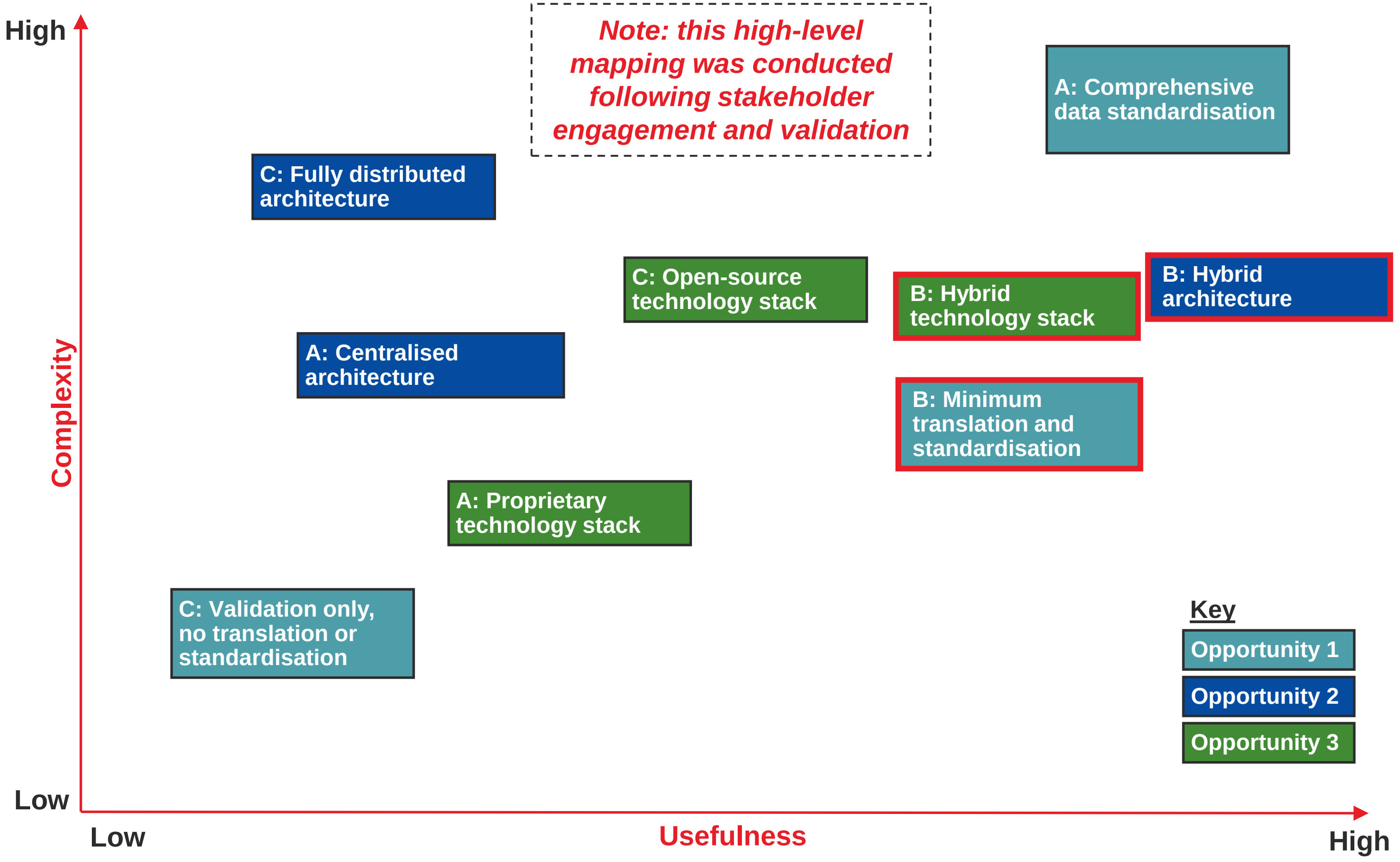
Mapping of the potential solutions

Understanding the complexity and usefulness of the potential solutions proposed to address each key problems to be solved by a data sharing infrastructure

The various solution options to address the three key problems to be solved were indicatively mapped to a graph to illustrate the extent of their usefulness to the sector, and their complexity to achieve. Their mapping was determined following stakeholder engagement and validation.

This mapping highlights three potential solutions:

- **Minimum translation and standardisation:** this will give the sector the correct tools to allow them to translate their data into a minimum interoperable standard. Further development of additional connectors and translation modules can be developed through future iterations of a data sharing infrastructure.
- **Hybrid architecture for a data sharing infrastructure:** will give the sector ownership and control of their data through a hybrid deployment of distributed (data preparation nodes) and centralised services (trust framework, security services, message brokers etc.)
- **Hybrid technology stack and blueprint:** will provide an open-source blueprint for a data sharing infrastructure but the implementation of specific components and modules (e.g. trust framework) may not be, thereby incentivising innovation across the sector.



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Defining a data sharing infrastructure

The approach to developing an initial definition for a data sharing infrastructure

Overview

As detailed on the previous pages, three potential solution options were identified following stakeholder engagement and validation.

The scope of these potential solutions helped to inform the development of an initial definition of a data sharing infrastructure which will provide a baseline for further iteration through the next phases of the study.

This working definition emerges from:

- A phase of **divergent thinking** exploring the problem space a data sharing infrastructure aims to impact;
- A phase of **convergent thinking** exploring potential solutions and homing in on recommended options;

The application of British Design Council 'Double Diamond' process of divergent-convergent thinking has allowed to route the design of a data sharing infrastructure through some of the key policy challenges currently preventing the digitalisation of the energy sector at the pace needed for net zero by 2050.

While these might evolve further through the course of the feasibility study, the link between problem spaces and solutions will ensure that the recommended definition will be focused on enabling core outcomes.

Key problem areas		→	Potential solutions	
Problem: Insufficient data interoperability	To maximise the value of data, users need to be able to join and blend data from multiple sources. Data must also be understandable to a wide range of users.	→	**Minimum layer of translation is performed by the data preparation node**	The data preparation nodes will give the sector the correct tools to allow them to translate their data into a minimum interoperable standard.
Problem: No common data sharing practices	Data users and organisations need to be able to access data through common procedures and processes to minimise complexity.	→	**Hybrid architecture for a data sharing infrastructure**	Mix of distributed services (data preparation nodes) and centralised services (trust framework, security services, message brokers etc) for a data sharing infrastructure to maximise usability and minimise complexity.
Problem: No flexible and scalable digital infrastructure	The energy sector needs a flexible and scalable digital infrastructure to minimise operational costs and harness innovation.	→	**Hybrid technology stack**	The foundational components of a data sharing infrastructure will be open-source development, however the development of closed applications and modules by the sector is incentivised to drive adoption and usefulness.

B.3

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Impact of a data sharing infrastructure

Impact of a data sharing infrastructure on decarbonisation targets

A data sharing infrastructure can have significant impact on the decarbonisation policy targets

Decarbonisation of the energy system

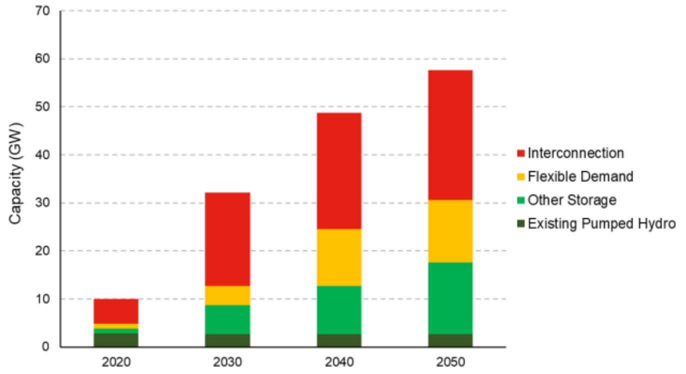
A smart, flexible energy system is one that can economically and efficiently integrate and utilise low carbon technologies such as heat pumps, EVs, batteries etc. This should be done in a seamless manner, and to their full value, to meet system needs in real-time.

This is achieved through the use of open and whole system data that drives innovation and competition. Doing so supports decarbonisation in a resilient and efficient manner across multiple sectors (including heat, transport and industrial) as they become more reliant on the electricity as their energy source.

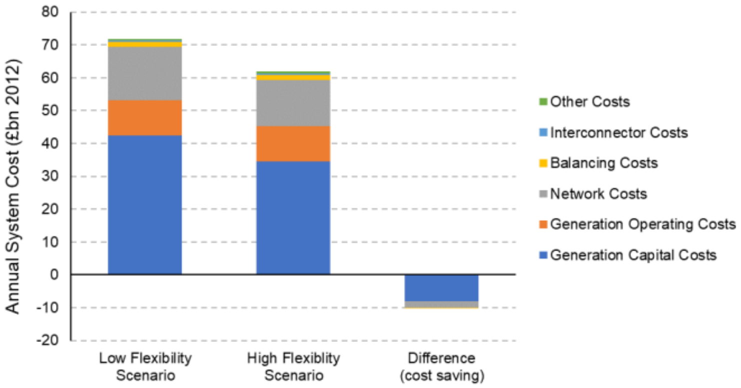
The Smart Systems and Flexibility Plan (SSFP) published in July 2021 provides an indication that a flexible energy system can deliver £10bn savings a year compared to a non-flexible energy system by 2050 as utilising flexibility reduces the level of generation build out (and thus the cost of generation Capex and Opex) as well as reduced transmission and distribution network costs. It is important to note that the SSFP only considered the benefits to the electricity system and a data sharing infrastructure would be expected to cover multi-vectors and will drive additional whole system benefits.

A smart and flexible energy system will have a wider array of organisations making operational decisions about the system, for example which assets to have, where to locate their asset, how to best use their asset (i.e. times during the day and beyond) and which revenue streams will provide the best return on investment. These decisions will be across both longer-term (through business case development and network planning processes) and close to real time data for markets and operations. As the complexity of interactions between market participants increases, standardisation in the data used by these actors will be of increasing importance to be able to operate a whole system that is significantly more complex than today.

A data sharing infrastructure can facilitate a smart and flexible system through supporting the sharing of data in a robust manner. This can be achieved via a technological and governance approach that prioritises and standardises critical data assets. Regarding decarbonisation and flexibility, a data sharing infrastructure's approach to standardising data can potentially function as a data exchange mechanism for the execution of contracts between flex providers and grid operators and is regulated in line with thinking on Ofgem's call for input on distributed flexibility.



SSFP Modelling: high flexibility and demand scenario generation mix
Source: BEIS



SSFP Modelling: Illustrative system costs in 2050
Source: BEIS

Impact on broader policy and government objectives

A data sharing infrastructure can support broader government objectives, policy and strategy

Impact of data sharing on government objectives

The impact of a data sharing infrastructure on the government's objectives for energy is considered as:

- **Delivering security of energy supply**: The future energy system is a decentralised coordination challenge, and the timely delivery of data to various participants is a security of supply prerequisite.
- **Ensuring properly functioning energy markets**: Ofgem has identified a market failure in flexibility provisions that, in part, can be solved with greater market access to standardised data.
- **Encouraging greater energy efficiency**: The ability to optimise systems for energy efficiency across differing scales (local, regional, national) will require the timely delivery of data and ability to compare sources in standardised formats.
- **Seizing the opportunities of net zero to lead the world in new green industries**: The emergence of new flexibility markets will be underpinned by data exchange. To seize the opportunity of this new market, provisions for the flow of information need to be made in a way that can coordinate with the whole system.

Impact of data sharing on Strategy and Policy

The government recently published their Strategy and Policy statement for the energy sector. The impact of a data sharing infrastructure on this is considered as:

- **Enabling clean energy and net zero infrastructure:** The acceleration of clean energy and infrastructure requires needs effective planning, coordination and justification of action taken by parties across the value chain. Facilitating the exchange of data in an interoperable way will be a core challenge to ensure this outcome can be met.
- **Ensuring energy security and protecting consumers:** As noted in the case study on the August 2019 blackouts (Appendix L), the provision of data between market participants is identified as a key component in mitigating risks of blackout events.
- **Ensuring the energy system is fit for the future:** The coordination of national and local energy markets, enabling technologies across all scales to support economic growth has a prerequisite of timely information being presented to a wide array of market participants with complex relationships.

Summary

Underpinning each of these key sets of objectives and policies is a pre-requisite of effective, interoperable data sharing to combat specific negative outcomes.

For example, a market failure identified in flexibility or resulting from blackout events, the information provision, timely access and standardised exchanges would have helped better predict the outcomes of a more renewable dominated energy system.

Fundamentally, each of governments priorities have a level of dependency of resolving the challenge of interoperable data sharing.

While it is likely that each specific objective or outcome will be achieved by a mixture of projects, decisions, and priorities across the energy domain, data sharing will be a fundamental enabler of each in some capacity.

It is considered that the most economically efficient resolution is to develop a solution that captures as broad a set of requirements as practical to mitigate the market failures identified and enable the sector to implement its use to overcome specific challenges, such as those described in the use cases (see Appendix C).

B.4

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High-level characteristics of a data sharing infrastructure

Characteristics of a data sharing infrastructure

The high-level characteristics of a data sharing infrastructure

Overview

As summarised in Section 2.3, based on the problem to be solved and the potential recommended solutions, 12 characteristics were identified for a data sharing infrastructure.

These were identified and validated through research, stakeholder engagement, and sector collaboration.

The provide a view into the essential and non-negotiable aspects for a data sharing infrastructure and consider **people**, **process**, **data**, and **technology**.

The characteristics are outlined in further detail over the subsequent pages.

People and process

The six high-level characteristics identified that consider people and process are:

- Fostering a culture for data sharing
- Hybrid architecture (centralised & distributed)
- Low barrier deployment
- Transparent operations
- Collaborative
- Use case driven development

Data and technology

The six high-level characteristics identified that consider data and technology are:

- Data standardisation & interoperability
- Hybrid technology stack
- Secure
- Self-serve platform
- Reliable and performant
- Low integration overhead

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People and process high-level characteristics (1 of 2)

The six high-level characteristics identified that consider people and process

Fostering a culture of data sharing

Fostering a culture is critical to ensuring that the industry and others engage with and adopt a data sharing infrastructure.

It helps organisations broaden their thinking beyond traditional business models and individualistic objectives to understand the opportunities presented by data sharing across the sector.

For this to happen, a culture for data sharing must be established as the first step in any change management activities considered as part of the ongoing delivery.

This allows participants to develop the skills and workforce characteristics required to interact effectively with the data sharing infrastructure.

This may require organisations to recognise the value of, and develop business cases associated with, data sharing so that IT and data strategies can set the direction for treating data as products that are useful and shared.

Hybrid architecture (centralised & distributed)

Deployment of a hybrid data architecture, whereby the data preparation nodes can be deployed in a distributed fashion within each organisations' environments (cloud, on-premise, hybrid etc.) but some services associated with the data sharing mechanism (trust framework, security services, data catalogue etc.) remains centralised.

A distributed nature will mean that each organisation can retain ownership of their data. This will enable them to conduct their own transformation (maybe using their own incumbent ETL component), set security permissions, and data licencing and handling conditions to their data, prior to publishing to a central data sharing mechanism platform. This doesn't preclude the option to conduct decentralised data sharing through peer-to-peer data exchange directly between the nodes.

A more central data sharing mechanism can conduct functions related to security services, governance controls around data licensing and handling conditions (through the trust framework), data cataloguing and message brokering. Appropriate governance entities can also oversee and ensure the appropriate use and implementation of it and wider data sharing infrastructure.

Low barrier deployment

Deployment of a data sharing infrastructure, including components such as the data preparation nodes should be seamless and relatively easy for organisations and users.

This can be achieved by adopting well understood technologies which are easily deployed and maintained, and preferably, the underlying technology complexity should be abstracted away from the users. Open-source implementation of the data preparation nodes should be well understood and managed.

Furthermore, accompanying documentation and support should also be available for organisations – especially for those which are perhaps less mature with their IT estate and skills.

This can help ensure that a data sharing infrastructure is widely adopted. We expect that, given the open-source nature of the data preparation nodes, organisations may begin to develop service propositions to support the deployment and integration of the nodes.

A marketplace of service provisions, which provide additional 'modules' to deploy in conjunction with data preparation nodes may be developed to support specific standardisation challenges.

People and process high-level characteristics (2 of 2)

The six high-level characteristics identified that consider people and process

Transparent operations

For organisations and users to develop trust in the data sharing infrastructure and consequently adopt it, they require a collective understanding of the system, its direction, and clear reasons behind the decisions made.

Therefore, communication and decisions will be facilitated through cross-sector engagement, like the engagement during the feasibility study.

This approach will ensure that stakeholders appreciate the value being created and understand how they can benefit from it.

Collaborative

The data sharing infrastructure is designed for the sector; hence, any actions and decisions related to the data sharing infrastructure should be taken collaboratively, utilising existing digitalisation initiatives whenever possible.

This approach ensures that maximum value is derived from the delivery of these initiatives, fosters a collaborative culture across the sector, and minimises the risks of failure or the need for future investments to realign potential solutions.

Use case driven development

Use case-driven development supports the design of a system that focuses on what the users need and, consequently, what the system needs to do, rather than how it is done.

This approach ensures that the data sharing infrastructure meets the users' needs and remains user-focused.

Additionally, a use case-driven approach facilitates incremental development, enabling early realisation of value through the delivery of the use cases, and provides tangible information to help participants understand the opportunities presented.

Data and technology high-level characteristics (1 of 2)

The six high-level characteristics identified that consider data and technology

Data standardisation & interoperability

A data sharing infrastructure will act as critical vehicle for the interoperability of energy data.

The data preparation nodes will allow organisations to offer their data in a way that will incentivise and facilitate its use.

This entails mapping their data to a minimum operable data standard that enables interoperability across a data sharing infrastructure. This will also help to ensure that the data is described to facilitate search and discovery.

A data sharing infrastructure will also have a role in pushing standards across the network of data preparation nodes and assists their creation where they are missing.

Specifically, a data sharing infrastructure should promote an agile standard development process that allows standards to swiftly emerge and to be iterated, thereby allowing data exchange for new use cases.

Hybrid technology stack

Foundational components of a data sharing infrastructure are offered as an open-source blueprint for the sector to adopt and implement.

This means that the development of the blueprint for a data sharing infrastructure is open source, but any given implementation for specific components e.g., the trust framework, may not be.

However, the technology implementation for the MVP data preparation node will be built using an open-source software technology stack. This will foster collaboration within the wider energy community, eliminate risks of vendor lock-in, and enhance accessibility by lowering entry barriers associated with costs

This may offer commercial incentives for organisations and start-ups across the sector to develop useful components for a data sharing infrastructure to address specific needs and functionalities that are outside the scope of the foundational blueprint components.

This may also lead to the emergence of a marketplace of providers creating new components for a data sharing, thereby accelerating specific use cases for data sharing and the standardisation required.

Secure

A data sharing infrastructure will need to provide trusted, secure and resilient sharing of data.

It will need to adhere and align with international security standards and best practices, to secure and protect the data and to minimise vulnerabilities in order to build trust and confidence with participants.

A shared responsibility model will also need to be established between the participants and the data sharing infrastructure.

Finally, core housekeeping practices, regular testing and resilience mechanisms should form part of the wider governance of a data sharing infrastructure.

Data and technology high-level characteristics (2 of 2)

The six high-level characteristics identified that consider data and technology

Self-service platform

Adopting a self-serve platform design will help foster a data-driven culture that promotes collaboration and empowers organisations to provide and consume data for decision making.

This approach will result in a data sharing infrastructure that provides organisations with the appropriate components and techniques to prepare, trust and share their data. The implementation should abstract technology complexity away from the users, thereby enabling a self-serve data environment in which individuals can quickly and independently obtain the data they need in an accessible way.

This aligns with Data Mesh principles related to *Self-serve Platform Design*, whereby a data sharing infrastructure offers organisations with the tooling and techniques for data exchange through a self-serve manner.

The data should ideally be published, when appropriate, as events or messages flowing through message brokers, rather than through a centralised data pipeline. This enables event-driven architectures and asynchronous data sharing.

Reliable and performant

A data sharing infrastructure will need to be performant and reliable to accommodate a variety of use-cases and data.

This will mean that a variety of requirements will need to be established and incorporated into the design of a data sharing infrastructure.

Some of these requirements will pertain to scalability, performance, availability, and fault-tolerance.

Others may pertain to design patterns (e.g., event-driven architecture), asynchronous data sharing, and considerations around the user journey and experience.

Low integration overhead

A data sharing infrastructure will need to be easily adopted and to seamlessly integrate with an organisations' existing data pipelines, platforms and data stores.

This means that the data preparation nodes should be decoupled from the organisations' data pipelines and applications, thereby allowing siloed and legacy data to be pulled into a data preparation node for standardisation.

The data preparation node should also be deployed using well-understood APIs and connectors. This is crucial as a solution that requires significant change will create barriers to adoption.

Furthermore, organisations with mature IT capabilities can use their incumbent tooling to prepare their data, then publish through the data preparation node's APIs. The node forms the blueprint for data preparation and organisations may use their internal tooling to achieve this.

B.5

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Outline data types and categories

Outline data types and categories

Identifying outline data types and categories exchanged across a data sharing infrastructure and the conditions for effective exchange

Overview

This section provides a high-level overview, and non-exhaustive list, of the key data categories that would be exchanged, with a focus on those data assets that need to be interoperable to enable wider flexibility and decarbonisation of the energy sector. The potential benefit that the exchange of this data would bring is summarised in the description.

For instance, the emergence of new market propositions for flexibility and the possibility of organisations becoming licensed to operate in this space will need the transfer of interoperable data to facilitate the new markets. The current lack of standards across the sector is however a limiting factor in decarbonisation efforts.

Therefore, analysis of these data types and their interoperability needs was completed in more depth during the use case development. See Appendix C.

Conditions for effective exchange

To enable an effective exchange of this data, a data sharing infrastructure will need to promote interoperability across these datasets.

A data sharing infrastructure should drive the identification of where standards exist and where they are lacking for these data assets.

It should then facilitate the agreement around a common implementation of standards where these are present for data assets, or around and initial standard where a standard currently does not exist. This alignment should be based on the following principles:

- Re-using existing standards where applicable
- Adopting consistent metadata standards (e.g. Dublin core) and re-using existing energy sub-domain metadata terms where applicable
- Creating the 'lightest' or ‘thinnest’ possible standard to get started, if no standard is currently present
- Ensuring that the data becomes easily understandable by non-experts
- Ensuring the data is structured, machine readable, and well documented

A data sharing infrastructure will need the right governance processes to oversee such a process and be able to prioritise efforts in a way that it remains grounded in engagement across the sector and conform to established governance mechanisms.

Therefore, when defining further what could be the core datasets and use cases for a data sharing infrastructure, it will be essential to assess the effort needed to accelerate the adoption of standards (e.g. data, metadata, format, exchange protocol etc.) that will ensure these dataset are interoperable and can be successfully shared across a data sharing infrastructure.

Potential data types and categories (1 of 2)

Non-exhaustive list of the data assets that would be shared with system participants as part of a data sharing infrastructure

Network topology & constraint data

There is a need for a common network model which is essential for optimal operation and planning network improvements. This does not currently exist in full and is typically mastered in proprietary systems. The adoption of CIM could be a solution to this challenge. There are also known issues in data quality at sub 11kV voltage level, which lacks completeness.

By standardising the approach to describing network assets, its connectivity and the management of network constraints, all networks can more easily align signals with each other, and to the market.

Market data

Overlapping markets creates potential for conflict between price signals which could result in price escalation and system instability.

A data sharing infrastructure can be used by market operators to reliably share market signals, enabling the sector to maximise return on investment and identify conflicting messages, and mediate as required.

Carbon monitoring

There is a challenge to track carbon through the economy. Developing tools, data standards and methodologies within the energy sector through a data sharing infrastructure implementation may enable this to commence sooner.

This would enable a data sharing infrastructure to help standardise the way carbon is accounted for across the energy system which could be a key function enabled by the data provided through a data sharing infrastructure.

Faults and outages

By standardising approaches in how network operators describe faults and outages on their networks, all stakeholders can begin to assess like for like faults and outages on the network, thereby increasing clarity to impacted citizens.

Remote asset monitoring could be used to enhance predictive maintenance regimes and strategies for different components, all potentially using machine learning to analyse. This would reduce downtime and potential cascading failures caused by faults.

System monitoring data

Consistency in data standards relating to the monitoring of various parts of the network would benefit all actors, enabling market actors to bring forward solutions by identifying needs consistently, and facilitating operational improvements.

In doing so, a data sharing infrastructure is enabling the feedback loop which is a characteristic of a connected digital twin.

Energy balancing data

The balancing of the energy networks between forecast and actual demand is increasingly more complex with the higher number of dynamic energy assets. If the operator had more visibility of which assets existed and had visibility of system monitoring data through a data sharing infrastructure, it will better enable system operators to maintain a stable, balanced system.

The alternative operating paradigms of more distributed models with a Distribution System Operator (DSO) could potentially be supported with this data.

Potential data types and categories (2 of 2)

Non-exhaustive list of the data assets that would be shared with system participants as part of a data sharing infrastructure

Consumer data

There is a greater dependency on demand side flexibility and so consumers (and their devices) will be required to interact with a complex system for device control and monitoring.

The opportunity for interoperability will allow consumer devices to build and integrate with smart tariffs, markets and system operators more easily, therefore benefiting the consumers and providing the desired domestic flexibility outcomes.

Smart meter data

Access to smart meter data can provide insight into the demand side response, energy consumption and consumer use patterns. This is valuable data for infrastructure decisions. It is critical that the data is effectively anonymised to protect consumers.

Aggregated smart data delivered at an appropriate timeliness and granularity could enable improved system management and planning. It could also be useful for local authorities to undertake social-economic research and inform Local Area Energy Plans (LAEPs)

Gas network data

The gas networks have a variety of datasets that are comparable to the electricity networks, relating to the network and the gas assets.

However, there has been less formal standardisation in gas, so there is not a comparable standard to CIM (for electricity), that is ready to be applied to gas.

Network operators have been considering whether to adopt a standard or develop one themselves to aid with interoperability requirements.

Energy efficiency data

Energy efficiency data is held within data.gov.uk based on a large sample of residential properties and averaged for different sizes and energy type. This general dataset is open-source and freely available.

However, the format is in Excel and must be downloaded for the selected year. Like other open datasets this could be made available within a data preparation node and made more accessible and queried via an API.

Modelling data

The energy system is changing from a small number of reliable assets to millions of highly dynamic energy assets in generation, storage and demand. To model such complex interactions and more effectively operate the system, more visibility across this system is required to understand its status and to maintain its stability.

This will require peak data, forecast future views, forecast load and generation data to effectively model and plan in this complex system, from many more actors, and hence the need for a data sharing infrastructure.

Renewable energy data

Having day or multi-day ahead projections of renewable generation could provide certainty to organisations on how they should hedge, trade and deploy flexible assets on the network.

A data sharing infrastructure could reduce the barriers to entry by providing a consistent approach for organisations to access renewable generation projection data from an accessible and trusted source.

Appendix C

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Use cases and user journeys

Use cases and user journey

Development of use cases and user journey

Overview

This appendix focuses on the development of the use cases and user journey, which were derived from user research and stakeholder engagement activities.

It summarises:

- Approach taken
- Key user stories
- Key user journey
- Long list of use cases
- Detailed use case analysis
- Prioritised day 1 use cases
- Prioritised strategic use case

C.1

Approach

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Approach to determining use cases

The proposed approach for developing use cases

The below diagram outlines the approach for stakeholder engagement, and use case definition. Each of the numbered stages is detailed in the subsequent pages.

	Use case exploration					Use case detailing			
Methodology	1 Setting Criteria	2 Identify potential uses cases for testing	3 Engagement with priority stakeholders	4 Industry wide engagement	5 Mapping & alignment with UK Energy policy goals	6 Use cases Prioritisation & justification for selection	7 'Day 1' use case selection	8 User journey definition	9 Needs identification
Engagement Activities	Workshop	High priority stakeholder interviews Workshop	1-2-1's interviews	Webinar	1-2-1's with selected stakeholder groups	1-2-1 Interviews Prioritisation Workshop	1-2-1's with selected stakeholder groups		
Stakeholders	Experts across the consortium	Experts across the consortium	High priority stakeholders	Wider industry	Industry experts Experts across the consortium DESNZ	Selected stakeholders DESNZ	Key actors according to the specific use case brought forward. These will be selected from the stakeholder groups identified against each of the use cases.		

Use case exploration

Stages 1 and 2 of the approach

1) Setting criteria

Based on the draft definition of a data sharing infrastructure from Appendix B, we identified key aspects across the energy sector where a data sharing infrastructure could help. These aspects include:

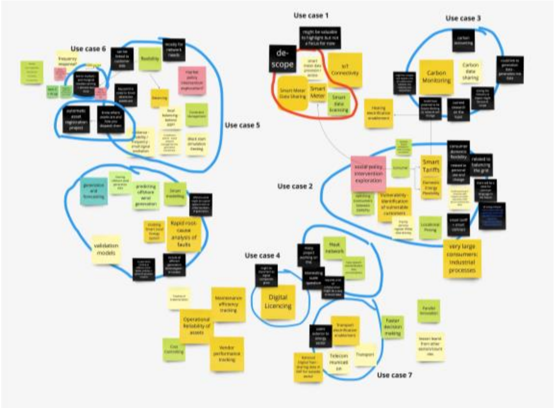
- **Promotes interoperability**
- **Promotes data sharing**
- **Contributes toward key UK energy objectives**
- **Responds to a clear need gap**
- **Involves a breadth of energy actors or sectors**
- **Promotes digital transformation of the sector**

These aspects have formed a set of **Eligibility Criteria** that was used through the duration of the use case exploration phase to assist with the identification of best suited use cases.

2) Identify potential for uses cases for testing

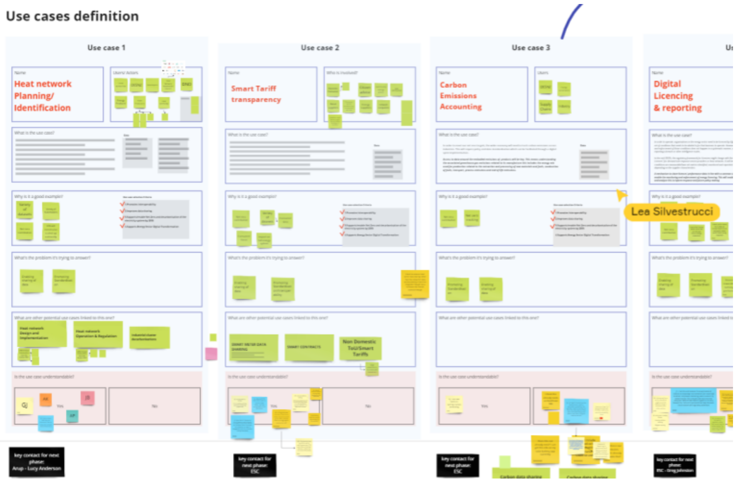
We explored various areas, including but not limited to system planning and visibility, markets, system operation, energy poverty, flexibility, new power generation, and decarbonisation. Next, we outlined a set of ‘problem spaces’ that met the eligibility criteria, showcasing a clear need for a data sharing infrastructure across the energy sector.

The focus for the ‘problem spaces’ was to demonstrate the value of a data sharing infrastructure to various energy sector players, including policy makers, consumers and system operators, as well as linking to other sectors beyond energy.



Next, we drafted an initial set of 8 use cases that were further refinement through testing with industry stakeholders, and subject matter experts from across the consortium. These use cases outlined the problem space, associated data sets and actors, and defined the potential impact of a data sharing infrastructure.

The purpose of these initial set of use cases was to gather stakeholder feedback on potential 'day 1' use cases that the feasibility study could examine in detail. These use cases aimed to elicit the core needs for a data sharing infrastructure and identify the key user journeys.



Use case exploration

Stage 3 of the approach

3) Mapping and alignment with policy priorities

We highlighted the potential contribution and impact the current use cases could have toward the implementation of critical policy goals.

Based on UK energy commitments and recent policy (such as *Powering up Britain 2023*), we have considered the four high-level key objectives shown in the adjacent table.

We have highlighted where the current use cases contribute toward these goals, and we assessed through further engagement with industry and policy experts other potentially relevant use cases.

Overarching policy objectives	Description
Energy equity and affordability	This objective includes initiatives such as making energy affordable to consumers, bringing bills down, keeping bills affordable, and making wholesale electricity prices among the cheapest in Europe, assisting vulnerable customers and reducing fuel poverty.
Energy security	This objective aims to set the UK on a path to greater energy independence, ensure reliability of energy resources, including price and geopolitics, provide a clean & secure energy supply, address demand by increasing efficiency, prepare for a net zero power system and improve energy system resilience & robustness.
Support net zero	This objective aims to cover initiatives such as increasing efficiency and reliability on greener products and generation, to accelerate decarbonisation of major energy demands, supporting the rest of the economy through the transition such as supporting industry to move away from expensive and dirty fossil fuels and minimising environmental harm such as climate emission.
Economic security	This objective aims to reduce inflation and boost growth, innovation and competition, deliver high skilled jobs for the future and incentivise the rest of the economy through the transition.

Use case exploration

Stages 4 and 5 of the approach

4) Engagement with priority stakeholders

To prioritise and gather information on our eight initial use cases, we engaged with our priority stakeholders asking them a series of questions about which use cases they believed would best demonstrate the value of a data sharing infrastructure, any other area for exploration, and which use cases could be valuable to explore further.

These priority stakeholders are given in Appendix A.1.

5) Wider industry webinar

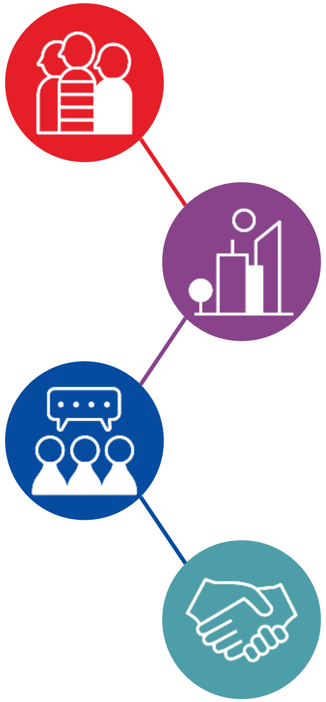
The consortium also hosted a wider industry webinar to gather feedback on:

- The developing thinking on the definition of a data sharing infrastructure.
- The initial use cases and the extent to which they would help demonstrate the value of a data sharing infrastructure.

We also provided the audience with the opportunity to ask questions and to participate in interactive polls through an online platform.

We asked participants what are the main challenges they face today with data sharing, how they would describe a data sharing infrastructure, and how they would rank the initial use cases in order of priority.

Further webinar details are given in Appendix A.2.



Numbers and insights from the webinar

Use case detailing

Stage 6 of the approach

6) Prioritise use cases & justification for selection

Following this first round of stakeholder engagement, market research, and consortium expertise, we identified a further seven use cases to add to our initial list of eight.

They aimed at finding potential use cases that helped with the definition of a data sharing infrastructure and met the overarching policy objectives.

The 15 use cases were further short listed through three steps, which are on the subsequent pages:

1. Eligibility criteria
2. Stakeholder preferences
3. Assessment against 'additional considerations'

By the end of three steps, the 15 potential use cases, were filtered down to five use cases.

Eligibility criteria	Description
Promote interoperability	• Is data standardisation needed to enable the delivery of the use case? • If available, are standards adopted by the sector?
Promote data sharing	• Are effective mechanisms and frameworks for data sharing in place to meet the need of the use case? • Does it require secure data exchange? • Is the data required part of critical infrastructure?
Contribute toward key UK energy policy objectives	• Does the use case contribute to one or more key UK energy objectives?
Need gap	• Is a data sharing infrastructure type intervention or need potentially required?
Breadth of sectors involved	• Does the use case involve several actors across the energy sector? • Does the use case involve other sectors?
Energy sector's digital transformation	• Does the use case support the digital transformation across the energy sector

User journey and further stakeholder engagement

Stage 7 and 8 of the approach

7) Further stakeholder engagement

Once the short list of use cases was established, we identified key stakeholders, from the energy sector and wider sectors, that could assist with detailing each use case.

We engaged them through 1-2-1 interviews and group interviews with a set of individuals within an organisation.

The insights gathered during the interviews allowed us to create high-level personas (archetypes of a user, detailing their role and their goal), extrapolate the overarching needs for a data sharing infrastructure and formulate a future user journey.

8) User Journey

The journey in Appendix C.3 mainly focuses on the *Electricity Flexibility* use case, but incorporates insights learned from all five use cases and in-sector and cross-sector actors interviewed.

Building a user journey allows the exploration of a data sharing infrastructure as an ecosystem that facilitates data sharing. It is an important tool to visualise and to consider how users could interact with such an infrastructure, and what would be the benefits they could get out of these interactions.

C.2

Key user stories

User groups

Identifying the users of a data sharing infrastructure

Overview

Through the exploration of the use cases it was apparent that there are a large number of potential users of a data sharing infrastructure, both within the energy sector and cross-sector.

It is considered that the users can be categorised into two groups, based on how they might interact with a data sharing infrastructure.

- **Data providers:** actors that provide data
- **Data consumers:** actors that require access to data to solve a problem for themselves or others

It is possible for an organisation / actor to be part of both user groups, and for this interaction to vary through time.

The feasibility study has focused on understanding the user needs based on these user groups.

Users of a data sharing infrastructure

Users	Data provider	Data consumers
Regulatory & Policy Makers (Ofgem, DESNZ, others)	✓	✓
Transmission & Distribution NO (Network Operator)	✓	✓
ESO (Energy System Operator)	✓	✓
Energy Suppliers (B2B/B2C)	✓	✓
Local Authorities (LAs)	✓	✓
Flexibility Service Providers & Aggregators	✓	✓
Energy Generators (Electricity & Gas)	✓	✓
Investors & Asset operators (heat, Hydrogen)	✓	✓
Consumer	✓	✓
Gas Transmission & Distribution NO (Network Operator)	✓	✓
Other Sectors (Water companies, EV providers)	✓	✓

Key user stories

Understanding the key ways in which a user will interact with a data sharing infrastructure

Identifying the interaction

User research was conducted to understand how users might interact with a data sharing infrastructure. This aimed to identify:

- User needs around access and sharing of data
- Current barriers and issues encountered when sharing or trying to access data
- Potential opportunities, things that work well and things that would enable those needs to be met.

This allowed the identification of the key ways in which the two user groups of data provider and data consumer might interact with a data sharing infrastructure.

This has been presented in the format of user stories to clearly link the user groups to their interaction with a data sharing infrastructure and the expected outcome. These user stories follow the structure:

- As a … [user group]
- I need … [interaction]
- So that … [expected outcome]

The user stories set the roadmap for further exploration of the MVP remit for a data sharing infrastructure and will allow for the formulation of more detailed technical and functional requirements.

Summary of findings

Overall, interaction of users with a data sharing infrastructure can be defined by the following overarching steps, as summarised in Appendix C.2.1.

1. Deploy data preparation node
2. Register with data sharing mechanism
3. Identify data for sharing
4. Connect data source to the node
5. Align data to minimum operable standard
6. Publishing data for sharing
7. Search for data
8. Review and request access
9. Access the data

Key consideration

It is apparent from the user research that in order to meet the needs of the users, a data sharing infrastructure should be conceived as more of an ecosystem that facilitates data sharing.

As part of this ecosystem, there must be:

- Governance and process gaps that need to be met for users to exchange and access data effectively – These are identified in the user stories as ***enablers***
- Capability gaps that need to be met for users to carry out the data exchange – these are identified as potential ***MVP functionality***
- Potential capability gaps that could be addressed to ensure better/effective sharing of data – these are identified in the user stories as ***extended functionality***

Given the extent of needs surfacing from the research, an overreaching core set of high-level key user stories has been created. These summarise the common needs identified. Where relevant, we have extracted more detailed user stories.

C.2.1

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User interactions with a data sharing infrastructure

Step 1: Register

Ensures data consumers and producers can use the data sharing infrastructure to share data

	Interaction step	User stories	Key consideration	Detailed user needs
1a	Register as a user	**As *a*** *Data Provider*, **I need to** register my organisation as a data sharing infrastructure user, **So** that I can share data via a data sharing infrastructure.	**MVP Functionality** Core feature that allows access into a data sharing infrastructure for all users through common standards, checks, and balances.	**As a** *Data Provider*, **I need to** understand how identity management works, how it is managed, and how it is utilised in a data sharing infrastructure, **So** that I can be entrust the system to share my data. **As a** *Data Provider*, **I need to** understand how to register my data on a data sharing infrastructure, **So** that I can become a user of a data sharing infrastructure to share my data.
1b	Register as a user	**As a** *Data Consumer*, **I need to** register my organisation as a data sharing infrastructure user, **So** that colleagues in my organisation can access data shared via a data sharing infrastructure.		**As a** *Data Consumer*, **I need to** understand how identity management works, how it is managed and used by a data sharing infrastructure **So** that I can trust the system to provide access to reliable data
1c	Register as an asset*	**As a** *Data Provider*, **I need to** register my assets/asset, **So** that asset data can be shared via a data sharing infrastructure.		

* by asset we mean anything that produces data, including physical assets connected to the grid such as power plants, smart meters, etc.

Step 2: Identify data for sharing (1 of 2)

Ensures data consumers and producers can find and verify the data needed to enable a use case

	Interaction step	User stories	Key consideration	Detailed user needs
2a	Identify data for sharing	**As a** *Data Provider*, **I need** to review the data I own, **So** that I can understand what could/should be shared.	**Enabler – Process** A process that clearly outlines data sensitivities, end goals, and data quality control requirements. Common guidelines and standardised approaches are needed to support this is carried out consistently.	**As a** *Data provider* (DNO, Energy Supplier, Retailer, Licensee), **I need** review the data I own, **So** that I comply with regulatory data sharing requirements and sector 'best practices' **As a** *Data Provider*, **I need** to understand the value (outside of regulatory compliance) sharing my data could provide, and understand for what purposes, **So** that I can assess whether to share this data.
2b	Identify data for sharing	**As a** *Data Provider*, **I need a** clear explanation of different ways data can be shared through a data sharing infrastructure, **So** that I can assess the implication of making my data available.	**Enabler – Process** A process that outlines the journey of data as it interacts with different aspects of a data sharing infrastructure to inform a robust trust framework.	**As a** *Data Provider*, **I need** a clear framework to assess my data against the open data spectrum, **So** that I can implement consistent data sharing behaviours across the sector. **As a** *Data Provider*, **I need** review guidance and understand options in relation data sharing licencing that can be used to support the exchange of data through a data sharing infrastructure (e.g. will there be a recommended Open Data Licence, or a set of options to use to form licencing agreements for shared data or best practice and principles), **So** that I can set and agree to the right set of conditions for the sharing of my data and understand the implication of sharing my data.

Step 2: Identify data for sharing (2 of 2)

Ensures data consumers and producers can find and verify the data needed to enable a use case

	Interaction step	User stories	Key consideration	Detailed user needs
2c	Identify data for sharing	**As a** *Data Provider*, **I need** a framework to assess the sensitivity around my data **So** that this can be shared accordingly	**Enabler – Process** A clear process that outlines the security, privacy, and commercial implications of data sharing. Common guidelines and standardised approaches are needed to support this is carried out consistently.	**As a** *Data Provider*, **I need** to understand the security implication of making my data available, **So** that I can set up my data to be shared in most appropriate way and I can accept the risks associated to it. **As a** *Data Provider*, **I need** to understand the privacy implication of making my data available, **So** that I can set up my data to be shared in most appropriate way and I can accept the risks associated to it. **As a** *Data Provider*, **I need** to understand the commercial implication of making my data available, **So** that I can set up my data to be shared in most appropriate way and I can accept the risks associated to it.

Step 3: Deploy the cross-sector data preparation node

The ability to deploy a node to enable data sharing.

	Interaction step	User stories	Key consideration	Detailed user needs
3a	Deploy the cross-sector data preparation node	**As a** *Data Provider*, **I need** my node or each node I deploy to be associated to me, **So** that so that ownership of that node is clear across the system	**MVP Functionality** Core feature that allows for single ownership and control of a node.	
3b	Deploy the cross-sector data preparation node	**As a** *Data Provider*, **I need** clear documentation around deployment and running of a data preparation node, **So** that so I can deploy and run this correctly.	**Enabler - Process** Clear guidance on how to operate, maintain, and diagnose a data preparation node.	**As a** *Data Provider*, **I need** update processes, service line agreements; support model; update schedules; technical specifications; future roadmap to be explicit **So** that I can prepare for that/ensure we are up to date. **As a** Data Provider, **I need** Fault escalation, security policies, back up processes, down time and restart procedures to be explicit **So** that I know how to act and impact of potential disruption. **As a** Data Provider, **I need** to have clear view of how to comply and use a data sharing infrastructure, **So** that I can identify the resource required /build up a team to meet our needs/obligations.

Step 4: Publishing data to the node

The ability to share data in a common standard, format, and security parameters

	Interaction step	User stories	Key consideration	Detailed user needs
4	Publishing data to the node	**As a** *Data Provider*, **I need to** publish data to a data preparation node, **So** that I can enable its sharing by transforming the data into a suitable format and applying security & access controls permissions.	**MVP Functionality** Core feature that allows data to be processed through the data preparation node and be made suitable for sharing.	**As a** *Data Provider*, **I need a** clear guidance on best way to publish the data to a node, **So** that I can most effectively carry out alignment to standards and setting access permission.

Step 5: Align data to minimum operable standards

Ensures data providers and consumers can specify and align to common sector standards

	Interaction step	User stories	Key consideration	Detailed user needs
5a	Align Data to Minimum Operable standards	**As a** *Data Provider*, **I need to** clearly understand what set of minimum operable standards (i.e., metadata, a specific data standard, data schema) I am encouraged to share, **So** that I can assess the alignment needs and select/build/define the appropriate standardisation/data transformation processes.	**MVP Functionality** Core feature that clearly details the minimum set of standardisation the data should align to ensure sufficient interoperability	**As a** *Data Provider*, **I need to** easily validate to what extent my dataset and its metadata conforms to suggested minimum operable standards, **So that** I understand the extent of the work needed, if any, needed to map my data and its metadata to the minimum operable standards encouraged
				As a *Data Provider*, **I need** a data sharing infrastructure to facilitate the encouraged MINIMUM DATA alignment process by providing components that can be used or potentially processes specific to my use case/datasets, **So that** I do not have to spend too much effort in transforming my data
				As a *Data Provider*, **I need to** be able to save & automate the data transformation processes carried out for my data and its metadata, **So that** I do not have to set it up every time I share an updated version of my dataset
5b	Align Data to Minimum Operable standards	**As a** *Data Provider*, **I need to** specify the standards or specifications my data adheres to, **So** that this is visible to Data Consumers	**MVP Functionality** Core feature that allows the user to specify what their data conforms to.	**As a** *Data Provider*, **I need to** be able to share my data and specify the schema and standards it follows in its original state, **So that** I can share it even if a minimum set of operable standards is not yet available avoiding delaying the value derived from sharing my data with potential consumers

Step 6: Publishing the data for sharing (1 of 2)

The ability to publish data through a node to enable data sharing

	Interaction step	User stories	Key consideration	Detailed user needs
6a	Publishing the data for sharing	**As a** *Data Provider*, **I need to** associate the right licencing condition to my dataset, **So that** I know my data will be shared and used appropriately.	**MVP Functionality** Core feature that allows the user to define how its data can be used.	
6b	Publishing the data for sharing	**As a** *Data Provider*, **I need to** define where needed who can or cannot access the data I make available for sharing and how they can do so, **So that** I know my data will be shared appropriately.	**MVP Functionality** Core feature that allows the user to assign access restriction and access mode based on Data Consumer identity.	**As a** *Data Provider*, **I need the** ability to restrict access to my data to only certain Data Consumers, **So that** I can ensure this is shared appropriately. **As a** *Data Provider*, **I need to** select the most appropriate privacy enhancing technology (PET) to be applied when my data is shared via the data sharing infrastructure, **So that** I can still provide information while retaining control over my data (e.g. when sharing raw data is not acceptable and I do not want this to escape). **As a** *Data Provider*, **I need to** be able to set what data entities within my dataset certain Data Consumers can access, **So that** I can grant or restrict access at a granular level.

Step 6: Publishing the data for sharing (2 of 2)

The ability to publish data through a node to enable data sharing

	Interaction step	User stories	Key consideration	Detailed user needs
6b	Publishing the data for sharing	**As a** *Data Provider*, **I need** a single common/standard way to make my data available for sharing, **So that** I do not have to use multiple methods of communicating or exchanging data with different actors.	**MVP Functionality** Core feature that gives common mechanism for sharing the information across all users.	**As a** *Data Provider*, **I need** an effective and a common way to exchange static data, **So that** it can be used by all actors across the system.
				As a *Data Provider*, **I need** an effective way to exchange dynamic data (e.g. real time data), **So that** it can be used by all actors across the system.
				As a *Data Provider*, **I need** the data exchanges that take place through a data sharing infrastructure to be tracked and recorded, **So that** this can be audited in future.

Step 7: Search for data

The ability to quickly and efficiently identify the data shared by a data sharing infrastructure

	Interaction step	User stories	Key consideration	Detailed user needs
7	Search for Data	**As a** *Data Consumer*, **I need an** effective way to search what data is available/is being shared, **So that** I can find the data I need to answer my question/problem.	**Extended Functionality** A functionality to search data can be provided by third party services rather than being a new core component built by a data sharing infrastructure.	**As a** *Data Consumer*, **I need** to identify myself as part of an organisation, **So that** I can access whole data sets that are accessible to my organisation.
				As a *Data Consumer*, **I need to** understand how I can search for the data, **So that** I can search for data based on my needs (e.g. use plain English description to respond to my accessibility needs).
				As a *Data Consumer*, **I need** different ways to search for the data based on metadata available (e.g. filters, machine readable metadata), **So that** I can search for data effectively.

Step 8: Request and review access to data

Ensures a trust mechanism between data providers and consumers

	Interaction step	User stories	Key consideration	Detailed user needs
8a	Request and review access to data	**As a** *Data Consumer*, **I need to** request access to data where this is not available to me, **So that** I can kick start conversation with the Data Provider	**Extended Functionality** A functionality to request data and approve access would facilitate triage of requests. This however can be provided by third party services rather than being a new core component built by a data sharing infrastructure. It will also need the creation and application of an associated governance framework.	
8b	Request and review access to data	**As a** *Data Provider*, **I need to** be notified of a data access request that sits outside the defined access setting, **So that** I can review and assess the request from the Data Consumer		**As a** *Data Provider*, **I need** guidance around a framework for data request triage process, **So that** I effectively and consistently triage the data I am sharing with what others are doing across the sector.

Step 9: Access the data (1 of 3)

Provides the considerations for data consumers to access the data shared by the data providers

	Interaction step	User stories	Key consideration	Detailed user needs
9a	Access the Data	**As a** *Data Consumer*, **I need to** understand the terms of the data licencing condition associated to the data I want to access, **So that** I can comply to usage term.	**MVP Functionality** Core feature that allows the user to check if their intended data use complies licensing conditions before sign up to them.	**As a** *Data Consumer*, **I need** a functional explanation of the licencing condition (in plain English), **So that** I understand its main objective of the condition before reviewing and agreeing to the fully detailed licencing terms.
				As a *Data Consumer*, **I need** the data licencing condition to be in machine readable format, **So that** my software is informed and incorporates the licencing conditions.
9b	Access the Data	**As a** *Data Consumer*, **I need** to a way to consistently and securely access to the data available through a data sharing infrastructure, **So that** I can easily consume a variety for my specify purpose.	**MVP Functionality** A core feature that provides consistency around how data can be accessed.	**As a** *Data Consumer*, **I need to** access to data in machine readable format, **So that** my software can automatically read it and process it as part of my organisation data flows.
				As a *Data Consumer*, **I need to** connect to the data via a standard API, **So that** I can easily access any data shared and do not have to use multiple methods of communicating/accessing data based on different Data Providers.

Step 9: Access the data (2 of 3)

Provides the considerations for data consumers to access the data shared by the data providers

	Interaction step	User stories	Key consideration
9c	Access the Data	**As a** *Data Consumer*, **I need to** understand the reliability and SLAs guaranteed by a data sharing infrastructure. **So that** I can ensure I use the data and build services accordingly.	**MVP Functionality** Core feature that allows the user to check ensure the data sharing infrastructure can be used to support the services it will feed.
9d	Access the Data	**As a** *Data Consumer & a Data Provider*, **I need** the data access/exchange through a data sharing infrastructure to be monitored (security, usage, uptake, technical performance), **So that** I can trust this meets expected service requirements and I can rely on it to exchange data.	**MVP Functionality** Core features that gives the users ensured the safe and effective functioning of the data sharing infrastructure.

Step 9: Access the data (3 of 3)

Provides the considerations for data consumers to access the data shared by the data providers

	Interaction step	User stories	Key consideration	Detailed user needs
9e	Access the Data	**As a** *Data Provider*, **I need to** access to my data to be granted according to the specified access control and privacy settings, **So that** my data is shared in the intended way only to authorised users.	**MVP Functionality** Core feature that gives ensures data is shared in accordance what set by the data provider.	
9f	Access the Data	**As a** *Data Consume*r**,** **I need** to access to the data available through a data sharing infrastructure via best suited method to me**,** **So that** I can easily use the data accessed for my specific purpose	**Extended Functionality** Functionality that gives consumers optionality in ways they can consume the data, but is not required to enable a data sharing infrastructure and could be provided by third parties.	**As a** *Data Consumer*, **I need** a simple way to access data available to me, **So that** I do not have to rely on digital know-how/skills to access data that is of interest to me.

C.3

Key user journey

Key user journey

The value of a user journey and how to read the data sharing infrastructure's user journey

Value of user journey

Building a user journey allows the exploration of a data sharing infrastructure as an ecosystem that facilitates data sharing.

The journey selected describes the end-to-end journey users go through in order to extract value from the data they collect and use.

Its creation allows to consider how users could interact with a data sharing infrastructure, and what would be the benefits they could get out of these interactions. It also enables the identification of where other activities would be needed to enable users to effectively interact with a data sharing infrastructure.

To create this journey the first step is to create personas, which are fictional characters based on user research and interviews. These personas represent the different types of actors and stakeholders interviewed and allow the exploration of how different actors could interact with a data sharing infrastructure.

Following this, each individual user journey is built from the insights gathered during the stakeholder interviews.

The data sharing infrastructure's user journey

The created user journey describes how a multitude of actors could interact with a data sharing infrastructure. It effectively includes a multitude of singular journeys. This was intentionally done to explore and show the breadth of an energy system data sharing infrastructure.

The journey mainly focuses on the *Electricity Flexibility* use case, but incorporates insights learned from all five use cases and in-sector and cross-sector actors interviewed (e.g., transport, heat, and Local Authorities).

The specific users followed through the user journey are archetypes of different user types and are indicative of the type of users that might be present across a specific organisation. They are intentionally not meant to be fully representative of the multitude of users present in an organisation.

The user journey is provided on the next page.

How to read the user journey

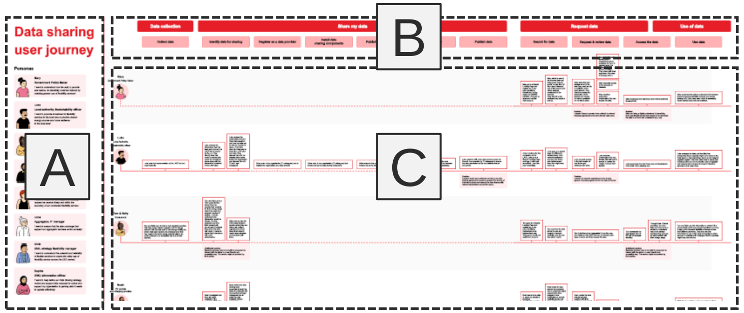
The user journey on the next page has three components:

A. The left bar lists the different personas involved in the journey, with their name, role and organisation, and a summary of what goal they are hoping to achieve by using the data sharing infrastructure.

B. The services stages and sub-stages of the journey

C. The individual journeys for each persona, and their activities in each service stage.

The user journey can be read left-to-right (to follow the steps a specific user go through) and top-to-bottom (to understand the different actions across industries and sectors needed for a specific service stage).



Three components of the user journey

Data sharing user journey

Personas

Mary
Government Policy Maker
'I want to understand how the cost, in pounds and carbon, for electricity could be reduced by enabling greater use of flexibility services'

Luke
Local authority, Sustainability officer
'I want to promote investment in flexibility services in his local area to provide cleaner energy sources and more resilience to the local area'

Tom & Sally
Consumers
'We want to try and reduce our bills this winter by being flexible about when we use electricity.'

Noah
EV vehicle and charging provider
'I want to build wider electrification services for our customers and recruit new customers.'

Tanveer
Heat network, operation team manager
'I want to ensure we can respond to flexibility request we receive timely and within the boundary of our contracted flexibility service.'

Luna
Aggregator, IT manager
'I want to ensure that the data exchange that support our aggregator services works correctly.'

Alvin
ESO, strategy flexibility manager
'I want to understand the potential and reliability of flexible services to ensure the wider use of flexibility service across the ESO market.'

Sophie
DNO, information officer
'I want to help define our Data Sharing strategy, review and support data requests for actors and support my organisation in gaining data it needs to operate effectively'

Provisioning data for sharing

Deploy data preparation node | Register with data sharing mechanism | Identify data for sharing | Connect data source to the node | Align data to minimum operable standard | Publish data for sharing

Accessing shared data

Search for data | Review and request data | Access the data

Mary – Government Policy Maker

Search for data
- Mary goes to a Search Landing Page and register as a new user, identifying themselves as a policy maker for DESNZ/OFGEM. They get an email and verify their account.
- Mary starts to search for relevant data and looks at the "how to guide" to help filter for data about historical use of flex service and future planned investment in the network. They identify a few datasets they want to look at.

Review and request data
- Mary sees that data about future investment work is available for them to request under the datasets shared licence condition. They check with their legal team if its okey to proceed with it.
- Mary requests access to the datasets of interests.
- Mary receives automated confirmation they can access the data.
- Mary sees that they can access some of the data they need as this is available under open licence. They therefore review the description of the dataset and checks that the data is available for the last 3 years.
- **Enabler**: Lawyers network operator have defined the shared licensing agreement terms and defined Data users.

Access the data
- Mary downloads the data they need in their preferred format (e.g. CSV).
- Mary combines the data to understand the increase impact of growing flexibility services and shares findings with their policy team which is assessing future market incentives and enablers.
- **Enabler**: Mary not being a digital professional is benefitting from user friendly service that allows them to download the data in a format they understand (e.g. CSV)

Luke – Local Authority, Sustainability officer

Deploy data preparation node
- Other actor in the organisation (IT colleagues) look to/have set up the data preparation node.

Register with data sharing mechanism
- Other actor in the organisation (IT colleagues) look look to register their data preparation node.

Identify data for sharing
- Luke reviews the information that has feed and informed the LAEP that is owned by the LA. They identify data that could be shared and would be valuable to share along with the information contained in the LAEP plan.
- Luke reviews the explanations around Open data and how the data can be shared across the data sharing infrastructure. They think about the best way to share the LAEP plan and data. They discuss this with the relevant data owner inside the organisation and discuss this with IT and Legal colleagues.

Connect data source to the node
- Other actors in the organisation (IT colleagues) connect their data sources to the data preparation node and set up relevant data pipelines

Align data to minimum operable standard
- Luke is asked by IT colleagues to provide more information and a description for one of the datasets they own and that they want to share (metadata).

Publish data for sharing
- Luke, together with other data owners across the Council, are consulted by IT colleagues to ensure the data permission set for the datasets shared are correct
- **Enabler:** Lawyers would have reviewed and set up any data sharing agreements needed to support the sharing of information above and beyond the open licence with relevant stakeholders across the sector.

Search for data
- A few months after the completion of the LAEP, Luke go to a Search Landing Page and logs in with their accredited Local Gov user credentials.
- Luke goes to a search page and filters for dataset about DNO network application and any new future grid reinforcement work that might have come up.

Review and request data
- Luke requests access to the last version of new future grid reinforcement work.
- Luke receives confirmation they can access this data and is prompted to review the Usage Licences term agreed.
- **Enabler:** Lawyers for relevant organisation have already agreed a licensing agreement for the data of interest.

Access the data
- Luke downloads the data they need and feed/upload it into their LAEP planning tool
- Luke analyses the data and identified that unexpected future capacity might come about in the local area in a few year times, due to a new network upgrade project. They then plan how to refine their investors pitch and communication plan to highlight new reasons why it is good to invest in flexibility services to this Local Area.

Tom & Sally – Consumers

Identify data for sharing
- Tom and Sally go to a Third party Service where they can provide their consent for their energy usage data to be used by a selected number of parties. They are explained what information would be shared, for what purposes and how their consent will bound each Providers they share this data with when it comes to share their information with other stakeholders.
- Sally also log into the Third party service's service where they are able to let multiple organisations know about their support needs when services communicate with them.
- **Additional service:** Separate services need to be built for consumers to interact with the data sharing infrastructure in a user friendly and accessible way. This service might be provided by third parties.

Search for data
- Tom goes to a Search Landing Page and register as a new user, identifying themselves as an independent user. They get an email and verify their account.
- Tom searches for data about the use and impact of demand flexibility over the last few winter month.

Review and request data
- Tom finds there is an aggregated 6 monthly view from National Gird ESO that can be viewed under Open Licence and they request the data.

Access the data
- Tom downloads the aggregated view of the use of domestic flexibility.
- Through their different providers, Tom and Sally are informed in a simple to understand way of the saving/ earnings they accrued by being flexible with their energy usage.
- Tom and Sally use this information to review if it is economically worth and overall impactful to continue to sign up for domestic flexibility schemes across their different providers. They also use this information to use a third party comparisons online service to understand if a change of tariff or provider might help them further.
- **Additional service:** Separate services need to be built for consumers to interact with the data sharing infrastrucure in a user friendly and accessible way. This service might be provided by third parties.

Noah – EV vehicle and charging provider

Deploy data preparation node
- Other actor in the organisation (IT colleagues) look to/have set up the data preparation node.

Register with data sharing mechanism
- Other actor in the organisation (IT colleagues) look look to register their data preparation node.

Identify data for sharing
- Noah investigate how they can make available to the market the KWh data of potential flexibility generated by their EV and charging services/ station.
- Noah review the data sharing level supported through the data sharing infrastructure and discuss with commercial and legal colleagues how to make the data available without undermining commercial interests. They then ask support to their digital team to share this data through the data sharing infrastructure.
- **Enabler:** Lawyers have agreed with a specific Aggregator counterparts a 121 licensing agreement for the data of interest.

Connect data source to the node
- Other actors in the organisation (IT colleagues) connect their data sources to the data preparation node and set up relevant data pipelines

Align data to minimum operable standard
- Noah is asked to review that the data set to be shared conforms to requirements in the specific licensing agreement.

Publish data for sharing
- Noah review that access permission are set correctly and allow data to be viewed only by the Aggregator of choice.

Search for data
- Noah wants to be able to report on benefit of providing electrification services to their current and future customers, so they log into the search portal with their account.
- Noah looks for data around the monetary return customers might expect back when plugged in and consenting to provide flexibility service but does not find much. However, they find that data around the DNO network configuration can be requested at different granularity.

Review and request data
- Noah review the data request process together with their legal team and submit requests to the DNO user group for access to network configuration data at sub station level.
- Noah wait as the data request is sent and evaluated by the data providers in the DNO user group.
- **Enabler:** Data request triage processes guidance could provide consistency and asset organisation in reviewing data request more effectively.

Access the data
- While Noah awaits for updates in relation to their data request, they think about how they could use this data to provide their prospective customers with early understanding of if they could be able to provide flexibility service back to the grid in future based on the configuration of their local network.

Tanveer – Heat network, Operation team manager

Deploy data preparation node
- Other actor in the organisation (IT colleagues) look to/have set up the data preparation node.

Register with data sharing mechanism
- Other actor in the organisation (IT colleagues) look look to register their data preparation node.

Identify data for sharing
- Tanveer reviews with their IT, legal and commercial team whether the data sharing infrastructure fits their needs to exchange data with their Aggregator of choice to provide balancing and constraint management services to the grid.

Connect data source to the node
- Other actors in the organisation (IT colleagues) connect their data sources to the data preparation node and set up relevant data pipelines

Publish data for sharing
- Tanveer is assured by IT colleagues tests that the data agreed can be successfully pulled by the Aggregator with the right timeliness.

Search for data
- Tanveer instruct Digital/IT colleagues to set up a data connection request to receive their Aggregator flexibility dispatch signal.

Review and request data
- Other actors in the organisation set up the request

Access the data
- Other actors in the organisation (IT colleagues) connect to the Aggregator API, pull data on required timeliness and integrate it with HN control system.
- Tanveer and their team can view the flexibility dispatch request coming from their aggregator and the response.

Luna – Aggregator, IT manager

Deploy data preparation node
- Luna and their technical team deploy a data sharing infrastructure's data sharing component on their technical infrastructure to enable the sharing of aggregated flex service to be surfaced to the relevant markets.

Register with data sharing mechanism
- Luna and their team test their implementation of the data preparation node to ensure this does not bring security issues/opens back doors in their IT infrastructure and transmit the data securely.

Identify data for sharing
- Luna and their technical team review the technical, deployment, security and SLA information in relation to the data sharing infrastructure's data sharing component and assess if this is fit for purpose to be used to pull data from their flex resource and transmit responses in the timeliness required.

Connect data source to the node
- Luna and their technical team create the relevant data pipelines to feed data into the data preparation node.

Align data to minimum operable standard
- Luna and their technical team ensure the business provides input in relation to the data transformation needed, as well as provides some additional metadata information for some of the dataset exchanged.
- Luna and their technical team set up the relevant access permission as instructed by the business and legal teams.

Publish data for sharing
- Luna and their team ensure the data sharing API exposed by their deployed data preparation node can be called correctly at timeliness needed (big assets on a second by second basis while small assets on a 10 second basis)

Search for data
- Other actors in the organisation (business/ops colleagues) identify data needed to be received and organisations that provide those (e.g. flex asset status, dispatch signals)

Review and request data
- Other actors in the organisation (business/ops colleagues) request access to data needed and liaise with provider to gain access approval.

Access the data
- Luna and their team build connection to the relevant API (big assets on a second by second basis, while small assets on a 10 second basis) and integrate that into their data flows.
- Luna and their team monitor the data exchange through the data sharing infrastructure to ensure their organisation can effectively sell flexibility services.
- Other actors in the organisation (business/ops colleagues) use the data to effectively sell flexibility services.

Alvin – ESO, Strategy flexibility manager

Search for data
- Alvin log in a search page. They use the search to look for granular demand data around the use of smart appliances. They also look for data for record on past deployment of demand flexibility services and DER over the last 4 quarters.

Review and request data
- Alvin is able to request past dispatch data they are looking for automatically as this is licensed to used within ESO itself.
- Alvin identifies they can request a certain view of sub station demand level data for a series of DNO across the country for their research purposes thanks to sharing agreement between ESO and DNO.
- Alvin identifies aggregated figures and analysis around consumer behaviour form retailer and flexible service providers that might be interesting to looked in more detail so they sends an access request to the relevant party.

Access the data
- Alvin access the dispatch data, granular demand data for certain area of the country while they work data sharing conversation with retailers.
- Alvin analyse the use of small flexible resources and their response to better understand their behaviour patterns. This seems to lead to increase confidence in the ability to rely on those in future balancing strategy.
- Alvin discuss with the forecasting team how to use some of the data they have requested to better understand future demand across the network and what is the percentage of that demand that could offer wider demand response to flexibility services.

Sophie – DNO, Information officer

Deploy data preparation node
- Other actor in the organisation (IT colleagues) look to/have set up the data preparation node.

Register with data sharing mechanism
- Other actor in the organisation (IT colleagues) look look to register their data preparation node.

Identify data for sharing
- Sophie work with different teams across the business to identify what of the data they own needs to be made available due to regulation, presume opened steer, current data sharing agreement and potential value/benefit to the wider system. They also engage legal and digital team in the conversation and evaluation of using the data sharing infrastructure.

Connect data source to the node
- Other actors in the organisation (IT colleagues) connect their data sources to the data preparation node and set up relevant data pipelines

Align data to minimum operable standard
- Sophie monitor that IT colleagues receive the support needed from the business team in transforming some of the dataset into the right standards and ensure metadata is provided consistently.

Publish data for sharing
- Sophie review that access permission sets follow what has been agreed for a specific datasets.
- **Enabler:** Lawyers would have reviewed and set up any data sharing agreements needed to support the sharing of information above and beyond the open licence with relevant stakeholders across the sector.

Search for data
- Sophie work with different teams across the business to identify what data they need from other parties across the energy system to operate most effectively (e.g. view of status of assets connected to the network). They set up a plan for setting this up through the data sharing infrastructure.
- They log in a portal using their organisation profile and identify data available and gaps
- Sophie log in a portal using their organisation profile to look at the data request dashboard as they have been notified of pending requests.

Review and request data
- Sophie support business colleagues data requests where data is not already accessible.
- If an access request is approved, Sophie then work with colleagues across the organisation to make this data available to the data consumer via the data sharing infrastructure.
- If an access request is denied, Sophie support drafting of rational.
- Sophie also review data access request received from users of the data sharing infrastructure and initiate their organisation triage process to asset the request involving business and legal colleagues.

Access the data
- Other actors in the organisation (IT colleagues) set up the necessary integration with API to get the data and business colleagues download the data from the data sharing infrastructure as per needed.
- Sophie review the level of data sharing and progress carried out through the data sharing infrastructure against their data strategy objectives to ensure data supports business outcome as much as possible and that their organisation is compliant with regulatory ask and at the forefront of data sharing best practices across the sector.

Deploy data preparation node | Register with data sharing mechanism | Identify data for sharing | Connect data source to the node | Align data to minimum operable standard | Publish data for sharing | Search for data | Review and request data | Access the data

Provisioning data for sharing

Accessing shared data

C.4

Use cases

Use case exploration

Understand the specific outcomes on a data sharing infrastructure

Purpose of use cases

Use cases are a way to identify how users interact with a system to achieve a particular outcome.

Use cases capture:

- **What?** – the problem that needs to be solved to achieve a particular outcome
- **Who?** – the users & stakeholders
- **How?** – the functionality of the system and the data needed by users to successfully complete their journey
- **Why?** – what is the value and outcome achieved

Extensive stakeholder engagement has enabled the defining of how users would interact with a data sharing infrastructure to achieve a particular goal.

This helped the contextualisation and identification of how a data sharing infrastructure could enable specific activities and respond to un-met needs across the energy sector. The primary scope of use case exploration done is to enable the definition of a data sharing infrastructure, and not a deep dive study of each specific areas and the wider solution space.

How use cases are described

Each use case explored has:

- **Problem** – the problem/pain point it addresses
- **Key users** – the actors for whom there is value solving the problem
- **Data** – some of the key dataset associated with the use case
- **Why is it a good example? -** the value the use case will bring, and why it should be prioritised.

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Use case approach

Summary of the process used to short listing potential use cases

Methodology

In total, 15 potential use cases were identified through stakeholder engagement, market research, and consortium expertise.

They aimed at finding potential use cases that helped with the definition of a data sharing infrastructure and met the overarching policy objectives.

The 15 initial use cases were further short listed through three steps, which are detailed over the subsequent pages

1. Eligibility criteria
2. Stakeholder preferences
3. Assessment against 'additional considerations'

By the end of three steps, the 15 potential use cases, defined in Appendix C.4, were filtered down to five use cases.

These use cases were explored in greater detail, as outlined in Appendix C.5 and subsequent sections.

The detailed use case analysis is in Appendix C.4.1.

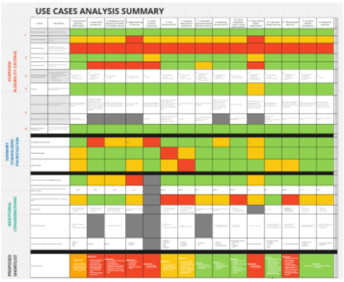
Long List

- Heat network planning & identification
- Digital licensing & reporting
- City decarbonisation
- Vulnerable consumer/households Identification
- Local Area Energy Planning (LAEP)
- Smart tariff transparency
- Policy carbon impact mmeasurement
- Transport electrification enablement
- Electricity market reforms
- Electricity flexibility
- Development & operation of markets for flexibility services
- City decarbonisation
- Dynamic network management
- Sector coupling for carbon neutral power systems
- Whole-system operation

1. Eligibility Criteria

2. Stakeholder Preferences

3. Additional Consideration



Note: Full details of the use-case prioritisation assessment are available in Appendix C.4.1

Short List

- Vulnerable Consumer/Households Identification
- Local Area Energy Planning
- Electricity Flexibility
- Electricity Market reforms
- Sector Coupling for carbon neutral power systems

Additional consideration

Additional considerations to further reduce the long-list of use cases

Overview

In addition to the eligibility assessment and stakeholder prioritisation, each use case has been assessed against a set of additional considerations including:

1. Timescale
2. Complexity of exploration
3. Data Challenges
4. Links to other use cases
5. Cross sector impact
6. Impact and value towards meeting net zero.

These are outlined in the table on the right-hand side.

Additional Considerations	Description
Timescale	Is the use case Day 1 (use cases that can benefit from a data sharing infrastructure without other dependencies) or Year 10 (use case that will be an enabler to wider use case. These use cases will be more strategic that will enable long term goals)
Complexity of exploration	Qualitative RAG assessment of how complex use case will be to explore where • Red = High Complexity • Amber = Medium Complexity • Green = Low Complexity
Data Challenges	Use cases consideration from a lens of data availability, and data acquisition. This aspect will consider commercial, privacy, and security needs, as well as the need for real-time data exchange.
Links to other use cases	Use cases that are interlinked with each other. This aspect explores the whether there are any dependencies between each use cases.
Cross sector impact	Outline of the actors or sectors that may be impacted by a use case. This includes but is not limited to, network operators, markets, transport, consumers, and local communities.

C.4.1

Detailed use case analysis

USE CASES ANALYSIS SUMMARY

Section	#	criteria	Description	1 - heat network planning / identification	2 - smart tariff transparency	3 - development and operation of markets for flexibility services	4 - digital licensing & reporting	5 - Carbon Emission Accounting	6 - City decarbonisation	7 - Transport electrification enablement
OVERVIEW ELEGIBILITY CRITERIA	1	**Promote interoperability**	*Is data standardisation needed to enable the delivery of the use case?*							
		Promote interoperability	*If available, are standards adopted by the sector?*							
		Promote data sharing	*Are effective mechanisms and frameworks for data sharing in place to meet the need of the use case?*							
	2	**Promote data sharing**	*Does it require secure data exchange?*							
		Promote data sharing	*Is the data required part of critical infrastructure?*							
	3	**Contribute toward key UK energy policy objectives**	*Does the use case contribute to one or more key UK energy objective?* • *Energy Equity and Affordability* • Energy Security • Net Zero • Economic Security	3/4 • Energy Security • Net Zero • Economic Security	3/4 • Energy Equity and Affordability • Energy Security • Net Zero	2/4 • energy security • Net zero	2/4 • Energy Security • Economic Security	1/4 • Net zero	3/4 • Energy Security • Net Zero • Economic Security	3/4 • Energy Security • Net Zero • Economic Security
	4	**Need gap**	*Is a digital spine like intervention/need potentially required?*							
	5	**Breadth of sectors involved**	*Does the use case involve several actors across the energy sector?*	Developers, Heat network, DNO, Energy producer, Heat producer	Citizen advice, community energy group, consumer service providers, DESNZ, domestic consumers, energy suppliers, local communities, network companies, Ofgem, retail supplier, smart device developeprs	DNO/DSO, ESO/FSO, flexible service providers, grid operator, market operator, Ofgem, energy customers	DESNZ, licensee, Ofgem, general public	consumers, energy suppliers, local communities, network companies, retail suppliers,	Asset/building stock owner, DESNZ, DNO, energy producer, ESO, gas suppliers, heat network, hydrogen producers, local energy plan, Ofgem	Communities, DESNZ, DNO, ESO
		Breadth of sectors involved	*Does the use case involve other sectors?*	Water sector, built environment, public sector				Any industry	Build environment, Industries and businesses, local authorities, local communities, transport	Transport,
	6	**Energy sector's digital transformation**	Does the use case support the digital transformation across the energy sector							
SUMMARY STAKHOLDERS' PRIORITISATION		**GOVERNMENT & POLICY MAKER**					Ofgem			
		NETWORK OPERATORS								
		WIDER INDUSTRY								
ADDITIONAL CONSIDERATIONS		**Degree of overall impact from DESNEZ perspective**								
		Timescale: Day 1 (more detailed, specific) vs Year 10 (wider breath, strategic)		**DAY 1**	**DAY 1**	**DAY 1**	**DAY 1**		**YEAR 10**	**YEAR 10**
		Complexity of exploration (High = Red. Medium = Yellow, Low = Low)								
		Data challenges		• Data with commercial, privacy and security sensitivity	• Data with commercial, privacy and security sensitivity	• Data with commercial, privacy and security sensitivity • Real time data exchange	Data with commercial, privacy sensitivity		• Data with commercial, privacy and security sensitivity	• Data with commercial, privacy and security sensitivity • Real time data exchange
		Links to other use cases		• City Decarbonisation • Leap • Energy network Coopling		• Flexibility Markets Reforms			• Heat Networks • Leap • Transport Electrification	• Leap • City decarbonisation
		Core energy sector segment or other sector involved		• **Network** • **Heat** • **Gas**	**Consumers**	**Markets**	• **Regulation** • **Services**		• **Network** • **consumers** • **Heat,** • **Gas,** • **Hydrogen**	• **network** • **consumers** • **Transport**
PROPOSED SHORTLIST		**Selection Rational**		**DESELECTED AS** • core actor challenges and data types can be explore to a some extent by LEAP and Energy Network Coocupling use case	**DESELECTED AS** • vulnerable customer use cases been brought forward providing opportunity to explore the consumer angle while being linked to more urgent policy needs • also initiative already in play in this area	**DESELECTED AS** • as Flexibility Market Reform use case prioritised • also ongoing OFGEM initiativealready exploring this problem space so this is well understood and has already identified the need for a digital spine	**DESELECTED AS:** • not consistently prioritised by stakeholders • lower policy impact for DESNEZ	**DESELECTED AS:** • reframed as policy impact assessment	**DESELECTED AS** • core actor challenges and data types can be explore to a some extent by LEAP use case	**DESELECTED AS** • core actor challenges and data types can be explore to a some extent by LEAP use case • very broad would need to focus on subquestion if it si to be brought forward (e.g. EV)

Section	#	criteria	8 - Vulnerable Consumer/Households Identification	9 - Electricity Market reforms	10 - Sector Coupling for carbon neutral power systems	11 - Policy Carbon impact measurement	12 - Local Area Energy Planning	13 - Whole-system operation	14 - dynamic network management	15 - Electricity Flexibility
OVERVIEW ELEGIBILITY CRITERIA	1	**Promote interoperability**								
		Promote interoperability								
		Promote data sharing								
	2	**Promote data sharing**								
		Promote data sharing								
	3	**Contribute toward key UK energy policy objectives**	4/4 • Energy Equity and affordability • Energy security • Support net zero • Economic security	2/4 • Energy Equity and affordability • Support net zero	2/4 • Energy Security • Economic Security	3/4 • Energy Equity and affordability • Energy security • Economic security	3/4 • Energy Security • Net Zero • Economic Security	3/4 • Energy equity and affordability • Energy Security • Net Zero	3/4 • Energy equity and affordability • Energy Security • Net Zero	1/4 • Net Zero
	4	**Need gap**								
	5	**Breadth of sectors involved**	OFGEM, DESNZ, ONS, energy companies,	DESNZ, domestic consumers, energy suppliers, local communities, network companies, transmission operator and generators, energy retailers	Actors across energy,	Ofgem, DESNZ, consumers, energy suppliers, local communities, network companies, retail suppliers, smart device companies	Electricity network and system operators Gas networks operators	DESNZ, DfT, FSO, ESO, DSO, National Gas, aggregators, energy suppliers, community heat providers	ESO, DNO, Generator, Flexible service providers, DER, Large consumers, consumers	Generators, system operators, distribution networks, consumers, suppliers, retail, trading
		Breadth of sectors involved	Vulnerable households, local authorities, government departments,		other energy networks (heat Hydrogen gas)		Local authority Transport other energy networks (heat Hydrogen gas)	Other sectors providing flex services	Other sectors providing flex services	Other sectors providing flex services
	6	**Energy sector's digital transformation**								
SUMMARY STAKHOLDERS' PRIORITISATION		**GOVERNMENT & POLICY MAKER**				Ofgem				
		NETWORK OPERATORS								
		WIDER INDUSTRY								
ADDITIONAL CONSIDERATIONS		**Degree of overall impact from DESNEZ perspective**								
		Timescale: Day 1 (more detailed, specific) vs Year 10 (wider breath, strategic)	**DAY 1**	**YEAR 10**	**YEAR 10**	**DAY 1**	**DAY 1**	**YEAR 10**	YEAR 5	YEAR 5
		Complexity of exploration (High = Red. Medium = Yellow, Low = Low)								
		Data challenges	Data with privacy and security sensitivity	Data security and commercial sensitivity	• Real time • Data security and commercial sensitivity		Data security	• **Real time** • **Data security, infrastructure**	• Real time • Data security, infrastructure	• Real time • Data security, infrastructure
		Links to other use cases		• Development of market for flexibility services	• Whole system Operations	• Carbon accounting	• City decarbonisation • Transport electrification • Heat network planning	• Dynamic Network management • Electricity Flexibility	• Whole system operation • Electricity Flexibility	• Whole system operation • Dynamic network Management
		Core energy sector segment or other sector involved	• **Consumers** • **Gas**	• **network** • **consumers** • **local communities**	**Across All power system:** • **Electricity,** • **Heat,** • **Hydrogen,** • **Gas**	**Across All Energy sector**	• **Local government** • **Network** • **Transport** • **Gas** • **Heat**	• **Across All Energy sector**	• **Flexible Service Providers** • **consumers**	• **Distribution network** • **consumers**
PROPOSED SHORTLIST		**Selection Rational**	**SELECTED AS** • High /urgent priority across majority of sector stakeholders	**SELECTED AS** • HIgh impact and strategic with contribute to energy prices decrease	**SELECTED AS** • Match the Digital Spine ambition • looks at the entire power system • allows to explore challenges and data from the whole system operator	**DESELECTED AS** • not highest impact across stakeholders	**SELECTED AS** • allows to explore the city decarbonisation, transport electrification and heath network planning use cases • the initiative has already been launched in some Local authorities and will support them in the Digital transformation	**DESELECTED AS** • selectedd a related Day 1 use cases (either Dynamic Network Managenent or Electricity Flexibility) allowing to explore core challenes and data • selected secotr coupling which looks at wider howle systems operation questions	**SELECTED AS** • allow to explore core whole system challenges in detailed way	

C.4.2

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Long list of use cases

Use case 1 - Heat network planning / identification

Overview of use case

What is the use case and the problem statement?

Heat networks are vital to making net zero a reality in the UK. In high density urban areas, they are often the lowest cost and low carbon heating option. This is because they offer a communal solution that can provide heat to a range of homes and businesses by capturing or generating heat locally.

Through the Heat Network Transformation Programme (HNTP) the government is working with industries and local authorities, and investing over half a billion pounds in funds and programmes, to develop new heat networks and improve existing ones (e.g. the Heat Networks Zoning Pilot).

To help shape a successful heat network market the government also works closely with senior industry leaders through the Heat Networks Industry Council.

Access to a variety of national and local datasets is critical for the identification and development of heat networks in zones where they provide lower cost and low carbon heat to consumers through regulation, mandating powers and market support. Availability and sharing of this data consistently and at scale is a challenge and requires high coordination/collaboration efforts which is impacting on the speed of policy making and wider HN roll-out across the country.

Users/Actors

Local authorities, DESNZ, Developers, Heat Network stakeholder council, DNO, Energy Producer, Heat Producer (e.g., industries, wastewater treatments, hospital, constant temperature water source (water sewer), data centres, etc.), Local communities (e.g., community energy group)

Secondary users/actors: academia, consultancies/expert

Why is it a good example?

- Variety of datasets
- Variety of stakeholders
- Net zero contribution
- Heat Network will need to be scaled up nationally

Data

National Data set
- Energy demand
- Energy supply
- DESNZ Waste Heat Data
- DNO constraints
- Meter usage at building level
- Electricity cost uplift
- Public sector decarbonisation scheme

Local Data set
- Local Zoning
- Heat Demand
- Building stock type
- Heat consumption of different building types
- Ownership of buildings
- Age of plant
- Mandateable status
- Heat Sources
- Constraints
- Existing heat networks
- New Developments

Use case 2 - Smart Tariff transparency

Overview of use case

What is the use case and the problem statement?

With the increased use of Smart meters more granular domestic usage data become available (half-hourly intervals). This enables suppliers to start offering new types of off-peak tariffs (sometimes called 'time of use' tariffs)/Smart Tariff that charge consumers different rates for their electricity usage depending on the time of day.

This can help consumers save money on their energy bill as well as being able to take advantage of 'smart' off-peak tariffs in which the price of electricity drops in real-time, for example if a sudden surge of wind is expected. In this scenario, consumers could plan ahead to the following day, to take advantage of the wind energy, or, they might be able to ask their supplier to provide power for a certain activity (e.g. charge their EV vehicle) overnight during the windiest times.

However, current consumers are unable to realise the value of their half-hourly energy consumption data to make an informed switch to, or between, time of use (ToU) tariffs. At the moment there is no standardised way for this data to be shared with third parties to enable comparison, and consumers' data is scattered across the industry in different formats and varying quality. Making this data sharable and interoperable can allow smart meter-enabled tariffs to be compared, giving consumers the information they need to switch to the best deals and integrate new low carbon technologies. Sharing this data can also allow the wider sector to demonstrate how this innovative tariffs can be used to offer consumers a greater range of products and services.

Users/Actors

Citizen Advice, Community Energy Group, consumer service providers (e.g., comparison services), DESNZ, domestic consumers (e.g., vulnerable customers), energy suppliers, local communities, network companies, Ofgem, retail suppliers, smart device and smart device interface developers and providers

Why is it a good example?

- Variety of datasets
    - Consumer data
- Net zero contribution
- Consumer focus
- Impact on full energy system

Data

- Energy half-hourly consumption data
- Predicted energy generation mix
- Energy pricing

Use case 3 - Development and operation of Markets for Flexibility services

Overview of use case

What is the use case and the problem statement?

The decarbonisation of the energy system will call on millions of low carbon technologies (many of which are small e.g. EV, heath pump, batteries) which when aggregated can deliver substantial flexibility value to the system.

To date, this flexibility has not been brought to market due to the cost and complexity of the coordination of this services (for which Ofgem has put out a Call for Input: The Future of Distributed Flexibility in March 2023). Currently, the execution of contracts between flexibility providers and grid operators is hindered due to a combination of market silos, lack of transparency and data availability.

Data around the value of assets and services that flexible providers can offer, contract, dispatch signal from the market operator, and conflict resolution and settlement need to be visible and exchanged to facilitate the interaction between flexibility service providers (FSPs), market operators (MOs) and grid operators needed to deploy the level of flexibility necessary for net zero.

Users/Actors

DNO/DSOs, ESO/FSO, flexible service providers, grid operator, market operator, Ofgem, energy customers

Why is it a good example?

- Link with Ofgem System-wide Flexibility Exchange (SFE)
- Market focus
- Net zero contribution
- Transform grid balancing services from better/richer information, coordination T/D network requirements
- Unlocks the ability to procure and dispatch flexibility in a consistent way
- A step towards whole-system coordination, operation, aligning renewable outputs with EVs and HPs operation
- Variety of data sets

Data

- Flexibility service data
- competition data
- participant data
- Purchasing data
- Contract data
- Bid result data
- Availability data
- Dispatch data
- conflict data
- Performance data
- Invoice data

Use case 4 - Digital Licensing & Reporting

Overview of use case

What is the use case and the problem statement?

In order to operate, organisations in the energy sector need to be licenced by Ofgem which determines the set of conditions that needs to be abided to for that business to operate. However, the current monitoring and enforcement of those conditions does not happen in a systematic manner, and it relies on the licencee reporting a breach or other intelligence routes.

In the mid 2020's, the regulatory framework for licencees might change with the introduction of "Digital Licences" for demand side response service providers or heat networks. It will be required that licence conditions are measurable/have set metrics identified, monitored and reported upon at relevant intervals, depending on the supplier characteristics.

A mechanism to share licences' performance data in line with a common standard will be critical to enable the monitoring and enforcement of energy licencing. This will enable regulators to collect and analyse this to inform response and future policy making.

Users/Actors

DESNZ, licensee (e.g., heat network, demand side response service providers, network and energy suppliers – DSO, DNO, ESO, generators, hydrogen production facilities), Ofgem, Public (RFI can be submitted)

Why is it a good example?

- Enable performance from different license holders to be compared, with better performance being rewarded
- Ensure the license holder serve the current and future energy customers
- Net zero contribution
- Regulatory push/change by 2025/6
- Variety of stakeholders

Data

- Static business information
- Dynamic information on license conditions
- Performance metrics against each licence condition
- Regulatory Reporting

Use case 5 - Carbon Emission Accounting

Overview of use case

What is the use case and the problem statement?

In order to meet our net zero targets, the wider economy will need to track carbon emissions across industries. This will require policy and data standardisation which can be facilitated through a digital spine implementation.

Access to data around the embodied emissions of products will be key. This means understanding the associated greenhouse gas emissions related to its manufacture this includes the energy mix used for production related to the extraction and processing of raw materials and fuels, combustion of fuels, transport, process emissions and end-of-life emissions.

Users/Actors

DESNZ, Supply Chain, Industry, Energy generators

Why is it a good example?

- Net zero contribution
- Net zero tracking

Data

- Industries
- Supply chain data
- CO_2 Footprint
- Energy mix generation data for production

Use case 6 - City Decarbonisation

Overview of use case

What is the use case and the problem statement?

In June 2019, the UK Government pledged to reach net zero greenhouse gas emissions by 2050 with more actions needed especially in the area of **urban emissions.** Cities, and large towns, have greater potential to drive transition in the next period and are therefore central to the UK meeting its net zero objective.

It will be key to understand the role that different places will have to play to help the UK achieve its target; how far cities and large towns are from net zero; how it varies between places; and the scale and effort required to get there.

Several initiatives in the UK are supporting the cities' decarbonisation agenda (such as the licence Public Sector Decarbonisation Scheme which provides grants for public sector bodies to fund heat decarbonisation and energy efficiency measures) and more upcoming polices, incentives and industry efforts, will provide additional tools to decarbonise UK cities (Heat network zoning policy, gas levy reform, hydrogen).

Access to vast amounts of data is critical to the identification/understanding of what is the best viable mix/combination of options that can be used in a specific urban context which will provide the lower carbon/ lower costs to carbon. Specifically, city characterisation data, intervention opportunity data, energy and gas related data and consumer data are needed to enable the whole energy system decarbonisation modelling to identify and evaluate the best decarbonisation pathway and the best balance of solution from heath network, hydrogen use and electrifications, for a specific city.

Users/Actors

Asset/building stock owners, businesses & industries, consumers, DESNZ, DNO, energy producers, ESO, gas suppliers, heat networks, hydrogen producers, local authorities, local communities, local energy plan, Ofgem, transport

Why is it a good example?

- Cross-sector decarbonisation
- Net zero contribution
- Variety of datasets
- Variety of stakeholders
- Whole system use case

Data

City characterisation
- Measurement of carbon dioxide emitted by a wide range of sources within a specific, urban area
- Building Stock

Intervention opportunities
- Carbon dioxide of potential interventions
- Financial costs associated

Network Information
- Electricity
- Gas

Consumption, Demand, Usage

Consumer preferences

Use case 7 - Transport electrification enablement

Overview of use case

What is the use case and the problem statement?

In June 2019, the UK Government pledged to reach net zero greenhouse gas emissions by 2050 with more actions needed especially in the area of **transport and its electrification.**
The electrification of transports will have significant impact on UK energy supply and demand posing both challenges, such as balancing of the grid , and opportunities, such as use of batteries for DER, for the UK energy system. It also requires the integration of transport modes into a reliable and affordable as well as easy-of-use infrastructure for the supply of energy currently not present due to limitations of current energy storage systems.

Access to a vast amount of data about network, supply, flexibility services, storage, demand for different transport modes and more will be needed to plan for a reliable and efficient electrification of the transport system, optimise energy usage and reduce carbon emission.

Users/Actors

Communities, DESNZ, DfT, DNO, ESO, EV charging providers, general public (EV), heavy vehicle/goods transports, local authorities, National Highways, Network Rail, public transport network (e.g., TfL)

Why is it a good example?

- Benefit from greater alignment of large and small energy players
- Help consumers to make decision
- Net zero contribution
- Real-time information on carbon emissions and energy usage
- Sharing data for better planning and allocation of resources for sustainable transport infrastructure

Data

- Energy demand & supply
- Network Data
- Rail transport
- Recharge infrastructure
- Road network
- Usage
- Vehicle (electric passenger cars, vans and buses)

Use case 8 - Vulnerable Consumer/Households Identification

Overview of use case

What is the use case and the problem statement?

Vulnerable people, who represent millions of households, are often disproportionally impacted by policy changes. There is however no real way to understand in detail the impact that current and future policies have on vulnerable people as there is no clear shared detailed understanding of which people are part of this group. Furthermore, there is no common way to track and monitor how this part of the population is changing. This leaves a gap in policymaker and government understanding of its segments of its population and in energy companies' understanding of their customers.

Access and sharing of various data related to vulnerable people (vulnerable person register, ONS data, household, consumption information and more) would allow this data to be connected to provide a holistic and up to date view of this part of the population which would help policy makers and other players (e.g. energy company) understand how vulnerable people are impacted and how could be supported.

Users/Actors

OFGEM, DESNZ, ONS, energy companies, DNOs, Vulnerable households, local authorities, government departments, consumer advice/third sector organisations

Why is it a good example?

- Current Urgent priority in the energy space
- Clear focus on the ultimate energy system end user – the consumer
- Clear link to top government priority around energy equality and affordability
- Some of the data that could be utilise will require privacy, consent and security considerations to be explored. There are already however several data sources at less granular level that could be leveraged for an immediate initial trial (e.g. at post code level)
- It involves the sharing of information with actors outside the energy sector.

Data

- Vulnerable Person Register
- PSR register
- ONS data
- Household data
- Consumption data
- Meter data (e.g. pre-paid meter)
- Retailer's consumer data
- Building stock data
- User consent

Use case 9 - Electricity Market reforms

Overview of use case

What is the use case and the problem statement?

Currently, the GB electricity market has a uniform pricing system that does not accurately reflect the actual cost of energy due to transmission constraints and varying weather conditions. To ensure fair pricing and reflect the real cost of energy, the UK Government is reviewing the electricity market and consider reforming the market design (REMA). Some of the options to reform are either dividing the GB market into zones or having a nodal market with a large generation unit acting as its own node connected to the transmission network.

Access to good and robust information about generation, transmission, distribution, cost and demand will be essential to enable the market reform to reflect more accurately the cost/price of power (such as the rise in cheaper renewable electricity) and provide cheaper rated to consumers.

Users/Actors

Ofgem, DESNZ, domestic consumers, energy suppliers, local communities, network companies, transmission operator, generators, energy retailers

Why is it a good example?

- Moves pricing closed to actual costs
- Access to information on all assets in the GB electricity system will benefit to consumers and suppliers
- Improve the energy system resilience as it will be more adaptable, flexible and fair
- Data in scope have commercial and security (e.g. cyber) sensitivities
- Promotes use of cheaper renewable electricity
- Makes electricity more affordable to consumers
- This could provide a way to assess the optionality of different market options currently being assessed
- It could help provide transparency, information, innovation to protect consumers and businesses interests.

Data

- Assets across the system
- Network and System performance Data
- Pricing Data and Market Data
- Energy cost and availability for a range of energy demand
- Power generation data
- Demand and Supply data
- Storage data

Use case 10 - Sector Coupling for carbon neutral power systems

Overview of use case

What is the use case and the problem statement?

The concerns about greenhouse gas emissions, energy shortages, and global warming are increasing the interest in migrating to a carbon-neutral power system that relies on renewable energy. However, the increasing share of renewable energy has added volatility and uncertainty to power system operations. While utilising flexible services may help solve the problem, this might not be sufficient. Sector coupling, which integrates production, consumption, conversion, and storage by connecting various energy domains (e.g. heat, hydrogen, gas) could potentially meet the needs of each domain while reducing uncertainty and volatility, generation of surplus energy and unnecessary carbon emissions.

Access to vast amount of data needed will be critical to enable the process of integrating various energy systems/domains to match demand and supply (through co-production, co-consumption, operation and market) and create a more integrated and carbon neutral energy system able to increase the acceptance of renewable energy in the current/traditional power system.

Users/Actors

Actors across Electricity, Heat, Hydrogen, Gas domains

Why is it a good example?

- Explores how energy networks could benefit from data sharing and coordination to help migrate towards Carbon-Neutral Power Systems moving to a whole-system approach to operation of the power system
- This could allow to have a whole system plan which looks across energy networks and help with the discussion about more strategic placement and planning (at national and local level)

Data

- Operational data across energy domains
- Asset data across energy domains
- Market data across energy network
- Forecast data each energy network
- Energy Demand and supply data

Use case 11 - Policy carbon impact measurement

Overview of use case

What is the use case and the problem statement?

Understanding the efficacy and impact of policies in relation to decarbonisation is challenging. However, measuring performance against this core energy sector objective is essential to ensure that the actions undertaken have the right impact and that are resilient and secure. From measuring progress against net zero pledges, requires identify and track the carbon impact of efforts. It is currently difficult however to understand how to set and identify the right metrics and to track those due to the lack of visibility and access to consistent energy sector data that could be used measure (e.g. KPIs).

Visibility and access to consistent energy sector data (e.g. from smart devices to Co2 emission of energy mix) will enable government to understand how to assess and track the carbon impact of its policies while in future enabling the entire energy ecosystem, including suppliers, distributors, and consumers look at their performance and improve our actions.

Users/Actors

OFGEM, DESNZ,

consumers, energy suppliers, local communities, network companies, retail suppliers, smart device companies

Why is it a good example?

- By measuring KPIs, we can track progress towards our core objectives of achieving net zero emissions
- Thanks to data sharing we can provide transparent data and enabling stakeholders to make informed decisions about energy consumption and investment.

Data

- Energy consumption
- Energy generation
- Co2 emission
- Energy prices
- Smart devices
- Socio economic data
- Policy related data
- Supply chain data

Use case 11 - Local Area Energy Planning

Overview of use case

What is the use case and the problem statement?

Across the UK, over 300 local authorities have declared a climate emergency and have set ambitious decarbonisation targets[1]. To deliver these targets, many of these Local Authorities are looking to create a Local Area Energy Plan (LAEP) that sets out the change required to transition an area's energy system to net zero. In developing an LAEP, local authorities need to explore different decarbonisation pathways, and create scenarios based on the different low-carbon technologies, and available infrastructure.

However, to create an LAEP, Local Authorities, or third parties working on their behalf, will need to access and utilise data from across the electricity and gas network, as well as supporting building stock, transport, and socioeconomic data.

In exchange, Local Authorities can provide valuable information on local planning to networks to inform future network investment and upgrade plans.

Providing equitable access to this data will be essential to accelerate the transition to low carbon environment.

Users/Actors

Local Government (Local authorities, council and planners)
DESNZ
Electricity network and system operators
Gas networks operators
Consultants

Why is it a good example?

- Maximise the value derived from utility infrastructure data
- Help address variation in data regionally across the UK and drive consistency
- Demonstrates a practical use-case where the energy sector data deliver tangible value to adjacent industries (local planning)
- Demonstrates how adjacent industries could provide data to local utilities (In the form of planning data) Improve data sharing between Utilities and Local Authorities
- Responds to a clear need gap
- Understanding the value of data sharing between differing organisations at various sharing volume, frequency and quality
- Support co-decarbonisation between differing energy sectors

Data

- Electricity and Gas Network Data
  - Asset Locations
  - Asset Capacity
- Heat network plans
- Building stock data
  - Forecasted Demand
- Socioeconomic data
- Local planning data

ARUP CATAPULT Energy Systems UNIVERSITY OF BATH

Use case 12 - Electricity Flexibility

Overview of use case

What is the use case and the problem statement?

Current cost of balancing the UK electricity grid are dramatically increasing. Enabling flexibility mechanism is key to reduce the overall cost to the system. While different flexibility options are available to address variability at different timescales, higher flexibility is now becoming essential particularly as power systems integrate higher shares of renewables. Flexible generation, flexible transmission and distribution , flexible demand side resources and flexible system operation (practices that help extract flexibility out of the existing physical system, such as making decisions closer to real time and more frequently) all require access to vast amount of accurate data at the right time.

There is currently not enough information available making difficult to use these services, understanding the flexibility capability at a given point at a local level or even understand how useful these intervention actually are once deployed.

Trustworthy access to a near real time granular view of each assets connected to the grid, available flexibility options, demand, network status and more is essential to establish the information flows to enable the best suited flexibility action to be deployed (e.g. for network management, operation and for consumers value).

Users/Actors

Generators, flexible service providers, assets owners, transmission & distribution networks, consumers, suppliers, retail, aggregators, consumers

Why is it a good example?

- reduces the cost of electricity flexibility
- improves the energy system's resilience, and promotes consumer confidence
- enables system operators to balance the network more effectively
- Using flexibility of asset will cost less if we operate more efficiently the asset on the Network
- Understand and utilise better consistent electricity data
- Could lead to consumer becoming more then passive actors as they could get value out of providing flexibility services

Data

- Asset data
- Flexibility service data
- Generation data
- Network data
- Energy demand & supply
- Whole sale & price data
- Energy cost and availability for a range of energy demand (fixed and flexible), i.e. vehicles, heating and classical demand
- System performance (cost, carbon, security, stability and resilience)
- Consumer data

Use case 13 - Whole-system operation

Overview of use case

What is the use case and the problem statement?

The current approach to energy system operation is siloed and deeply-rooted in traditional structures (i.e. national system operators, regional distribution networks, passive energy supply-businesses and focused on a few hundreds fossil fuel stations). This system will not be able to adapt to a future net zero energy system featuring millions of new active players and their data (e.g. in the transport and heat sectors, green energy providers) amplifying the scale and the complexity of an already extraordinarily large and complex system.

Access to timely and interoperable vast amount of data sources (across demand, network, assets and more) will be critical to enable the creation of a distributed whole-system digital infrastructure that will be needed to enable a range of stakeholders to work collectively to coordinate the future millions of new active users to achieve energy balancing at lower cost and carbon.

Users/Actors

DESNZ, DfT, FSO, ESO, DSO, National Gas, aggregators, energy suppliers, EV charging providers, general public (EV), community heat providers, local authorities, organisational climate action leads, consumers

Why is it a good example?

- Enable millions of GW and kW devices talking to each other
- Benefit from greater coordination and alignment of large and small energy players
- Drive a high coincidence between renewable and clean energy and customers' power, heat and transport demand
- Help local authorities to develop and implement community energy strategy towards net zero
- Support just-transition
- Improve data sharing between large and small players
- Identify potential risks for key stakeholders and vulnerable customers
- Support co-decarbonisation between differing energy sectors

Data

- Energy demand & supply,
- Network Data and flows of energy, cash and carbon
- System performance in terms of cost, carbon, security, stability and resilience
- Energy cost and availability for a range of energy demand (fixed and flexible), i.e. vehicles, heating and classical demand

Use case 14 - Dynamic network management

Overview of use case

What is the use case and the problem statement?

The new for real time ramping up and demand curtailment for distributed grid balancing and secondary markets will be critical for network resilience. With the increased growth and distributed nature of the UK energy sector, it will become more complex to deal with unforeseen circumstances (such as primary market failures, failures to network and generation due to various causes mechanical, weather, malicious intent) and manage its impact across the electricity system. Ramp up of additional auxiliary services and /or demand curtailment actions will need to take place at increasingly rapid speed while assessing its impact against a more complex and interconnected network.

Access to near real time, granular status of each assets connected to the network such as smaller distributed generator, large demand/consumers as well as network hierarchy information will enable to respond to unforeseen balancing needs choosing the less costly (money and carbon) interventions.

Users/Actors

ESO, DNO, Generator, Flexible Service Providers, DER, Large Consumers, Consumers

Why is it a good example?

- Data is siloed, held by several third parties, shared but at the right granularity, not available with the timeliness required in real-time, no set of shared standards.
- Some of this data has commercial as well as security sensitivity
- Policy push toward a greater energy independence and use of new power generation is bringing more assets to be connected to network. This creates more unpredictable and distributed balancing need that would not be able to be met but current processes.
- Flexibility is a cheaper option than reinforcing or investing in changing the networks
- Volatility of the network increasing making this use case more and more pertinent

Data

- Assets status across the network (e.g. generators)
- Network data
- Demand data

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Impact of a data sharing infrastructure on the decarbonisation of the energy system

Potential use cases

Use cases and areas where a data sharing infrastructure can support decarbonisation

Benefits of potential use cases

The benefits that will be delivered by a data sharing infrastructure will depend on how it is deployed by organisations using it, or regulation put in place to mandate specific uses of it. Emerging thinking associated with the potential use cases for a data sharing infrastructure are articulated in this slide and will be further explored in the next phase.

Types of data a data sharing infrastructure could support:

System planning and asset visibility

- System monitoring
- Faults and outages
- Network topology
- Gas network data
- Modelling data
- Energy efficiency data

Development and operation of markets

- Market data
- Carbon monitoring
- Consumer data
- Smart meter data

System dispatch and operation

- Network constraints
- Energy Balancing
- Renewable energy data

System planning and asset visibility

A flexible energy system will have millions of low carbon technologies assets (LCTs), which when aggregated can deliver substantial value to the system. As these LCTs connect onto the system, it will be critical to know what assets exist and their location, as well as their utility.

A possible outcome is the intersection of the future of the Automatic Asset Registration programme (AAR) and a data sharing infrastructure. The AAR solution as proposed would provide data on low carbon technology assets, where a data sharing infrastructure can surface that data to a wide array of market participants. Joining that data with other market signals and datasets may allow for the value of the asset (i.e. how the user may behave and how much flexibility can be provided by that asset across different timescales such as on an intra-day or longer-term basis) to be understood by system planners and market facilitators which can then be included as potential solutions within system and network planning.

By surfacing data from different market participants relating to flexibility in a standardised way a data sharing infrastructure can allow market facilitators to develop market products that can provide flexibility solutions such that they are utilised in the most economic and efficient manner.

Also, given that many low carbon technologies will be small in size, such as electric vehicles heat pumps and batteries, the benefits to the system will be driven through the aggregation of DSR. Having a data sharing infrastructure may allow innovators to develop business cases/solutions/products that increase the volume of flexibility that can be provided to the system, for example a third party that aggregates demand side response.

This greater visibility and understanding of assets could result in removal of barriers to greater utilise existing generation and demand assets and thus reduce the need for further build out of both generation and network reinforcement. It could also support more economic and efficient system operation which could reduce network faults and outages.

Potential use cases

Use cases and areas where a data sharing infrastructure can support decarbonisation

Development and operation of markets

A data sharing infrastructure can facilitate different types of flexibility providers to develop offerings for consumers and network operators, demand side response service providers will be building disparate systems and data ontologies.

As part of the visibility, dispatch and settlement activities, this data will be exchanged with different market participants for a variety of purposes, for example to demonstrate they have executed contractual terms and agreed market positions.

This standardisation via a data sharing infrastructure will allow for those assets to respond quickly by either increasing or decreasing their supply or demand position to the system.

Managing this level of price signals would either not be possible without of a data sharing infrastructure or would require considerable data interfacing between likely multiple data systems to allow for signals to be sent, which would likely take longer to deliver.

This could deliver benefits through better utilisation of assets connected to the system (including reduced curtailment of renewables), reduced network infrastructure development or network Opex as flexibility could be used to deliver a more economic and efficient system

The benefit of a data sharing infrastructure's decentralised approach could lead to a future where digital infrastructure to support DSRSP market operation would simply integrate with those providers using a data sharing infrastructure as a data transfer mechanism.

System dispatch and operation

Linked heavily to the delivery of market/price signals, is the need to communicate with assets that they are to respond to these signals to enable efficient and agile dispatch of technologies in line with agreed market positions. The system today is transforming from large fossil-fuel generators to millions of renewables of all different types and sizes which are connected across both transmission and distribution, as well across sectors (heat, transport and industry).

This will increase the complexity of dispatching assets in the most economic and efficient manner and will require substantial communication to ensure that the right assets are dispatched at the right times in the right locations. In addition, system operators (across multiple vectors) will need to have confidence that these signals are delivered to ensure the whole system is balanced accordingly. A data sharing infrastructure would be able to help better manage these signals

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Prioritised use cases

Use case prioritisation

Understand the specific outcomes on a data sharing infrastructure

Prioritised and "day 1" use cases

Five use cases were selected and prioritised for further research. These were divided into two types:

- **Day 1 use cases** – those use cases for which a data sharing infrastructure could bring immediate value. Three use cases were identified in this category. See Appendix C.5.1 for full details.
- **Strategic use cases** – those use cases that provide the future strategic potential of a data sharing infrastructure. Two use cases were identified in this category. See Appendix C.5.2 for full details.
- Given the breadth of these use cases, focus was directed to areas that could be explored in more in detail based on stakeholder feedback.

All five use cases were refined through iteration and testing with stakeholders.

The day 1 use cases were detailed further to understand the clear definition of how they would use a data sharing infrastructure to achieve a particular goal.

This meant it was possible to assess the extent of the contribution a data sharing infrastructure would make in achieving that use case.

The two strategic use cases were re-shaped to focus on a more confined problem statement against which a high-level evaluation of the use of a data sharing infrastructure could be made.

How use cases are described

Each use case explored has:

- **Problem** – the problem/pain point it addresses
- **Vision** – the successful outcome and goal
- **Key users** – the actors for whom there is value solving the problem
- **Functionality** – a description of how the problem can be solved and the goal achieved.
  - For the day 1 cases, this has been further detailed to understand the core functionality requirements.
  - Four core requirements have been highlighted for further assessment as part of R6 and R7 activities.
- **Day 1 contribution** – the way in which a data sharing infrastructure can enable the Day 1 use case.
- **Barriers and Dependencies** – what else will be needed to be addressed to unlock the value
- **Criticality** – assessment of the impact a data sharing infrastructure will have in delivering the use case.
  - **Enabler** – a data sharing infrastructure can be a viable component option for the overarching solution
  - **Key enabler** – a data sharing infrastructure is well positioned to be a key component part of the overarching solution
  - **Potential solution** – a data sharing infrastructure is well position to be core solution
- **Benefits** – the value the use case will bring. Where possible the value to the consumer is detailed (in red).

Prioritised use cases

Five prioritised use-cases based on the eligibility criteria, stakeholder preferences, and additional considerations

Use case	Selection rationale	Who is involved?	Impact Level	Complexity of exploration
Vulnerable consumer identification	High / urgent priority across majority of sector stakeholders	• Consumers • Gas	Highest Impact	Medium
Electricity market reforms - nodal pricing	High impact and strategic contribution to energy price decreases	• Network • Consumers • Local Communities	High Impact	Medium
Sector Coupling	Matches a data sharing infrastructure ambition Looks at entire power system Explores challenges and data from whole system operation	Across all Power systems • Electricity, Heat, Hydrogen, Gas	Highest Impact	Hard
LAEP & coordination of local decarbonisation planning	Explore city decarbonisation, transport electrification and heat network planning use cases Initiatives have already been launched with some local authorities and will support digital transformation	• Local Government • Network Transport • Heat/Hydrogen/ Gas	High Impact	Easy
Electricity flexibility	Explore core whole system challenge in detailed way	• Flexibility Service Providers • Consumers • Network	High Impact	Medium

Use case overview

Overview of the use cases explored and detailed

Type	Use case name	Use case goal	Core functionality			
Day 1	Vulnerable consumer identification	To provide a holistic and up to date view of vulnerability by facilitating the exchange and connectivity of data related to vulnerable consumers. To ensure this view is accessible for use at the right level of details needed to different parties to take appropriate actions.	Provide up to date access to vulnerability data owned across industries	Connect Vulnerability Information	Drive consistency and standardisation of information of vulnerability data	Streamline and leverage vulnerability self-disclosure
Day 1	LAEP & coordination of local decarbonisation planning	To use common input data and more granular level data to create better and more aligned decarbonisation plans. To enable easier coordination of local decarbonisation planning and actions.	Drive standardisation and interoperability of planning data used	Connect decarbonisation planning input data	Enable wider planning coordination	Enable wider planning coordination
Day 1	Electricity flexibility	To improve the timely exchange of information to better understand, use and incentivise the reliance on and provision of flexible assets	Create a Register of Assets	Improve visibility of flexible assets connected to the network	Facilitate sharing of real time operational data	Improve forecasting capability
Strategic	Electricity market reforms - nodal pricing	To enable the exchange of data needed to test the potential working of a future nodal market structure.	Simulation of system behaviour under new market structure			
Strategic	Sector Coupling	To enable to better forecast the demand for flexibility over time so that it will be possible to define how to integrate different energy system and the role they can play in a whole system operation of the power network	Enable to better forecast the demand for flexibility over time to model integration			

Use case summary of findings

Main observations emerging from the use case research

Emerging themes

Through the exploration of the use cases and stakeholder engagement activities, several observations and themes have emerged:

- A data sharing infrastructure should be equally a technological and a governance initiative, so that it can respond to the complex challenges around sharing of data.
- A data sharing infrastructure that was confined to the energy sector only would significantly risk the creation of further siloes across sectors and future abortive work.
- A data sharing infrastructure as an ecosystem for data sharing across the energy sector should be as simple as possible. It should avoid creating a barrier to entry for data providers, particularly in the requirement alignment to standards, and for actors with lower digital capability and reporting.

The value of a data sharing infrastructure

Through stakeholder interviews it was observed that the stakeholders found it difficult to clearly articulate the value of a minimal level data sharing infrastructure in relation to the problems they are trying to solve.

It was observed that stakeholders focused on the end functionality needed to solve a specific problem. For this reason, it is considered challenging to achieve and understand the proof of the benefit of a data sharing infrastructure if it is measured at a single use case level, or on a use case by use case basis.

The value of a data sharing infrastructure is realised by solving common challenges faced across several use cases. It is therefore recommended that a holistic approach for benefits is used, which considered whether it is better to solve each possible use case across the energy sector requiring data sharing in isolation or whether it is more effective to enable the missing foundational capability across the sector as a whole.

Observed currently un-met needs for data sharing

Through the stakeholder engagement activities several un-met needs for data sharing were observed:

- **A consistent way to facilitate the exchange of data classed as Shared and Closed data:**

  This is to facilitate exchange across multiple parties with a variety of access conditions, where the data will not meet the criteria to be published as open data.

  This is intrinsically depended on the creation of the right governance framework addressing data classification, access condition and licencing.

- **A way to facilitate interoperability (particular spatial and temporal) of key energy datasets related to asset, network, market, and trade:**

  These data sets enable a variety of use cases, and the correct governance will be required to unlock this.

- **A consistent robust mechanism to ensure the exchange of data with high security sensitivity, privacy and commercial sensitivity**

  For example: real time operational data, consumer data, trade data, etc.

C.5.1

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Prioritised:

Day 1 use cases

Day 1 use case – Vulnerable consumer identification

What is the use case trying to solve and for whom

Problem

Vulnerable people, who represent millions of households, are often disproportionally impacted by changes to their energy supply, whether these are policy, market, incident, or economy induced. It is currently very challenging to understand in detail the impact of changes across this segment of the UK population making it difficult to provide appropriate support, whether via policy design or other direct intervention.

This is mainly due to a lack of visibility and quality data around who is part of this group and how this might change over time. And, while several parties across industries collate information, efforts remain quite siloed and uncoordinated precluding a more complete understanding of the vulnerability picture to emerge.

Vision

To provide a holistic and up-to-date view of vulnerability by facilitating the exchange and connectivity of data related to vulnerable consumers. To ensure this view is accessible for use at the right level of details needed to different parties to take appropriate actions preventing mis-use.

Key users/actors

- **Energy Regulator** – Assess the experience of consumers in vulnerable situations and take action (e.g. regulation)
- **DNO** – Identifying vulnerable customer, support vulnerable customer during power cuts, refer and provide help with partners to address fuel poverty
- **Energy Supplier** – Identifying vulnerable customer, offer support, refer/help apply to support schemes
- **Advocacy Group** – Identify trends, campaign for change in policy and regulation to help vulnerable consumers
- **Vulnerable Consumer** – Identify and access help
- **Government / DESNZ** – Design policy to support vulnerable consumers, help target policy implementation, evaluate the impact of wider policy making on vulnerable consumers
- **Water industry** – Share data and coordinate storm response with the energy industry

Data needs

- Vulnerable Person Register
- PSR register (energy suppliers / network operators)
- Third party vulnerability and accessibility third registration services (e.g. Experian)
- ONS and census data (personal and household finance data (e.g. debt & expenditures), Household characteristics, Health and social care data, housing data, population data)
- Consumption data / meter data (pre-paid meter, smart meter data)
- Energy Supplier data (consumer behaviour, debt/arrears, tariff award data, social obligation
- DNO disconnection data, self-disconnection patterns
- Building stock data
- User consent
- Financial Information (e.g. credit score, affordability)
- Water Sector data (Water Companies and Ofwat vulnerability customer information, Water customers debt/arrears information)
- Healthcare Vulnerabilities information (e.g. NHS)
- DWP data (e.g. social surety information, income support scheme)
- Charity /third sector data
- Local Authority data
- Geographical risks and resilience data

Day 1 use case – Vulnerable consumer identification

What are the dependencies, barriers and benefits

Dependencies

The following dependencies are identified:

- An enhanced understanding of transient vulnerabilities and their implication so that this can be looked out for
- An enhanced understanding of the temporal dimension of vulnerabilities so this can drive better timely monitoring
- Policy making and regulation to support standardising, reporting and oversee use of information
- Clarity around cross-sector data sharing. The ICO has already provided guidance to support energy-water sharing.

Barriers

The following barriers are identified:

- Consumer trust and understanding around how, for what purposes and by whom their information is used
- Lack of clarity around the question of privacy, consent and significant public interests in relation to the sharing of personal sensitive information. This is found both across the general public and as well as actors across the energy sector.
- Potential and perceived potential for mis-use of information for service discrimination.
- Potential security risk if malicious actors access data.
- Poor data quality across many key data sources.
- Potential difficulties to align the view and needs of numerous stakeholders.

Benefit achieved

The following benefits are achieved. Those highlighted red have a potential direct consumer impact.

- Access to cross sector data to provide more holistic and more timely view of vulnerabilities
- Bring together data to target more effectively the application of interventions (e.g. LA energy efficiency schemes, pre-paid meter exemptions).
- Compensate the current over-reliance on vulnerable consumer self–reporting
- Resource efficient vulnerable consumer identification
- Drive better understanding of vulnerability (pattern, causes, impact)
- Bring more transparency around vulnerable consumer treatment and better enforce delivery of support on offer (e.g. tariff data vs PSR)
- Predict potential escalation to provide timely outreach or support (e.g. bill shock, energy rationing)
- Enable better accessible communication and outreach for vulnerable customers to make informed decisions
- Grow consumer trust via appropriate and transparent use of their information

Day 1 use case – Vulnerable consumer identification

How can the use cases will be delivered

Core functionality required	Day 1 contribution		Criticality
Provides up to date access to vulnerability data owned by multiple actors across different sectors. • Facilitate the exchange of data across sectors • Allow for aggregated or anonymised data to be shared	Deploy data preparation node	• Data Provider implements a node to make data available for sharing • Actor outside the energy sector can become data providers	**Potential solution** A data sharing infrastructure could be the best suited mechanism to consistently and timely share data about vulnerable consumer across sectors. Other approaches such as third-party centralised collection from all organisations could prove too resource intensive, and time consuming with higher security implication.
	Access the Data	• Timely access granted in accordance to defined access and licencing conditions	
	Publish data for sharing	• Data Provider retain granular control of how their information is shared (e.g. restriction to partial set of data, use selection of privacy enhancing technology)	

Day 1 use case – Vulnerable consumer identification

How can the use cases will be delivered

Core functionality required	Day 1 contribution		Criticality
Connect Vulnerability Information • Facilitate the understanding of available information about vulnerable consumer • Support the mapping and joining of information from multiple sources (temporal, geographical) • Connect vulnerability data to form a holistic picture	Align data to minimum operable standard	• Data Providers aligns a minimum set of metadata (description, temporal, geographical tags) and aligns to a data standard(s) before sharing the relevant data.	**Enabler** A data sharing infrastructure can drive the interoperability of existing relevant data by promoting best practices in relation to metadata provided, and by use of minimum standard in relation to the definition of vulnerabilities, expression of geographical and temporal information and other(s). However, services from third parties will need to be relied upon to aggregate and map the various data sets into a holistic view of vulnerability.
Drive consistency and standardisation of information • Promote adoption of standards, leading to understanding of vulnerabilities among consumers	Align data to minimum operable standard	• Promotes the alignment of minimum operable standard in relation to vulnerable consumer information (e.g. PSR).	**Enabler** A data sharing infrastructure can create interoperability across information shared by multiple parties. Consistency and standardisation could be achieved, and further enhancements through other types of interventions such as cross-sector policy making, legislative intervention to standardised vulnerability data, and reporting or governance interventions to create better cross-sector consistency.

Day 1 use case – Vulnerable consumer identification

How can the use cases will be delivered

Core functionality required

Streamline and leverage self-disclosure of vulnerability data.

- Allow consumer to make vulnerability disclosure once rather than across multiple organisations
- Deliver simple and clear communication about how the data sets will be used, and what the data set will be used for.
- Allow consumer to set sharing preference (organisation & level of details)
- Gives consumer sharing preferences to encourage data sharing

Day 1 contribution

Publish data for sharing	• The Data Provider(s) use the data preparation node to select access requirement, privacy enhancing technology, and data sharing condition.
Access the data	• Consumer preferences can be used to set access control settings.

Criticality

Enabler

A data sharing infrastructure could contribute to sharing of data sets by providing access to up-to-date information to all Data Consumers. However, its contribution would be depended on the existence of enhanced self-reporting external solutions available vulnerable consumers. This might take different form:

- **Option 1 -** A party (service provider, gov, advocacy etc.) builds a service to allow customer to make all disclosure in one place.
- **Option 2 -** Any Data Provider that offers self-reporting services enhance their offer to communicate wider data sharing arrangement benefit to customers and provide convenient data collection preferences.

With Option 1 the service provider could also deliver the sharing functionality without support from a data sharing infrastructure.

ARUP CATAPULT Energy Systems UNIVERSITY OF BATH

Day 1 use case – LAEP & coordination of local decarbonisation planning

What is the use case trying to solve and for whom

Problem

Across the UK local areas, there are several actors influencing the transition of an area's energy system to net zero. Over 300 local authorities have set out to create Local Area Energy Plans (LAEPs) with no standard methodology, assumption or data input across individual efforts. While DNOs work on Distribution Future Energy Scenarios and national initiatives such as the Heat Networks Zoning project look to identify where best in the country to deploy certain interventions.

All of these efforts require collation of a lot of data from a multitude of sources and parties. However, efforts do not build from a common 'local' data baseline but from different data sources aggregated to understand the local picture. Data is also often only available at national level with little updates preventing users from forming detailed understanding of the local picture.

Vision

To use common input data and more granular level data to create better and more aligned decarbonisation plans.

To enable easier coordination of local decarbonisation planning and actions.

Key users/actors

- **Local Authority** – Set out the change required to transition their local energy system to net zero and attract investment.
- **Government / DESNZ** – Support decarbonisation planning through different initiates at different scales (locally via LEAP, Heat network zoning nationally etc.).
- **Ofgem** – Review the current regulatory and governance arrangement to support effective planning and delivery of decarbonisation.
- **DNO** – Outline the future growth of the network and how and where it needs to open up capacity.
- **Consultant** – Commissioned by Local Authorities to support in the delivery of LAEP, as they often do not have the in-house capacity to do so.

Data needs

- Electricity Distribution Network data (e.g. grid congestion, capacity, grid reinforcement)
- Gas distribution network data (e.g. potential and location for electrification)
- Energy demand data
- Government Data
- Distribution Future Energy Scenarios (DFES)
- LAEP data (incl. progress data e.g. Energy efficiency measures)
- Building stock data (e.g. Demand, Heat demand & waste profile, Building typology, Location, Energy intensity)
- Local Planning Data
- Local Consultation Data
- Socioeconomic data
- Carbon emissions
- National datasets (e.g. Fuel poverty, Domestic intensity by property type, Total gas emission published annually)
- Consumer data (e.g. Smart meter)
- heat Network data & supply data (e.g. HN zone modelling)
- Transport data
- Air quality
- EV and HP/HV data

Day 1 use case – LAEP & coordination of local decarbonisation planning

What are the dependencies, barriers and benefits

Dependencies

The following dependencies are identified:

- Policy or industry actions are needed to deliver the standardisation of planning methodologies (LAEPs) and alignment of different decarbonisation planning with impact on a local level (e.g. LAEP, DFES, Heat Network Zoning).
- Clear governance is needed to provide accountability for wider coordination of decarbonisation planning efforts. The Ofgem recent Regional Planning System Planner consultation looks to address this, and other initiatives are present across this space (such as Ofgem Heat Network market regulation)
- Clarity around the requirements of stakeholders to carry out local decarbonising planning will be needed. LAEP are not mandatory, their overall target and reporting requirements are not set. This could lead to different levels of understanding around decarbonisation opportunities and progress across different areas of the country.

Barriers

The following barriers are identified:

- Quality of certain data is low. Particularly where data collection relies on engagement with local stakeholders (e.g. building owners, industry). Additionally, local actors (e.g. LA) have a lack of capacity to collect the information needed (it can take up to 2 years)
- Access to data at the preferred granularity is not available, in cases this is not aggregated or anonymised in a way that could enable sharing.
- Sharing data at lower granularity (e.g. actual demand and meter data) raises risks and concerns around confidentiality, commercial advantage, and security.
- Some data is not consistently available across different geographies as sharing of data that is not open is driven by the organisation that holds it and their relative engagement and capacity.
- Gap of knowledge and awareness across the sector of potential interdependencies and the impact of decarbonisation interventions is prevents further data sharing (e.g. impact of heat for balancing)

Benefit achieved

The following benefits are achieved. Those highlighted red have a potential direct consumer impact.

- Easier access to standardised decarbonisation planning input data will save stakeholders (such as LAs) substantial time and financial resources currently spent on external data collection
- Bringing together data will enable a suitable body (such as potential future Regional System Planner) to coordinate plans more effectively and would allow for more dynamic coordination
- Enabling the sharing of more dynamic data sources will allow better understanding of the local realities and maximise the local impact of interventions
- The consumer will be able to better understand the impact of proposed intervention and make informed choices on how to take action or contribute

Day 1 use case – LAEP & coordination of local decarbonisation planning

How can the use cases will be delivered

Core functionality required	Day 1 contribution		Criticality
Drive standardisation and interoperability of planning data used • Align similar datasets from different organisation (LA, DNO) to a minimum operable standard • Align key data entities across different datasets to a set standard (e.g. building typology)	Align data to minimum operable standard	• Data Providers aligns a minimum set of metadata (description, temporal, geographical tags) and aligns to a data standard(s) before sharing the relevant data.	**Enabler** A data sharing infrastructure can drive the interoperability of existing relevant data by promoting best practices in relation to metadata provided, and by promoting the use of minimum standards in relation to coordination of local decarbonisation planning, expression of geographical and temporal information and more. However, services from third parties will need to be relied upon to aggregate and map the various data sets into a holistic view of decarbonisation planning.
Enable wider planning coordination • Bring together decarbonisation plans outputs (LAEP, DFES etc..) at regional level and make them available for sharing across other actors • Provide access to the plans' input data • Enable re-run of planned scenarios or live planning and evaluation of scenarios based on latest available input data • Spot dependencies or clashes between data sets • Capture progress to various initiatives	Access the data	• Data Consumer can use standard consistent way (API) to access data and capture future updates or revisions to the relevant data.	**Enabler** A data sharing infrastructure can facilitate the sharing of decarbonisation plans and input data so that these are visible to chosen stakeholders. However, purposeful build third party services will be needed for anything further, such as re-run of scenarios, live planning, and detection of clashes. This third party could also be well placed to enable sharing of the data.

Day 1 use case – LAEP & coordination of local decarbonisation planning

How can the use cases will be delivered

Core functionality required	Day 1 contribution		Criticality
Connect decarbonisation planning input data • Facilitate the mapping and joining of data from multiple source at different level of granularity (e.g. spatial) and anonymity • Connect to aggregated or anonymised view of dynamic data sources • Create an up-to-date baseline of decarbonisation planning input data which stakeholders can access and use	Align data to minimum operable standard	• Promote the alignment of minimum operable standard	**Enabler** By enhancing the interoperability of the data, the data sharing infrastructure can facilitate easier connection of data to form, for example, locally relevant view of data or stitch together locally confined data to create a more extended picture. However, services from third parties will need to be relied upon to provide this aggregation and mapping. In doing so, some of these third parties could also be well placed to connect to multiple data sources and provide data wrangling to make data interoperable as part of their service offering.
	Access the Data	• Access to data is in line with access and licencing condition set by the data provider	
	Publish data for sharing	• Data Provider retain granular control of how their information is shared (e.g. restriction to partial set of data, use selection of privacy enhancing technology) • Data Provider sets data sharing condition and clarifies licencing terms	

Day 1 use case – Electricity flexibility

What is the use case trying to solve and for whom

Problem

Current costs of balancing the UK electricity grid are dramatically increasing. Enabling a flexibility mechanism is key to reduce the overall cost to the system. While different flexibility options are available to address variability at different timescales, higher flexibility is now becoming essential particularly as power systems integrate higher shares of renewables. In order to plan, operate and run effective markets for a more flexible energy system vast amounts of data is needed.

Data availability, granularity and access is a core problem encountered when looking to understand the flexibility capacity available at a given point in time and how to best deploy it (visibility of relevant assets being a key blocker). Lack of data sharing also hinders the effectiveness of forecasting leading to less confidence in procuring flexible assets.

Vision

To improve the timely exchange of information to better understand, use and incentivise the reliance on and provision of flexible assets.

Key users/actors

- **ESO** – Optimally balance the grid to facilitate security of supply at the lowest sustainable cost for customers, while enabling the transition to net zero.
- **DNO** – Optimally operate their network and increase the participation and volume in the local flexibility market
- **Flexibility Asset Owner** – Understand where to make investments & likelihood of service being used.
- **Aggregator** – Create product for the market, gather necessary assets, provide large-scale connections between assets, and deliver flexibility to operators.
- **Energy Supplier** – Supply energy to consumers, offer flexibility services, and ensure the network can support consumers' needs.
- **Consumer** – Support more sustainable running of the grid whilst monetising the willingness to flex energy demand & consumption.
- **EVs provider** – Understand where best to invest, be able to forecast returns to customers.
- **Tech platforms** – Support flexibility providers, aggregators, DNO and ESO.

Data needs

- Network data across transmission, distribution and low voltage network (connection data, demand and constraints forecast data, planning data, current constraints and congestion data, system 3-phase saturation, inertia, power flow analysis data, capacity and outage data, historical network data, cost, carbon, security, stability and resilience, power factor, line Asset data (voltage measurements, voltage spikes)
- Key characteristics, location, time to deployment, energy profile usage consumption, load profile, closeness to full operational capacity, metering data (30 min, 10 sec, 1 sec intervals), current status (energy consumption, inertia produced etc..), charging profile (EV))
- Energy demand & supply (e.g. forecast, energy generation mix)
- Market data (financial data, trade data, settlement and dispatch data, Energy cost and availability for a range of energy demand (fixed and flexible), i.e. vehicles, heating and classical demand
- Consumer data (Customer consent, smart meter data, behaviour)
- Local planning data
- Data standards

Day 1 use case – Electricity flexibility

What are the dependencies, barriers and benefits

Dependencies

The following dependencies are identified:

- Standardisation and clarification of asset information requirement needs to happen to increase availability, quality and granularity of data exchanged. Several initiatives are under way, such as Automated Asset Register, DER Information Implement plans, and evaluation of adoption of PAS1878 for smart appliances data exchange.
- Markets for flexibility services need further development, coordination and standardisation. Several initiatives are under way, including Ofgem's Call for Input of Distributed Flexibility, and ENA's Open Network project. Their development, roles of actors, and coordination will better inform the barriers that need addressing for data sharing.

Barriers

The following barriers are identified:

- Operational data and asset data linked to market operation can be very sensitive for national security, competitive/commercial interests, IP, privacy & GDPR, and legal challenges.
- Large sets of data exchanged can increase the risk of potential de-anonymisation or disaggregation of data through dataset combination.
- Requirements for real time exchanges might be too demanding for a small provider/player who might not participate.
- Time to define / put in place data sharing agreements
- Current ESO reliance on excel data transfers and current balancing system is not able to cope with the high volume of data from flexible assets
- Very limited availability of low-level voltage network data due to old infrastructure not being metered. Small connected assets are not visible.
- Collection of consent is very difficult
- Alignment on regulations, data quality and knowledge of the energy sector will be needed between old and new actors in the sector.

Benefit achieved

The following benefits are achieved. Those highlighted red have a potential direct consumer impact.

- Prepare to leverage the scale of potential future flexibility (35m EV chargers, 30m. Heat pumps, 100m smart white goods)
- Improve forecasting ability will allow for more confidence in deploying flexible services as behaviour of assets gets better understood.
- Reduce the system cost. E.g., better understanding of flexible services can translate into meaningful reduction in reserve procurement. Understanding demand shift opportunities can avoid curtailment
- Consistency of data sharing between DSO and ESO ensures more robust forecasts and processes that will directly contribute to improving flexibility market operation and making it easier for flexibility service providers to participate in the flexibility market
- Consumers have bigger opportunities to provide their flexibility to the grid and be rewarded for it.
- Potential to unlock storage capacity of EV batteries.
- Access to consistent data will streamline flexibility reporting as well as make it more accessible.

Day 1 use case – Electricity flexibility

How can the use cases will be delivered

Core functionality required	Day 1 contribution		Criticality
Create a Register of Assets • Standardisation of registration requirements, and of unique identifiers for asset identify • View of the registered asset	Access the data	• Data is accessed in a consist way (API).	**Enabler** A data sharing infrastructure could support the surfacing of asset information in a consistent way. However, registration and storage of asset information would be carried out by third party services such as the automatic asset registration programme (AAR). The AAR aims to support the development of a data exchange process for registering small-scale energy assets & accessing small-scale energy asset data.
Improve visibility of flexible assets connected to the network • Facilitate the identification and search of assets (e.g. spatially) • Provide consistent way to access to associated asset information (e.g. to enable planning, operational and market use)	Align data to minimum operable standard	• Promote the alignment of minimum operable data and metadata standards.	**Enabler** Through alignment to minimum operable standards (e.g. around metadata) and consistent surfacing of asset information (e.g. via common API), a data sharing infrastructure can promote better visibility of connected assets. However, a search or view function could well be supported by third party services rather than the core data sharing infrastructure itself. Furthermore, improved visibility of assets connected is intrinsically linked to efforts of mapping current networks where big information gaps exists (e.g. low voltage)
	Publish data for sharing	• Data sharing condition are applied before data is available for sharing.	
	Access the data	• Data is accessed in a consist way (API).	

Day 1 use case – Electricity flexibility

How can the use cases will be delivered

Core functionality required	Day 1 contribution		Criticality
Facilitate sharing of real time operational data • Harmonise and enable mapping and joining of operational & market data (e.g. temporally, spatially e.g. GSP level) • Enable sharing of real time operational data (e.g. asset status data) at required time intervals and granularity • Enable exchange of aggregated or anonymised view of dynamic data sources	Align data to minimum operable standard	• Promote the alignment of minimum operable data and metadata standards.	**Potential solution** A data sharing infrastructure could be well suited to enable consistent sharing of interoperable operational data across multiple stakeholders, and accordingly set varying degree of access and usage conditions. Legal input will be essential to reduce legal friction around licencing and ensure lawful exchange of this data (privacy, security, commercial sensitivities).
	Publish data for sharing	• Data Providers use a data preparation node to define access requirement, privacy enhancing technology, and sets data sharing condition.	
	Access the Data	A data sharing infrastructure enables real-time data sharing.	

Day 1 use case – Electricity flexibility

How can the use cases will be delivered

Core functionality required	Day 1 contribution		Criticality
Improve forecasting capability • Enable mapping and joining of data from multiple sources • Enable exchange of granular anonymised data sets • Enable better understanding of flexible assets behaviours • Enable demand forecasting at GSP level • Enable forecasting of future demand for flexibility	Align data to minimum operable standard	• Promote the alignment of minimum operable data and metadata standards	**Enabler** A data sharing infrastructure could be well suited to enable consistent sharing of forecasting data. However, forecasting functionality will need to be met by a third-party solution. Upskilling/growth of forecasting capabilities will be needed to drive real change in the deployment of flexibility service, and to better understand assets behaviour and asset potential in enabling flexibility.
	Publish data for sharing	• Data Providers use a data preparation node to define access requirement, privacy enhancing technology, and sets data sharing condition	

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Prioritised:

Strategic use cases

Strategic use case – Electricity Market Reforms (nodal pricing)

What is the use case trying to solve, its dependencies and barriers

Problem

To ensure fair pricing and reflect the real cost of energy, the UK Government is reviewing the electricity market and is considering reforming the market design (REMA). One of the potential designs under consideration is a nodal pricing structure. Nodal pricing refers to a market in which energy prices are determined for multiple locations on the transmission grid, called nodes. Therefore, the price of each node would reflect the locational value of energy.

Nodal pricing will require a level of data exchange that is currently not present across the sector. Current lack of availability and visibility of data about network performance and trade at a granular level (e.g. GSP), demand, cost and generation would prove insufficient to reflect more accurately the cost/price of power at a given node.

Vision

To enable the exchange of data needed to test the potential working of a future nodal market structure.

Dependencies

Without further definition of how the market might work (e.g. dispatch decision, roles of market participants), it is highly challenging to determine future data needs and therefore assess the potential impact of a data sharing infrastructure.

Barriers

- No register of trade exists, data is not standardised, and data is locked in old legacy systems.
- Lack of an asset register.
- Trade data is commercially sensitive. Trade data if lost can pose a CNI risk as it can be used by malicious actors to manipulate the market.
- Scale of market change would require high-level of intervention. Unclear if central actors would be capable of driving the data standardisation needed to support that (across transmission and distribution networks, energy suppliers, traders).
- No clarity around dispatch models to apply (more central dispatch or de-centralised/self-dispatch). The latter might require less resource and be less data intensive; therefore, become more achievable.

Key energy users/actors

- **Energy suppliers** – Trade their energy production and demand.
- **Traders** – Buy and sell shares of energy stock.
- **Industry association** – Advise customers and look after their members. They provide support on retail, regulation, finance and future market design.
- **ESO** – Procure energy across markets to meet demand.
- **Government** - *Input pending*

Data needs

- Trade data (e.g. how much is bought)
- Supplier information
- Network information (GSP / node data, where energy is bought v demand)
- Supplier's Energy wallet information (What it consists of, type of component trade, how assets would be dispatched)
- Asset information (Speed, Volume, cost, historic data)
- Node information
- Customer data
- Generation data
- Demand a supply data

Strategic use case – Electricity Market Reforms (nodal pricing)

How can the use cases will be delivered

Functionality required

Simulation of system behaviour under new market structure

- Facilitate sharing of grid supply point data (energy brought vs demanded and deducted, supplier wallet information, trade made/declaration, energy mix).
- Facilitate the understanding of the grid network (for a given node, what sort of node is it connected to and what the connection looks like).
- Develop a live understanding of the grid as this is currently operated*. Share assets' live performance and trade outcomes in real time.
- Model the potential re-distribution of assets dispatch at a node based on trade data and demand, compare with historic actions and test system stability.
- Model potential decision tree for dispatch at a node to test for flexibility of different dispatch models.

** See the Electricity Flexibility core functionality - Facilitate sharing of real time operational data*

Contribution & criticality

Through alignment to minimum operable standards (e.g. around metadata) and consistent timely surfacing of asset, trade, GSP and energy generation mix information (e.g. via common API), a data sharing infrastructure can be the best suited mechanism to provide the vast amount of data needed to simulate the energy system behaviours under a new nodal market structure.

However, simulation functionalities will need to be built by a third party rather than a data sharing infrastructure itself. Furthermore, the outcome will be dependent on the quality of the data used which currently has little levels of standardisation.

Benefit achieved

The following benefits are achieved:

- Bring understanding of potential effectiveness and challenges of a new pricing model.
- Help understand how the new model could increase transparency of dispatch design making, boosting market confidence and investment.
- Potentially provide higher transparencies and opportunity to provide innovative services to consumers.
- Provide visibility of different datasets which create opportunities to test varied electricity market reform approaches.
- Benefits in other areas such as investment planning and operations.

Strategic use case – Sector coupling

What is the use case trying to solve and for whom

Problem

The increasing share of renewable energy has added volatility and uncertainty to power system operations. While utilising flexible services may help solve the problem, this might not be sufficient. Sector coupling, which integrates production, consumption, conversion, and storage of energy by connecting various energy domains (e.g. heat, hydrogen, gas) could potentially meet the energy needs while reducing uncertainty and volatility, generation of surplus energy and unnecessary carbon emissions.

While access to vast amount of data needed is needed to enable the process of integrating various energy systems/domains to match demand and create a more integrated and carbon neutral flexible energy system, it will be critical to understand first for what purposes and in what instances these systems should come together. This will determine the level of integration and information exchange that need to happen for different energy networks to be planned for and operated in an integrated manner.

An overview of potential integration and their challenges.

Potential integration and associated challenges

Electricity & Gas
Gas and Electricity networks are largely two independent systems (e.g. different assets, management) but with connections (gas power station) and overlapping functions to an extent (both provide heat). The networks have been kept quite separate albeit they can interact in case of need (e.g. avoiding both systems being down at the same time). More interaction and exchange of data around forecasting of demand and long-term planning is needed to drive optimisation as well as manage the gas networks future planned decline.

Electricity & Heat
Currently, the network infrastructure planning across the various electricity networks and heat networks is not coordinated. The key ambition is to have more heat networks and heat pumps on the system for their ability to change the short run marginal cost as well as the long run marginal cost of the electricity network as these assets can support balancing and constraint management. It will be key to understand the expected role of these assets in providing so that the system can be shaped effectively (single assets or full heat network system).

Electricity & Hydrogen
These networks have two big touch points, i.e. hydrogen can fuel a power station and through electrolysis can store electricity by transforming this into gas/hydrogen. The process of electrolysis is currently the only known way to convert into storage effectively large terawatts of energy that might be on the system and go unused. This is particularly relevant as the UK energy system is on the trajectory of becoming very wind dominated. Hydrogen could store large excess of production to be reconverted when wind is down for long period. However, to enable this, there is the need for a hydrogen network to be created to transport, store, and use hydrogen. As operational and commercial arrangements of a hydrogen transport system are yet to be decided, it is unclear if/when the needed investment will be made (albeit initiatives such as hydrogen to heat might start to create the basis for distribution network needed).

Vision

To enable to better forecast the demand for flexibility over time so it will be possible to define how to integrate different energy systems and the role they play in a whole system operation of the energy networks.

Strategic use case – Sector coupling

What is the use case trying to solve and for whom

Key users and actors

- **ESO** – Plan on how to operate the grid in future at lowest sustainable cost and the future option available to balance the grid going forward.
- **DNO/GDNO** – Plan for medium and long-term optimisation of the system and increase shares of renewables in their network.
- **Ofgem** – Need to enable future regulations and standardisations between actors.
- **Heat Network Operator & Hydrogen Project Investor** – Understand how best to invest/expand and how their service might be utilised.
- **Gas Networks** – Plan how to operate the gas network and how this will transform in future.
- **Storage** – electricity, hydrogen and gas storage actors.
- **Government / DESNZ** – *Input pending*

Dependencies

Stronger steer and endorsement in relation to future development of some of the energy networks is needed, alongside their development to be able to assess the impact of a data sharing infrastructure.

Barriers

- Insufficient standardisation, availability and sharing of data across the sector hinders better forecasting.
- Forecast capability need further development to be able to include flexibility of demand.
- Scale of change needed to achieve the needed level of interoperability. However, there is currently no clear individual body/organisation setting the direction of what standards could look like.
- Security requirements will have to be looked at closely as moving toward a more integrated whole system, even if just starting with forecasting, increases the exposure to risks.
- Currently multiple decarbonisation trajectories are possible, which is limiting the ability of actors to take strategic decisions.

Data needs

- Electricity network data
  - Energy Demand forecast,
  - Operational data
  - Asset data
  - Market data
  - Flexibility services data
- For other networks:
  - Planning data,
  - Asset data,
  - Market data (where it exists)
  - Operation data (where it exists)
- Other sector data (e.g. water, transport)

Strategic use case – Sector coupling

How can the use cases will be delivered

Functionality required

Enables the better forecasting of demand for flexibility over time to model integration

- Facilitate the sharing of information to forecast future demand for flexibility on the electricity network from immediate, 30 mins-6 hours, day ahead, medium and long term*.
- Facilitate the exchange of operation and asset information across network to support modelling and evaluation of integration option.
- Forecast demand.
- Model integration scenarios.

** See the Electricity Flexibility Detail Day 1 use case - Improve forecasting capability.*

Contribution & criticality

A data sharing infrastructure can enable the sharing of the vast amount of data sources needed to better forecast the demand for flexibility (see use case Electricity Flexibility).

Through promoting alignment to minimum operable standards, a data sharing infrastructure can also further the interoperability of this data.

However, to both forecast and to evaluate the best ways and scenarios for wider integration across different energy systems other technical solutions need to be sought.

To achieve this, wider interoperability and data standardisation needs to be achieved across all different networks.

The scale of the modelling challenge might only be possible to address by starting with looking at single network integrations (e.g. use case electricity to heat, electricity to hydrogen).

Benefit achieved

The following benefits are achieved:

- Better understanding of the further flexibility needs will enable to assess the level of integration needed across different energy systems and how some of these should be developed to support that. This can then unlock policy, decision making and investments into the develop of a Carbon-Neutral Power Systems.
- Migration toward a more stable a less volatile Carbon-Neutral Power Systems able to deal with higher influx and use of renewable energy and flexibility services will result in a more reliable and cost-effective energy system for the consumer. It will also enable consumers to play a more active role in the energy system.
- Improved decision making and operational benefits if overall sector coupling is achieved.
- Benefits in other areas such as investment planning and operations.

Appendix D

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Learnings from other data sharing infrastructures

Learnings from other data sharing infrastructures

An overview of real-world case studies of ‘digital spine’ implementations

Overview

As the world moves toward a more digitally connected and data-driven future, the concept of a "digital spine" has emerged as a critical foundation for various sectors.

A digital spine sometimes refers to an integrated data sharing infrastructure that enables the seamless flow of information, data, and services across an entire sector.

This appendix outlines experiences and key learnings from real-world case studies of ‘digital spine’ implementations in different sectors, namely:

- Open Banking
- National Programme for IT in the NHS
- NHS Digital Spine
- Skywise
- Estonia’s X-Road
- Defence digital ‘backbone’
- Australia: energy system
- Singapore: digital twin for national power grid

Key learnings

Project management:

- **Competent leadership** – Crucial for large projects, requiring knowledgeable leaders who understand the issues, goals, market, and users.
- **Careful planning** – Developing a realistic timetable, conducting sufficient preliminary work, engaging stakeholders, and having an exit strategy can mitigate system-wide failures and address stakeholder opposition.
- **Multicourse procurement** – Offers flexibility and contingency for long-term contracts.
- **Agile working** – Regular assessment and correction of the project's direction ensures adaptability and enables early feedback through the iterative development of minimum viable products (MVPs).

Stakeholder engagement:

- **Stakeholders as designers** – Engaging key stakeholders in the design process and promoting collaboration is crucial, particularly in the energy sector with its diverse stakeholders who would benefit from the spine.
- **Regulatory input** – Encourage stakeholder participation through guidance and support.
- **Designing for adoption** – Prioritising user adoption is vital to identify use cases and strengthen stakeholder engagement in the energy system data sharing infrastructure.
- **Upskilling** – Providing opportunities for workforce upskilling ensures seamless adoption of a data sharing infrastructure in the energy sector.

Technical implementation:

- **Open-source solutions** – Offers lower licensing costs, flexibility, and community innovation. Open APIs can accelerate contributions from small innovators.
- **Cloud-based solutions** – Provide increased flexibility, reliability, performance, efficiency, and lower IT costs.
- **Distributed data storage** – Can avoid migration challenges, ensure data availability, and minimise security breaches.
- **Secure from the ground up** – Crucial for authentication, authorisation, integrity, and confidentiality in the energy system data sharing infrastructure.

Case study: Open Banking

Review of real-world 'digital spine' implementations

Overview

Open banking is a financial services term that refers to the use of open APIs that enable third-party developers to build applications and services around the financial institutions.

Open Banking was initiated to make finance more competitive - ending the dominance of banks and allowing new innovators the chance to improve services for the customer. After the 2013 European Commission's revised Payment Service Directive, the UK Treasury announced its commitment to delivering an open standard for APIs in UK banking, to help customers have more control over their data and to make it easier for financial technology companies (FinTech's) or other businesses to make use of bank data on behalf of customers in a variety of helpful and innovative ways.

Today at least 87% of countries have some form of Open API with different countries at different stages. The UK is one of the countries leading the way in open banking innovation and consumer uptake. As of January 2021, more than 2.5 million UK consumers have used open banking-enabled products.

Extracts of the research for this case study are referenced in the VirtualES Benchmarking Report.

Benefits & Costs

Open banking demonstrates that creation of cross sector data sharing is not solely a technological problem. The open banking initiative has enabled sector wide data sharing without developing new technology of its own and in its place creating the framework and standards which enable others to develop their own interoperable sharing protocols.

Open Banking has been successful in securing positive outcomes for consumers and small businesses. The ecosystem now extends to more than 330 regulated firms made up of over 230 third party providers of services and more than 90 payment account service providers who together account for over 95% of current accounts.

As of 2019, the nine largest banks in the UK have invested £81.1 million in the Open Banking Implementation Entity (OBIE), the organisation responsible for implementing the government's open banking initiative. Funding needs for the OBIE increased from £28.1 million between October 2016 and December 2017 to £38.8 million in 2018. Costs for the project have continued to rise, with £14.2 million spent in the first four months of 2019.

Lesson learned

Resistance to Change: The mandated transition to open banking caused friction in the industry as banks had to invest in upgrading their IT systems. However, these upgrades were already necessary due to other regulatory developments and technological advancements. The energy sector is currently undergoing a significant transformation which will inevitably see resistance from industry stakeholders who must invest in upgrading their infrastructure and adapting their operations.

Reaching Consensus: The energy sector involves multiple stakeholders, including government entities, energy providers, consumers, and environmental organisations. Building consensus among these diverse groups is crucial for implementing new initiatives, such as renewable energy projects or grid modernisation efforts. Engaging the right stakeholders, facilitating dialogue, and considering their perspectives are essential to drive meaningful change in the energy sector.

Regulatory Input: The involvement of regulators is essential. The presence of the Treasury as an observer during the framework formulation actively encouraged stakeholder participation, providing guidance and support. In the case of the UK energy sector, this role should be taken by OFGEM.

Case study: National Program for IT (NPfIT) in the NHS

Review of real-world 'digital spine' implementations

Overview

The National Program for IT (NPfIT) in the National Health Service (NHS) was the largest public-sector IT program ever attempted in the UK, originally budgeted to cost approximately £6 billion over the lifetime of the major contracts, later revised to £9.8 billion *(The Guardian, 2013)*. These contracts were awarded to Accenture, CSC, Atos Origin, Fujitsu, BT, and others.

The goal was to revolutionise the use of digital technology in healthcare by implementing electronic records, digital scanning, and integrated IT systems across hospitals and community care *(The Guardian, 2013)*. However, the project encountered numerous challenges and ultimately became one of the most costly and disastrous contracting failures in the history of the public sector.

In September 2011, it was announced that the project would be dismantled. However, the component parts were kept in place with separate management and accountability structures.

Reasons for failure

The failure of the NHS digital spine can be attributed to inadequate evaluation of risks and benefits, lack of considered plans, poor management, and lack of an exit strategy. Insufficient support from key stakeholders, particularly clinicians, led to significant stakeholder resistance.

Additionally, the project's ambitious and rushed nature, combined with the need for adaptive changes and technological advancements, contributed to its systematic failure *(Campion-Awwad et. al., 2014)*.

The lack of systematic learning from past IT disasters was evident. Concerns about centralising healthcare information *(Tonks, 1993)* and data aggregation *(Anderson, 1995)* were raised, cautioning against a rushed approach. Despite these warnings, the Prime Minister opted for a radical change instead of addressing core issues and learning from past NHS IT failures *(Brennan, 2002)*.

However, government eventually recognised the shortcomings and shifted towards a more plural supplier base, allowing Trusts to choose their systems and potentially saving £700 million *(Department of Health, 2010)*. This change reflected the understanding that centralised IT schemes imposed on semi-autonomous sites rarely work effectively.

Haste: Policymakers and program managers rushed into policymaking, procurement, and implementation, overlooking stakeholder consultation and confidentiality concerns. This resulted in unrealistic timelines, limited user engagement, and inadequate preliminary work without proper monitoring or exit strategies.

Design: The government pursued an ambitious and unwieldy centralised model to cut costs and facilitate quick adoption at the local level. However, this approach ignored the risks and limitations of large IT projects, lacked flexibility for new technologies, became difficult to manage, and raised confidentiality issues, stifling community innovations.

Governance: Failure to document and learn from digital implementations impeded progress and led to repetitive mistakes. National governance arrangements for NHS digital transformation became confusing, with unclear responsibilities at both national and local levels.

Culture and Skills: NPfIT suffered from a lack of direction, project management, and an exit strategy, causing system-wide failures. The project experienced a lack of clear leadership, constantly shifting goals, project control failures, and high costs due to poorly written specifications.

Case study: National Program for IT (NPfIT) in the NHS

Review of real-world ‘digital spine’ implementations

Lessons learned

The failure of the NHS spine allows the energy sector ‘spine’ to learn in the following areas:

Right Leaders: Projects of such magnitude, like an energy system digital spine, require leaders who understand the issues, end goals, market, and key users. The decision-makers should possess the necessary expertise and knowledge to competently guide the project in the right direction, recognise pitfalls and risks, and take swift action to rectify critical issues.

Stakeholder Engagement: Projects should be viewed as a broader process to deliver business benefits, requiring engagement with stakeholders to understand concrete benefits and potential user issues and ensure the legitimacy of potential solutions. This is of particular importance in the energy sector given the diverse array of stakeholders and possible use cases for a digital spine.

Balancing Risk and Reward: Contracts involving long-term relationships should balance risks and rewards. A hyper-aggressive approach to supplier management can be counterproductive, leading to high-risk absorption and potential failure of service providers.

Start Slow to Run Fast: The aim of starting slow is to allow the energy sector to thoroughly explore alternative approaches and build understanding around the extent of the challenges in a restricted number of applications. The learnings from this initial phase can then be used to gradually roll out the whole range of applications. Rushing into contracts without sufficient planning can lead to scope ambiguity and the need for change orders. Diligence and clear program aims should not be sacrificed for haste.

Multisource Procurement: Innovative structures, like awarding work to different service providers, can enable flexibility and contingency. However, careful consideration and planning are needed to foster collaboration and partnership between providers.

Checks and Balances: Regularly assessing the effectiveness of project approaches and making necessary adjustments is important in the dynamic energy sector. Implementing checks and balances from the beginning ensures timely and effective change control. Putting an exit strategy in place to prevent excessive exit cost from a doomed project.

What went right?

One aspect of that could be considered a minor success was the strength of political commitment to the project, specifically from the then UK Prime Minister Tony Blair, which provided significant momentum. However, it could be argued that this also contributed to the rushed design and procurement process that eventually led to its catastrophic downfall.

Case study: NHS Digital Spine – version 2 (2014)

Review of real-world 'digital spine' implementations

Overview

The original NHS spine was built to support various NHS business applications, providing interoperability and the sharing of data across different healthcare systems. However, the legacy system was costly to maintain and relied on many complex and proprietary software components.

To address these issues, BJSS, a technology and engineering consultancy, managed a major programme to rebuild the spine using open-source technology *(BJSS, 2021)*. Enabled by comprehensive end-to-end testing, deployment, service recovery and operational automation, the new spine has delivered a tenfold improvement in performance despite requiring only one-tenth of the legacy system's infrastructure.

The spine system manages 65 million summary care records and 92 million personal demographic records which are generated by 28,000 healthcare IT systems in 21,000 care organisations across the country *(BJSS, 2021)*. Authorised third parties, such as pharmacies, also have access to this secure data via the Electronic Prescription Service, making the prescribing and dispensing process more efficient.

Benefits

The new spine has also resulted in significant cost savings. Resourcing and operational costs have been reduced by over £21m per year using commodity hardware and open-source software *(BJSS, 2021)*. The lower licensing costs, greater flexibility, customisability, and added benefit of community innovation are some of the benefits of open-source software that played a role in the success of the redesigned digital spine.

According to NHS Digital, the spine has helped to save over £130 million for the NHS. Additionally, it has saved 750 working hours per day and has improved the NHS's response times by 90% *(BJSS, 2021)*.

The spine has also facilitated the development and integration of new digital services. For example, a new digital service for the London Ambulance Service has been developed, enabling paramedics to securely access summary care records when in the field, without the need for a smartcard or N3 connection.

Lessons learned

Overall, the success of the second iteration of the NHS digital spine can be largely attributed to its use of:

- Open-source technology
- Commodity hardware
- Agile working approach.

These strategies provide flexibility and transparency, which could be applied to the development of an energy system digital spine to reduce costs, improve system performance and allow community innovation to flourish.

The scale of the NHS digital spine makes the successes and failures in its implementation relevant to the energy sector.

Case study: Future NHS Digital Spine (on-going initiative)

Review of real-world 'digital spine' implementations

Overview

Launched in April 2022, the Spine Futures programme aims to transform NHS Spine, providing a secure, adaptable, and sustainable infrastructure that enables data integration between care settings *(NHS Digital, 2023)*. The programme aims to develop a new cloud-based data sharing platform to replace the current NHS Spine over the next 2 to 3 years.

The programme is following the 7 Rs industry standard approach for cloud migration. To start with, a small number of services have been chosen with which they aim to explore the approach and to understand the scale of the challenge.

The initial focus has been on the Messaging Exchange for Health and Social Care (MESH) and National Record Locator (NRL). The programme is currently assessing other Spine products and considering the most effective migration approach to move them to the cloud. The cloud migration approach will be informed by the learning and challenges uncovered from these first two products and the nature of Spine architecture.

Progress has already been made, with the development of the cloud-based MESH API and the completion of cloud migration assessments for various other Spine products.

Lessons learned

Although this future NHS digital spine is still in progress, the strong emphasis on phased migration to the cloud and the provision of APIs provides a secure, adaptable, and sustainable infrastructure for the health and care system in England to continue to innovate and extend. This phased approach to digital transformation and community innovation should inform the technical requirements for an energy system digital spine.

Case study: Skywise

Review of real-world 'digital spine' implementations

Overview

Launched in June 2017, Skywise is an aircraft operations platform developed by Airbus and Palantir Technologies.

It centralises and analyses in-flight, engineering, and operational data to address challenges in aircraft operations.

It hosts data from Airbus, suppliers, and over 100 airlines, providing a collaborative environment for stakeholders to improve operational efficiency and prevent disruptions. The platform leverages cloud computing and data analytics to enable data-driven decision-making, enhance safety, reduce costs, and improve reliability *(Mitty, 2020).*

The platform offers additional resources through the Skywise Academy for learning and the Skywise Store for accessing applications and services to support airlines' daily operations.

Risks & benefits

One of the primary concerns is data security, which involves safeguarding sensitive information from unauthorised access or breaches. Additionally, privacy concerns must be addressed to ensure the protection of individuals' privacy and personally identifiable information.

However, the benefits of implementing Skywise outweigh these risks. Operational efficiency is greatly improved through real-time monitoring, predictive maintenance, and performance analysis.

Success stories from airlines using Skywise, such as easyJet and Delta Air Lines, demonstrate tangible benefits, including reduced technical cancellations, significant time savings, and cost savings in maintenance. Using Skywise predictive maintenance, easyJet claims to have avoided 35 technical cancellations in August 2022. Delta Air Lines estimate that they have saved USD $6m per year using Skywise based on the amount of time saved *(Airbus, 2022).*

The platform offers additional resources through the Skywise Academy for learning and the Skywise Store for accessing applications and services to support airlines' daily operations *(Airbus, 2022).*

Lessons learned

Connecting data through trusted digital infrastructure can deliver value to the health of physical assets, the cost and quality of services and the time required to make better decisions.

The inclusion of the Skywise Academy for upskilling and Skywise Store for app purchasing and development are interesting features that help to create a more complete self-sufficient ecosystem. A similar system could be put in place for the energy sector, to ensure the right people have the capabilities to fully utilise the digital spine.

Case study: Estonia’s X-Road

Review of real-world ‘digital spine’ implementations

Overview

X-Road Data Exchange Layer, developed by Estonia's Information System Authority in 2001, facilitates secure data exchange between private and public sectors, ensuring data integrity and confidentiality.

X-Road's exponential growth started in 2007 when Estonia implemented the 'Once-Only Principle,' reducing redundant citizen information requests. In 2006, X-Road saw less than 30 million information requests, which surged to over 574 million in 2016, with nearly 250 connected databases *(apolitical, 2017).* It is now used in over 20 countries *(e-Estonia, 2023).*

To join X-Road, organisations must meet specific criteria, including having an information system, security measures, and online certification. Members receive digital identities for tracking requests and preventing unauthorised access. Data access terms are agreed upon separately between members.

X-Road requests are automatically triggered when staff actions require external data. Secure servers facilitate data transmission between organisations. Specialised portals like 'Your Estonia' and the Mini Information Service Portal (MISP) allow access without full membership. The source code's central components were released in 2016 under an MIT License *(Nordic Institute for Interoperability Solutions, 2023).*

Benefits

Estonia saves over 2.8 million labour hours annually through X-Road, digitizing 99% of government services at a development cost of $450,000 and yearly maintenance between $250,000 to $500,000 *(apolitical, 2017).*

Unlike other systems, X-Road lacks a central facility for storing data. Information remains in respective departments, ensuring decentralisation and reducing vulnerability. X-Road's approach yields three main benefits:

1. Avoiding complex legacy system redesign
2. Granting member-controlled data access
3. Preventing single points of failure.

Lessons learned

Embrace open-source solutions: The use of open-source software enables unified and secure data exchange between private and public sector organisations. Adopting open-source solutions can provide cost-effective and customisable options for developing data exchange platforms in the energy sector.

Implement the "Once-Only Principle": The implementation of this principle significantly increased the use of the X-Road system. Applying similar principles in the energy sector when retrieving customer information could streamline processes, reduce redundancy, and improve efficiency.

Distributed data storage: Implementing distributed data storage in the energy sector can avoid the challenges associated with migrating legacy systems while ensuring data availability and minimising the impact of potential security breaches.

Allow data access control: Giving organisations control over who can access their data and under what conditions, fosters trust and data governance. Allowing energy sector stakeholders to determine data access permissions and terms can facilitate collaboration while maintaining data security and privacy.

Case study: UK Defence digital ‘backbone’

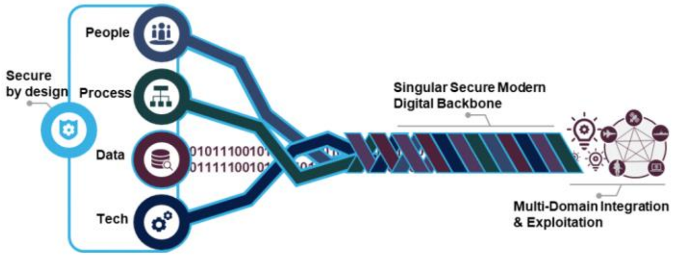
Review of real-world ‘digital spine’ implementations

Overview

The digital backbone is part of the UK Digital Strategy for Defence, published in 2021. It is described as a “combination of people, process, data and technology”. Ministry of Defence (MoD) estimates it will cost £11.7 billion over 10 years to remediate old legacy systems.

The digital backbone will create a secure, singular, modern digital backbone for Defence, connecting sensors, effectors, and deciders across military and business domains, driving integration and interoperability across platforms.

The strategy describes the digital backbone as being “secure by design, with people, process, data and technology woven through it.”



Extracts of the research for this case study are referenced in the Strategy Report, 2021.

People: This aspect of the backbone is concerned with upskilling the workforce to develop and embed digital skills across Defence. In addition, the development of a strong digital culture is also emphasised.

Process: This aspect encompasses the delivery of a singular and cohesive backbone through effective standardisation and governance.

Data: This aspect highlights the need for the MOD to fully exploit their available data.

Technology: This aspect is concerned with how the MOD will build the digital backbone. Much emphasis is placed on the use of hyper-scale cloud technology to improve scalability and adaptability.

Security: The goals for improving cyber security in Defence are to cultivate a positive security culture, upgrade cryptographic solutions, and implement secure design principles from the beginning. These efforts aim to protect sensitive information, enable appropriate data access, manage obsolescence, detect and respond to cyber-attacks, and minimise risks.

Lessons learned

The MOD’s vision of the defence digital backbone is strongly applicable to the energy sector in terms of upskilling workforce, standardisation and governance, digital technology and security design principles from start.

Since this project is still in the initial implementation phase, the lessons that can be taken from this digital spine implementation are currently unclear.

However, it can be said that proposal of a defence digital backbone hints at the possibility of securely sharing sensitive information on a digital spine. Given that the energy sector operates critical national infrastructure, trust in the spine to securely exchange data is crucial.

Case study: Australia - energy system

Review of real-world 'digital spine' implementations

Overview

The Australian Energy Simulation Centre (AESC) is a programme to delivered through a staged approach. When fully implemented, the AESC will encompass data and models of electricity and gas transmission, distribution and fuel dependencies. The AESC will provide an integrated real-world view of the energy system with 'what if?' analytical capability, built and maintained with actual operating data.

In 2019, the National Energy Simulator Feasibility Study concluded, identified a suite of seven tools that AMEO should develop to ensure the optimal management and operation of distributed generation resources that are connected to the National Electricity Market (NEM).

Two priority simulation tools were identified and are being developed to support the progress of connected systems. One is the Connection Simulation Tool (CST) a cloud-based resource available for developers to test and tune power system models for new generation projects planning to connect to Australia's NEM. Which aims to reduce risks, costs and time to approve the connection of new generation projects.

Extracts of the research for this case study are referenced in the VirtualES Benchmarking Report.

Benefits

It is expected to encourage data sharing amongst energy stakeholders, including original equipment manufacturers, consultants, network service providers and AEMO project planning, deployment and operations.

Operations Simulation Tool: Current modelling tools used to run EMT studies on a power system level can take hours to complete. This tool will allow AEMO to perform these studies in minutes, enabling operational management and power system security.

Connections Simulation Tool: It is anticipated that the CST will provide critical solutions to assist project developers in more efficiently preparing their applications for projects, such as new solar or wind farms, and reduce the time to connect them to the NEM.

The digital twins of the NEM and the wholesale energy market of Western Australia, will allow all parties to determine where new transmission and distribution infrastructure needs to be planned. Being able to rapidly model outcomes of design changes to the grid in a digital replica that integrates gas distribution and financial settlement markets will serve as decision support tool and enable acceleration in investment.

Costs

The Australian Energy Simulation Centre (AESC) is an AUD $12.95million programme to be delivered through a staged approach.

The initial feasibility study was AUS $1.71m, of which AUS $500k was funded by the Australian Renewable Energy Agency (ARENA) *(ARENA, 2022).*

ARENA contributed AUS $2.22m to the CST program, with the total cost of the projected estimated to be AUS $4.26m *(ARENA, 2023).*

Case study: Singapore - digital twin for national power grid

Review of real-world 'digital spine' implementations

Overview

Currently, Singapore national power grid comprises over 18,000 transformers, with more than 27,000 km of underground cables interconnecting over 11,000 substations. Singapore is looking to greener, more diverse sources of energy.

It is acknowledged that power grid operations will become more complex with increasing electrification and deployment of more distributed energy resources (DERs). The National Power Grid digital twin aims to future-proof the power grid within Singapore, to ensure that it is well-equipped to manage such complexities while maintaining reliability of grid operations.

Singapore National Power Grid digital twin is currently in a prototype stage and is expected to be fully developed over the next few years. When fully deployed, it will enable SP Group (SP, the transmission and distribution operator for Singapore) to better plan, operate and maintain the national power grid through modelling and simulations so that the actual works can be carried out in a more effective and efficient way.

Extracts of the research for this case study are referenced in the VirtualES Benchmarking Report.

Benefits

The benefits of the Grid digital twin are vast. They include but are not limited to:

- Improving network planning analysis and remote monitoring of asset conditions to save resources in carrying out extensive physical inspections
- Providing a more holistic model of the grid to facilitate planning of infrastructure for different needs (such as installation of electric vehicle chargers, and connection of solar photovoltaic systems).
- Lowering carbon emissions, and providing greater energy security and supply resilience.
- Enhanced condition monitoring of assets and prioritisation of asset renewal, by having a decision tool that can identify risks and prioritise grid assets renewal plans.
- Improvement in carrying out network planning analysis by having a better network utilisation when balancing new or peak electricity loads.
- Optimisation of asset investment, by identifying potential synergies between asset renewal and upgrades for load growth without compromising grid resilience.

Lessons learned

Start from core players: The initiative brings together the core players responsible for energy provision in Singapore across transmission and distribution such as EMA, and SP group. As SP Group is the sole electrical grid and gas grid operator in the country, the Grid digital twin is set from the start to be a nationally adopted initiative and has already locked in the support of existing key stakeholders.

Partnership with academia and research institutions: The Asset Twin is led by the SP Group, Institute of High Performance Computing (IHPC), Singapore's lead public sector R&D agency, research group from Technical University of Munich (TUM) and Nanyang Technological University (NTU). The collaboration between the research teams and relevant government agencies allows for integration of cutting-edge approaches with a new set of national level challenges. This will help create a set of approaches and standards that will best define the technology, modelling, data, methodology to be followed.

Cross sector data sharing: The choice to utilise MESMO as framework for the Network Twin is allowing Singapore energy grid modelling to be connected into other systems/sectors.

Appendix E

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Constraints and dependencies for a data sharing infrastructure

Constraints and dependencies for a data sharing infrastructure

Review of potential constraints and dependencies for a data sharing infrastructure

Overview

This appendix conducts a review on the existing constraints and dependencies, and policy developments that could impact the implementation of a data sharing infrastructure for the energy system.

It considers:

- Legislation, licenses, and codes
- Legacy technologies, processes, and system
- Required regulatory and policy developments

Key findings

Due to the complexity of the energy system and that the industry is segregated, there are many and diverse constraints and dependencies.

Within legislation, licenses, and codes there are several newly added clauses specifically aiming to facilitate data sharing, however there are still many legacy clauses which prohibit data sharing which can cause contradictions and confusion on intent.

These legacy clauses need to be updated to align with the more recent changes which facilitate coordination and holistic data sharing.

The legacy technologies, processes and systems are prominent in industry. Although the regulated companies are gradually updating their core legacy systems.

The range of subsidiary technology, processes and systems are not being updated in a coordinated way. Across both, there is a lack of speed which is holding up implementation of new data sharing capability.

E.1

Legislations, licences, and codes

Context

An overview of the role of legislation, licences, and codes for data sharing infrastructure

Policy, legislation, and regulation have a key role to play in providing general directions and rules in encouraging a coherent and consistent digital innovation, supporting coordinated data strategy and security, and promoting wide adoption and participation to incentivise new markets, business models, and services to unlock the value of data for the energy industry, energy customers and our planet.

They will impact and be impacted by the pace, the nature of digital innovations, technologies, and their evolutions. Collectively, they will impact on the roles, responsibilities and interdependencies of key stakeholders, and their interaction with energy customers.

These have been set up for an energy system with limited data, siloed and centralised data management, and poor data interoperability and sharing. Currently they are short of sufficiency, agility, timeliness and scalability to advance the pace of change in technology, market and social behaviours required for reaching net zero. More information on governance models of existing sector initiatives is given in Appendix I.1.

Whilst opening everything to everybody is not possible or desirable, the current arrangements pose key barriers to innovation, competition and participation.

Primary legislation of the Electricity Act 1989, Gas Act 1986 and the Utilities Act 2000 sets the overarching legislative framework within the energy sector.

The Electricity Act defines the following regulated activities which cannot be undertaken without a license: generation, supply, transmission, offshore transmission, interconnection, distribution, and smart meter communication. The Gas Act defines the following regulated activities which cannot be undertaken without a license: gas transporter, supply, shipper, interconnection, and smart meter communication.

This legislation is then delivered through the licensing framework, which covers supply, transmission and retail sectors and is regulated by Ofgem. The following activities are key to the functioning of the market; however, they are not fully licenced activities: market exchanges and trading platforms - ICE, N2EX (Day Ahead Auction), EEX (European Energy Exchange), transport and brokers.

There are multiple industry codes and standards which govern the industry processes to connect, use and plan the system to be low carbon ready, for example the Distribution Grid Code, the Connection and Use of System Code (CUSC), and the security and quality supply standards (SQSS).

Primary Legislation

Three core pieces of Primary Legislation in the Energy Sector, the Electricity Act, the Gas Act and the Utilities Act. Legislation tends to be high-level and set out broad principles. Additional digital/data Primary Legislation.

Licences

Each licensable activity has its own licence class. There are several different licence types.
The licences tend to be more detailed than Primary Legislation and place obligations on specific companies but also set out how they receive their revenues.

Industry codes

The industry codes set out the detail of the industry processes, e.g. what data should be shared to implement a power sale or provide connection offers.

Current landscape

Complexity of the GB energy market landscape

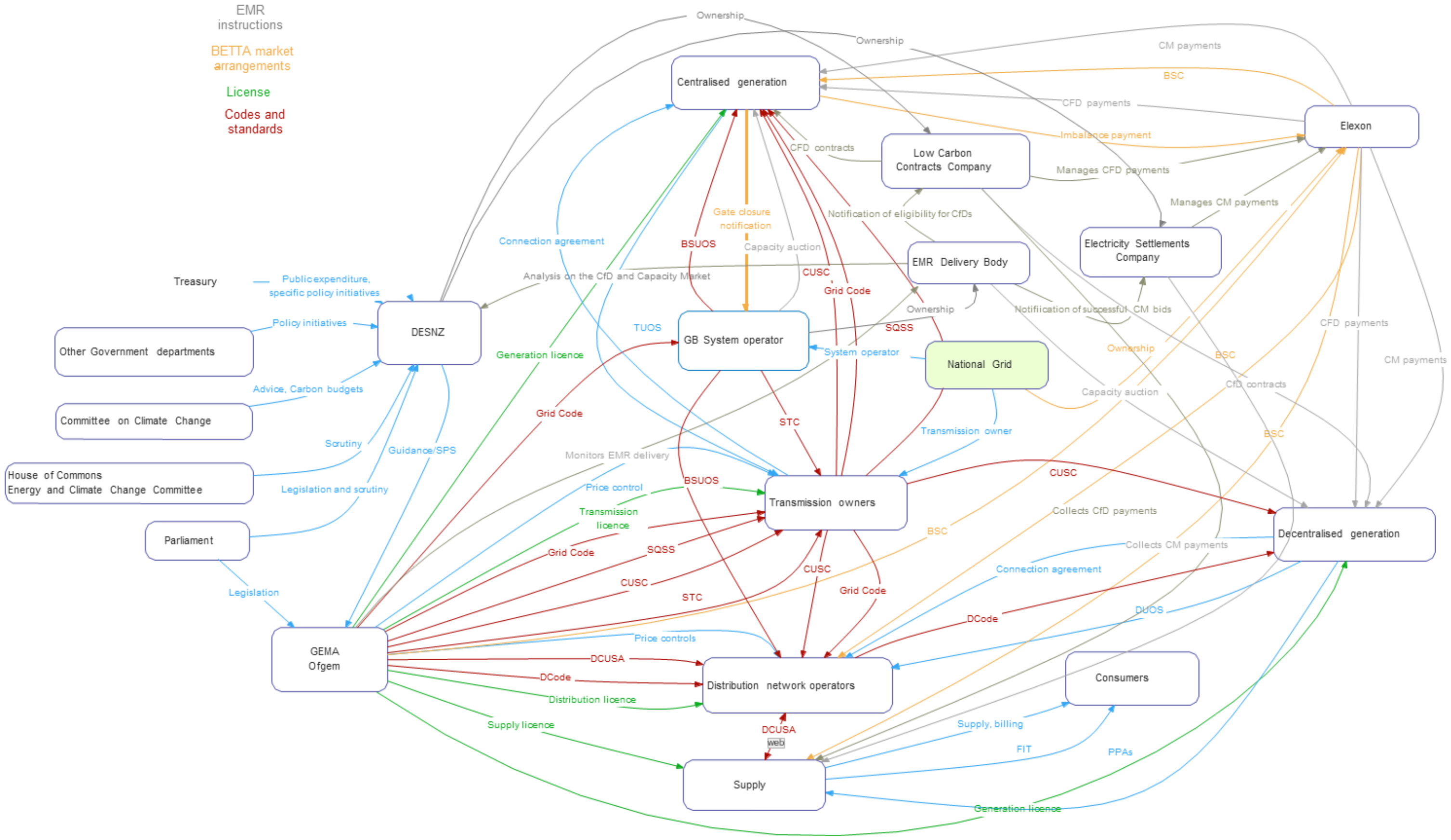
Overview

The GB electricity markets are key mechanisms that establish commercial relationships between generators, transmission and distribution system operators, network owners and suppliers.

Its key purpose is to provide appropriate market incentives to ensure that energy supplies will be affordable, secure, and low carbon to end customers. In doing so, all market participants are remunerated for their service. As such it involves numerous participants that form complicated and structured relationships.

These market participants have multiple functions and varying roles whilst they are governed by many layers of regulation and a multitude of complex codes and standards oversaw by the Government, as seen in the adjacent diagram.

The diagram also highlights the complexity of arrangements, and to note further market changes within this existing framework adds more layers of complexity.



Overview of the GB market institutions and market, licence and code arrangements

Source: Arup

Review of legislation, regulation, and policy

A summary of the constraints and dependencies from legislation, regulation, and policy

Overview

There are four main areas where data may be withheld by regulated and competitive energy companies that may restrict use cases of third parties:

- **Data considered to be personal data:** e.g. metering data at domestic and some small business premises (unless the customers express permission has been obtained).
- **National security:** may restrict some network data associated with CNI sites or other information deemed a risk to national security.
- **Commercial sensitivity:** a supplier' commercial strategy, or potential connection applications that are not finally approved and thus treated as confidential by network companies
- **Value proposition:** benefits for individuals, innovators and energy companies are often not clear to incentivise resources and investment, though recent developments from the regulator (Data Best Practice Guidance) and the industry (Data Triage Playbook) begin to set out standardised and common frameworks to enable efficient and cheaper data sharing

Legislation

Legislations prohibit data sharing for several reasons, from not collect/withholding personal data at the first place, to ensure the security of those collected personal data, or to ensure national security.

- **Electricity Act 1989 (as amended):** various references to not collecting and/or withholding personal data.
- **Utilities Act 2000 (as amended):** The Utilities Act 2000 (Supply of Information) Regulations 2000 – 'The Authority, a licence holder or the Council may refuse to supply (whether under section 24 or section 26) information the making public of which would be against the interests of national security.
- **The Data Protection Act 2018 is the UK's implementation of the General Data Protection Regulation (GDPR):** Companies in possession of personal data are obliged to comply with data protection legislation.
- **Data Protection and Digital Information No. 2 (DPDI) Bill:** Currently going through parliament.
- **The Data Protection Act (DPA) 2018**: the legislation that implements the GDPR, providing guidelines and requirements for processing personal data and ensuring the privacy rights of individuals.

Policy

All the utilities publishing privacy statements generally prohibit the publication of any data considered as personal information which would include domestic and many small businesses.

Transmission and distribution companies treat a new connection application and the potential network reinforcement as confidential until the connection offer has been accepted (or non-firm accepted for batteries). The required reinforcement of the network may not be published until the next update of a system development plan. Hence forward-looking analysis of networks by third parties may be restricted by data.

Generation companies and suppliers are required to publish their energy data on annual basis for the government to collate the digest of UK energy statistics (DUKES) on the production and consumption of energy.

Electricity producers and suppliers submit their commercial sensitive information to Elexon for System Balancing and Settlement, Electricity Market Reform Settlement. As users of energy networks, they also submit relevant energy data to network operators for connection and use of system charges.

Review of license conditions and codes

A summary of the constraints and dependencies from licence conditions and codes

Licence conditions

Condition 47 of the Standard Conditions of Electricity Supply Licence (SLC) only allows for data to be collected at granularity no more detailed than daily for the purpose of fulfilling certain regulated duties and sharing of such data is prohibited.

Through the Distribution Licence Condition 10.A.4 energy networks are permitted to access consumption data at greater granularity than monthly if they implement procedures to mask the identity of the individual consumer / premise

Ofgem must approve these privacy procedures on the basis that they meet the requirements of the condition.

Whilst these processes anonymise most data, via aggregation, single customers on transformers or LV feeders can still be identified and hence distribution companies will only be able to publish part of this data so some analysis by third parties will be impaired.

From March 2023, all network companies regulated through the RIIO price control are required to comply with Special Licence Condition 9.5 when updating their digitalisation strategies and action plans and complying to Data Best Practice.

The Licence aims to increase the transparency of Products and Services, improve stakeholder engagement and coordination, and encourages the licensees to adapt and evolve their Products and Services over time to stay fit and relevant.

The following two pages summarise the constraints and dependencies of the main licences that could impact a data sharing infrastructure

- Supply licence condition
- Electricity Distribution Licence
- Electricity Transmission Licence
- Offshore Transmission Owner (OFTO) Licence
- Interconnector Licence

Codes

Codes give several constraints and dependencies:

- **D Code:** DIN6 in code states 'The Distribution Code contains procedures under which the DNO's Distribution Business, in pursuance of its obligation as a DNO, will receive information from Users relating to the intentions of such Users. The DNO shall not, except in pursuance of specific requirements of the Distribution Code, disclose such information to any User or other person without the prior written consent of the provider of the information, subject to the requirements of the Distribution Licence (Condition 39).'
- **G Code:** Pre connection planning data is treated as confidential as well as control system models of generation.
- **Smart Energy Code:** Confidentiality restrictions apply to some data categories. This is outlined in more detail on the following page.
- **Retail Energy Code:** Confidentiality restrictions apply to some data categories, particularly in the Metering Code of Practice part of the code relating to tariff and/or consumption data of a customer.

Constraints and dependencies of licenses and codes (1 of 4)

The implications to a data sharing infrastructure resulting from licenses and codes

Supply licence condition

The supply licence is to set out the requirements and conditions for the licensees to supply electricity to domestic or non-domestic premises. This is for consumer data and is subject to consumer consent.

The supply licence condition requires licencees to comply with the Smart Energy Code, the GDPR and Data Protection Act. Licencees need to have processes that ensure data security. As it stands now licencees can use half-hourly data for forecasting, billing and settlement purposes. Each of these functions require consent in the form of Opt-out. The use of metered data for marketing purposes requires opt-in consent

Implication for a data sharing infrastructure

In general, the Supply licence code has limitations on data access. This comes in the form of consent. Moreover, it is limited to the use of metered data for settlement, forecasting, billing and (via a more stringent consent) marketing purposes.

If the full data potential was to be utilised the supply licence would most likely need to go through a review considering expanded utilisation of data

Smart Energy Code

The Smart Energy Code (SEC) in Great Britain governs various aspects of the smart energy industry, including the utilisation of data.

The SEC establishes rules and guidelines regarding the collection, management, and usage of data in the context of smart metering and smart energy systems.

It includes several provisions on how the data should be handled and protected including Consent and Control, Data Minimisation, Secure Data Transmission, Data Access Controls, Data Retention, Anonymisation and Aggregation, Security Standards and Audits, Incident Reporting and Response

Implication for a data sharing infrastructure

Even though the SEC sets the required framework for data handling within a smart energy system it is likely that it would require adjustments to benefit from easy access, quality, wider energy sector data.

These will be required to allow SEC to become fit for purpose for the extend of data handling required from a data sharing infrastructure and for a wide range of application for now and for the future.

Electricity Distribution Licence

The Electricity Distribution licence has two parts. The Standard Conditions sets out the general obligations that apply to all licensees and Special Conditions largely relate to the price control financial settlement. The application of the Special Conditions are likely to be specific to each licensee.

Several of the Standard Conditions place obligations about data sharing whether as a service or simply by publishing data for third party access.

This ranges from data relating to the networks themselves, e.g. Network Development Plans, or system information, or Priority Services Register information.

Implication for a data sharing infrastructure

The Electricity Distribution Licence requires the sharing of information between parties in the energy system. In general, when discharged the obligations become a dependency.

However, DNOs are able to charge for the provision of certain Data Services. This charge, which should be cost reflective could be a constraint against the flow of data around the system.

Constraints and dependencies of licenses and codes (2 of 4)

The implications to a data sharing infrastructure resulting from licenses and codes

Electricity Transmission (ET) Licence

As with the Electricity Distribution (ED) licence, the Transmission licence has two parts. The Standard Conditions sets out the general obligations that apply to all licensees and Special Conditions largely relate to the price control financial settlement.

The application of the Special Conditions are likely to be specific to each licensee.

Several of the Standard Conditions place obligations about data sharing to underpin the various market arrangements, e.g. Balancing Market, or Network Development.

Implication for a data sharing infrastructure

The ET licence does not contain the same requirements to share data with all parties (as the ED licence does, albeit at a cost). Though this is partly addressed by data best practice requirement.

Given the licence is broadly silent on data sharing other than to underpin markets in its current form it may be a constraint. However, new requirements could be introduced by Ofgem.

Offshore Transmission Owner (OFTO) Licence

OFTO license conditions outline the obligations and requirements that licensees must comply with when owning and operating offshore transmission assets.

OFTOs may share confidential information with relevant stakeholders for regulatory reporting, grid management, maintenance, and planning. However, data sharing is subject to stringent controls to protect the confidentiality, integrity, and privacy of the shared information. Sharing data with other market participants for the purposes of collaboration OFTOs (e.g., utilities, generators, grid operators) needs to have bespoke frameworks and protocols that address security, privacy, and confidentiality concerns.

Implication for a data sharing infrastructure

Based on the information provided within the licence condition the rules around data sharing are rather stringent with certain limitations.

Moreover, the rules around data sharing do not seem to be extensive enough. This could cause bottlenecks within a data sharing infrastructure environment. Reviewing the licence may be required adding in complexity and cost

Interconnector Licence

The Interconnector Licence allows the licensee to participate in the operation of an electricity interconnector.

No specific rules or frameworks relating to data sharing are laid out within the interconnector licence conditions.

Implication for a data sharing infrastructure

Based on this, interconnectors may not be ready to share data. This could lead to bottlenecks or the requirement of significant reviews to include rules that are fit for purpose around data sharing.

Constraints and dependencies of licenses and codes (3 of 4)

The implications to a data sharing infrastructure resulting from licenses and codes

Distribution Code (D-Code)

The Distribution Code (D-Code) is common to all electricity distributors in GB. It sets out the technical requirements and considerations for parties seeking to connect to the distribution networks.

The D-Code contains a Distribution Data Registration Code (DDRC)– this section of the code summarises all other elements of the D-Code which requires DNOs and users of the network to share information from time to time.

The DDRC defines three types of data – Standard Planning Data, Detailed Planning Data and Operational Data.

Implication for a data sharing infrastructure

The D-Code and DDRC place obligations on distributors and users of the distribution system. However, it only requires data to be shared between those parties. It is not clear whether aggregators or flexibility intermediaries are classed as users and have the right to access data. Domestic consumers are explicitly excluded from the definition, which may act as a constraint.

Grid Code (G-Code)

The Grid Code (G-Code) sets out the technical requirements and considerations for parties seeking to connect to the transmission network.

Like the D-Code, the Grid Code includes a Data Registration Code (DRC) – again this section of the code summarises the other elements of the Grid Code that require users of the Transmission Network, Network companies and network users to share with one another.

The DRC defines the same three types of information as the DDRC in the D-Code.

Implication for a data sharing infrastructure

The Grid Code and the DRC places obligations on transmission licensees and users of the transmission networks.

However, it only requires information to be shared between those parties adjacent to the transmission systems. Communications with wider participates, such as aggregators, Local Area Planning would help achieve whole-system efficiency.

Retail Energy Code

The Retail Energy Code (REC) is a set of obligations governing market participants in the energy retail market in GB.

The REC sets out several data related services that can be accessed by both parties subject to the agreement, and parties that are not subject to the agreement. The code sets out how charges will be derived for these services.

Implication for a data sharing infrastructure

The charges derived from the provision of REC services may be a constraint on data sharing.

However, the fact that services can be accessed by those who are not parties to the code may facilitate a data sharing infrastructure. Those parties will in turn have up-to-date, high quality to develop new products/services to maximise the value of customers' energy and flexibility assets.

Constraints and dependencies of licenses and codes (4 of 4)

The implications to a data sharing infrastructure resulting from licenses and codes

Gas Transporters Licence

The Gas Transporter Licence has three sets of conditions, these are the Special Conditions, the Standard Conditions and the Standard Special Conditions.

The Standard Conditions place obligations about data sharing whether as a service or simply by publishing data. Condition 14 places a general duty on transporters to cooperate with Authority or persons appointed by the Authority to share data so that full effect can be given to the outcome of a Significant Code Review. Condition 38 requires that where data is shared as a result of a code obligation that it be shared freely.

Implication for a data sharing infrastructure

The Gas Transporter Licence requires the sharing of information between parties in the energy system. In general, when discharged, the obligations become a dependency. Condition 38 specifically reduces friction in data sharing between licensees, so data is shared free of charge for improving coordination between electricity and gas system operators and owners, and electricity and gas suppliers to energy customers.

Gas Shipper Licence

The Gas Shipper Licence contains Standard Conditions and includes the same general duty to coordinate as the Gas Transporter Licence. In this case the requirement sits in Condition 18.

The Gas Shipper Licence does not place many other obligations on Shippers regarding data and data sharing.

Implication for a data sharing infrastructure

Without modification the Licence is not likely to facilitate the development of a data sharing infrastructure as it is largely silent on data sharing.

Great data sharing will present the opportunity to understand the short-term and long-term needs of energy systems and energy customers, hence helping gas licencees to target their shipping scheduling.

E.2

Legacy technologies, process, and systems

Context

An overview of the role of Legacy technologies, processes, and systems for a data sharing infrastructure

Overview

Energy companies hold significant data about energy production, energy networks and energy consumption. Although physically they are interconnected, digitally they are segmented and hosted by different companies – resulting in siloed and closed approach to data curation, storage and management. For example, Elexon hosts all commercial data derived from Balancing and Settlement Code and Capacity Market Settlements, network companies host network and system data on their respective licensed areas, suppliers, aggregators and DCC host customer information.

Historically, energy companies are free to choose their preferred digital technologies, systems and processes for internal use, with limited consideration for external access and sector-wide data interoperability, sharing and coordination. The current set up has led to disparities in data and digital systems across the industry, in turn leads to *a large volume of under-utilised digital assets*.

They are not suitable for a low carbon world where data sharing, coordination and symmetry are critical for whole-system operation efficiency in real-time, timely management of growing threats to energy systems, effective whole system planning, wide-spread innovations, and competition.

Within and between energy companies

Due to lack of common frameworks across the energy industry and limited data and digitalisation standards, data interoperability, sharing and coordination is particularly poor between differing energy companies, and between different departments within the same company. Consequently, there is significant data duplication, poor data access, and low data sharing frequency and volume. It was not uncommon to find two data sets of the same data within the same company - not always aligned when brought together.

The limited data sharing exists in the industry has been largely for fault reporting, regulatory reporting, commercial purposes and national energy statistics, albeit mostly ex-post:

- Post-fault reporting within and between electricity network companies.
- Commercial purposes between network operators and network users for system balancing and settlements, system services and use of system charges.
- Between producers/suppliers and the government for producing annual digest of energy statistics.
- Between monopolised network companies and the regulator for assessing system performance, incentives and innovations.

With small and emerging new players

Due to information asymmetry, many new innovators and service providers, whose participation needs to be encouraged, do not have a full picture of the nature of energy and system needs, this will limit their ability to develop innovations, or create new market/business models to better address the needs than the traditional engineering solutions.

Due to the complexity of energy systems, a wide range of alternative solutions can be used to address system and energy needs. This includes measures internal to the network operators (e.g. the rescheduling of maintenance and/or adoption of particular network operating arrangements) and measures external to balance supply and demand.

This will make it difficult for third parties to invest set-up costs, as financial rewards in the future is unclear to conduct cost, benefit, and risk analysis. Additionally, the innovation process could also be longer and therefore innovative products will be slower to market.

Diverse progress since Ofgem's digitalisation strategy (2019)

Summary of the progress observed

Overview of aims and objectives

In 2019, for the first time in the market's history, Ofgem asked network operators to include Digitalisation Strategies as part of their business plan submission for their network price control period (RIIO2).

Network operators responded to the invitation, outlining their strategies and plans around data management and data sharing to unlock the value of data in 2019.

Significant progress has been made since, guided by the regulator (Data Best Practice Guidance) and by the industry (Data Triage Playbook). Most network operators adopt new ways for managing and sharing their network and system data.

However, the pace and direction of the travel are diverse for differing network companies, led to diverse data maturity, where differing digital systems, to differing types of data, and data formats being adopted among UK's regional distribution network operators.

This added further cost and frustration to third parties from the need for understanding and using differing digital systems.

Progress and diversity in DNOs' digital innovations

The below table illustrates two broad frameworks emerged from the publicly accessible data portals with major diversity in data completeness, format, and accessibility.

It was observed that the terminology for network assets is inconsistent across network companies, and that there is no consistency in what each dataset contains apart from mandated datasets such as Embedded Capacity Register.

DNO – data based on public websites	**Framework**	**Datasets available**	**Accepts user data requests**	**Data formats**
National Grid Distribution	CKAN	90	Yes	Csv, json, Zip, PDF, GeoJson, GeoPackage, Docx, sqlLite
UK Power Networks	OpenDataSoft	60	Yes	Xls, Csv, Json, Excel, Geojson, Shapefile, kml
Northern Power Grid	OpenDataSoft	4	Yes	Xls, Csv, Json, Excel, Geojson, Shapefile, kml
Scottish & Southern Electricity Networks	No API available	17	Yes	Xls, pdf
Electricity North-West	OpenDataSoft	27	Yes	Xls, Csv, Json, Excel, Geojson, Shapefile, kml
Scottish Power Energy Networks	OpenDataSoft	14	Yes	Xls, Csv, Json, Excel, Geojson, Shapefile, kml

Constraints of legacy technologies (1 of 2)

A summary of the constraints from legacy technologies

DSO / GDNO data portals

Currently most network operators have data portals. However, as illustrated on the previous page, their level of sophistication and the number of datasets varies depending on data maturity of the organisation and how far each organisation has completed their digital infrastructure deployment.

There is some emerging consistency in using OpenDataSoft or CKAN for the data portals. However, there is significant inconsistency on the datasets uploaded and the data structure used.

Data Best Practice and the efforts of the ENA's Data and Digitalisation Steering Group are gradually improving this.

System balancing and flexibility solutions

The ESO and DNOs have a variety of tools to facilitate various services however the ESO's tools are far more mature as DSO is still rapidly evolving.

The maturity of the ESO tools mean that they were designed primary for internal use and therefore native data sharing is not catered within its core design, albeit the outputs in the forms of the tenders are widely shared.

Digital tools have been blockers in the past with the ESO developing a digital balancing tool. The ESO started in 2016, spending in the order of £100m on a digital electricity balancing solution.

However, this solution did not come to fruition, leaving the ESO continuing to use its legacy manual method - although it is still exploring digital balancing approaches.

Network modelling tools

There has been a gradual convergence of network modelling tools with most network operators using PowerFactory DIGsilent, although this is still not universal. Particularly at lower voltage levels where there are many more applications used.

There is consistency being driven via the uptake of CIM however, the CGMES 3.0 CIM standard suggested by Ofgem is not universally implemented in many of the tools and CIM version conversion can often lead to unexpected issues, such parameters or attributes not converting completely, or exact configurations of assets being lost.

The adoption of CIM is further encouraged by the Common Information Model report published alongside Distributed Flex call for input from Open Grid Systems.

Significantly, CIM is helping consistency of the network models themselves, but there are still a range of assumptions in how these models are run and the way that the load sets are derived which can lead to very different outputs.

Constraints of legacy technologies (2 of 2)

A summary of the constraints from legacy technologies

Forecasting tools

Forecasting is becoming more significant across the energy sector and is very prominent in the electricity sector with the Future Energy Scenarios (FES) and Distribution Future Energy Scenarios (DFES).

Although there is consistency in the building blocks, the data is presented differently across the network operators.

Near real time forecasting is becoming more important through the more active use of flexibility, but as this area has largely been developed internally to each organisation there are diverging methodologies.

Private actors

Digitalisation in the energy sector has been largely driven through network operators either through innovation funding or regulation updates aimed at regulated companies. This has led to more focused effort and communication aimed at these companies.

The private sector has had less direct intervention, leading to the private sector working in collaboration with network operators or trying to evolved their own existing propositions to meet the digitalisation need.

Fundamentally it has led to an array of unfocused developments with limited coordination.

Interoperability is generally considered a “too large” problem for the majority of the established players who are not directly in this energy data field.

Other Innovators

There has been a marked increase in small digital innovators, largely helped by the Modernising Energy Data Applications (MEDApps) InnovateUK funding, which supported third parties to use the emerging open energy data for specific digital use cases.

This has enabled several small organisations to respond to the digitalisation requirements, however as this group is relatively small and prominent, meaning vender lock in is a potential risk.

Each has created specific business models and solutions, but this leads to specific, high value, solutions being developed without the underlying and supporting development needed to aid the full-sector coordination to harness ongoing developments across the wider energy industry.

Dependencies of legacy technologies (1 of 2)

A summary of the dependencies from legacy technologies

DSO / GDNO data portals

The network operators' data portals are fundamental conduits to share data more broadly within the electricity sector and beyond across other sectors.

The core technology of their open data portals are unlikely to limit the ability to share data in consistent and coordinated way directly.

However, their core data, governance and broader consistency is important to ensure that the broader value is accessed.

The key way in which the portals present data, preview data and implement API integration makes them far more accessible. Fundamentally, the user experience to access and interface data should be as consistent as possible.

System balancing and flexibility solutions

The tools for DSO that are currently being developed by the DNOs are fragmented due to their independent focus and each of the DNOs holds different interpretations of DSO.

They are all at different points of deployment meaning that the data generation and shared is very inconsistent in the core systems.

There are however business processes for sharing information externally, with the C31E flexibility submissions being the focal points.

As the maturity of DSO systems increase, this consistent data will be incorporated and potentially expanded. The system operating data will need to align with the ESO flexibility service data such as the Balancing Mechanism, which is one of the key objectives of DESNZ's Flex Markets Unlocked Programme.

Network modelling tools

Being able to consistently model energy networks across multiple sectors is important, particularly as there are significant numbers of actors with varying expertise.

It is important that the results, format and data export of these various systems are defined in a consistent way in line with a cross sector data glossary along with consistent key datasets which span across all sectors. This will support the alignment of datasets derived from markedly different software tools. This would be complex and would only realistically be implemented for specific use cases or initiatives, such as local energy planning.

Alongside the consistent data export, the readily accessible visualisation and data analytics tools will also need to be able to interpret this consistent data structure so cross vector data sets can be analysed together easily.

Dependencies of legacy technologies (2 of 2)

A summary of the dependencies from legacy technologies

ESO Portals

The EMR delivery body (a part of the ESO) has data portals for the Capacity Market, Contract for difference and the Low Carbon Contracts Company which manages many different contacts through these market mechanisms.

To enable effective whole system coordination, the key terms of these contracts and who they effect needs to be readily accessible to enable revenue stacking, operational planning and broader market enablement.

Broader digital transformation

All the network operators through RIIO2 are investing heavily in their digital systems. Many of these deployments will displace legacy systems which historically have been siloed and hold data in completely different structures.

Within the digital infrastructure being deployed there is a significant focus on enabling local flexibility alongside facilitating the decarbonisation of heat and transport.

This is driving significant focus on more granular data and more timely data across the network operators' systems.

In addition to this the focus on open data in driving the implementation of data management systems to improve their data quality and governance.

Code repositories

As much as the raw data will be important, the analysis and processing of the data to derive insight is also critically important.

Often this analysis will be covered by intellectual property if it have been developed privately. However, in some cases this will be open source or freely available.

If the energy data is consistent, then the key parameters of associated code should also be consistent and more importantly be accessible through a centralised location to enable ongoing development. There are various code repository solutions available, such as GitHub, that could provide this functionality.

This will aid innovative deployments of this data and help improve the collective industry's understanding.

Constraints and dependencies of processes and systems

A summary of the constraints and dependencies from processes and systems

Xoserve

Xoserve is the central data management and settlement agent for the gas market in Great Britain. Formerly owned by National Grid Gas, it became an independent company in 2017.

Xoserve collects gas market data from gas shippers, transportation system operators, and metering point administrators. This data includes meter readings, gas flows and supply point details. Xoserve consolidates data from multiple sources, applying necessary conversions or adjustments and applies validation checks to the collected data against industry standards.

Xoserve delivers the following responsibilities:

- Determines the charges, payments, and allocation of costs among market participants, such as gas suppliers and transportation system operators.
- Manages the process of settling imbalances between gas suppliers and customers.
- Calculates and settles these imbalances by reconciling the differences and applying appropriate charges or credits.
- Publishes anonymised aggregated gas market data to promote.

Elexon

Elexon is a wholly subsidiary of National Grid ESO and its role is to accurately manage electricity settlement. Elexon collects key market data from suppliers, generators, and transmission system operators. This data includes meter readings, generation outputs, and consumption information.

On the received data, they performs validation checks to identify any discrepancies or errors by comparing it against predefined rules and standards.

They perform the crucial function of determining the imbalance settlement calculation for market participants. This then informs the charges and payments associated with energy generation, consumption, and balancing services.

Elexon allocates electricity volumes to licensed suppliers based on their customers' consumption. This ensures that the appropriate amount of electricity is allocated to each supplier for billing purposes.

Elexon publishes aggregated and anonymised electricity market data to enhance transparency and enable market analysis. This data is made available to industry participants, researchers, and other interested parties

Implication for a data sharing infrastructure

The settlement process is a fundamental part of the energy ecosystem, and the data processes of Xoserve and Elexon play a key role. However, the settlement process can be lengthy and cumbersome. This is partly because of difficulties on the collection and validation of data.

There are significant differences on the speed of processing settlement between gas (Xoserve) and electricity (Elexon). On average it takes Xoserve 40 days to process settlement and 14 days on average for Elexon to process settlement.

Full electricity market settlement is dependent on the reconciliation process of BSUoS charges undertaken by the ESO, this can take up to 18 months. This can reduce the precision of settlement processes and impede customer switching and accurate billing.

Changes to the settlement processes fall under the code modifications process and can be subject to incumbent bias (an inherent and acknowledged problem with the general code process). Elexon publishes key balancing market data through the Balancing Mechanism reports website. However, historical data is limited. More historical data and analysis is provided by the private firm Netareports.

Constraints and dependencies of processes and systems

A summary of the constraints and dependencies from processes and systems

ElectraLink

Created in 1998 by the DNOs, ElectraLink was set up as an independent body to facilitate the transfer of energy sector data.

They collect energy consumption and market data from various sources, including energy suppliers, distributors, and network operators.

ElectraLink aggregates and manages the collected energy data, ensuring its accuracy and reliability. This data is shared between industry companies via “data flows”. They have established processes and systems for data quality assurance and validation.

ElectraLink provides secure platforms and infrastructure for authorised stakeholders to access and exchange energy data.

They act as a central hub for data sharing in the energy market for authorised stakeholders. In addition, they provide reports, analytics, and tools for industry participants.

Smart Data Communications Company (DCC)

The Smart DCC manages the collection and exchange of data within the GB's smart metering system. It has a number of roles and responsibilities and describes itself as the 'digital spine' of the energy industry.

They operate the secure communications network that connects smart meters to the systems of energy suppliers and other authorised parties.

They collect and aggregates the data from individual smart meters across the country and are charged with ensuring the integrity and accuracy. The Smart DCC is also charged with ensuring that customer data is handled securely and in compliance with data protection regulations.

Energy suppliers and other authorised parties can access the aggregated data through the Smart DCC's secure systems.

They provides a range of data services and applications to energy suppliers, network operators, and other stakeholders.

Implication for a data sharing infrastructure

ElectraLink, having been set up by the DNOs, is principally focused in enabling data sharing.

Understanding the full extent of smart meter data could play a pivotal role in estimating the consumer response to smart/time of use tariffs. The pathway to how this could be realised is unclear.

Smart DCC data focused on incumbents and could impede new entrants and innovators.

E.3

Required regulatory & policy developments

Required regulatory and policy developments

Changes required to ensure MVP delivery, adoption and applications

Overview

Swift digitalisation is a key enabler to decarbonising the energy sector faster and cheaper, lower consumers energy bills, and benefit the wider economy.

It will use data across our energy system and open-up the system to harness innovation and competition from existing and emerging, large and small players.

Historically, codes, licences, regulation and governance have been developed and evolved for a mature energy system with a slow pace of development.

Physical assets have many years of life, upgrading is both expensive and time consuming. Individual energy companies are large-in-size, manage their businesses with little understanding and interaction with the rest of the supply chain. There is limited governance for digital assets to govern the roles and responsibility of differing energy actors and encourage or mandate data sharing

A data sharing infrastructure will make the first step to breaking data silos and unnecessary data hoarding, encouraging data standards and interoperability to enable greater data sharing. Changes are therefore required in regulation and governance to ensure quick delivery, early adoption, and self-sustainable growth.

Change required for implementation phase

For the initial implementation stage, the required changes should be initiated and assessed by:

- Their ability to enable speedy delivery of an MVP data sharing infrastructure
- Quick and early adoption by major energy company that host some of the most valuable information across the whole system
- Whether the data is fundamental for access to markets, improvement of system operations, and new service development.

To ensure a successful MVP delivery, an immediate adoption with a major potential to generate significant value, it is considered that one viable route is to expand energy networks licence conditions – such as mandating the publication of LTDS data to the data sharing infrastructure.

This will be built from the regulator and industry’s progress on LTDS reform. This will also have a minimal additional governance complexity that may limit the delivery, adoption, and expansion.

Change required for steady-state operation phase

For the steady state, due to limited legacy systems, there are great opportunities to introduce agile regulation and governance to reflect the fast development cycle of digital assets and infrastructure.

They can be developed in an iterative and modular fashion to meet the rising digital demand, adapt to diverse and growing energy actors, open to changing relationships to self-sustainable growth over time.

To avoid strong monopoly tendencies, differing options are considered for overseeing the development, operation and maintenance of data sharing infrastructure, and its transition from the implementation phase to the steady-state operation phase.

It is considered that there are new roles within the sector governance, and that these roles can instigate the necessary regulatory and policy developments required.

Appendix F

Cyber security and resilience of a data sharing infrastructure

Cyber security and resilience

Consideration of the cyber security and resilience aspects for a data sharing infrastructure

Overview

This appendix considers the cyber security and resilience aspects of developing and delivering a cross-sector data sharing infrastructure. In conducting the analysis, the end-to-end infrastructure and governance requirements were considered to ensure a holistic approach may be proposed.

The following areas have been reviewed:

- Central coordination requirements and security considerations
- Critical National Infrastructure (CNI) risks and impacts
- Security considerations for delivering a data sharing infrastructure

Key findings

As a system**,** a data sharing infrastructure will need to provide trusted, secure, and resilient sharing of information. To do this, designers will need to be confident that the solution aligns with key international security standards and practices, such as ISO27001, NIST, the NIS Directive, as well as applicable data privacy legislation.

Given the purpose of the infrastructure is to provide greater interconnectivity, and interoperability, between operators within the Critical National Infrastructure, security risks will need to be carefully assessed and managed throughout the design and development process.

Not only will this ensure that the proposed solution is secure-by-design, but it will also enable the system owners, developers, and participants to embed appropriate governance and trust models within their ways of working.

Good governance will be critical to understanding and managing the risk associated with the end-to-end solution and so a data sharing infrastructure governance model and trust framework will be key to ensuring data can be shared securely and the system remains resilient.

The solution itself will also need to be secure-by-design. Therefore, proportionate and cost-effective security controls should be identified and included in the solution design from the outset.

These controls will be required to project the data sharing infrastructure itself (e.g. system hardening, access management, cryptographic controls etc.), as well as the data that is transferred across it.

During operation, additional security services (e.g. protective monitoring) may be necessary to provide participant with the assurance that their data is being handled appropriately and across security infrastructure.

These requirements should be assessed during subsequent stages of development, alongside the future activities contained in this appendix.

F.1

Central coordination requirements and security considerations

Overview

Overview of the central coordination requirements and security considerations

Overview

A data sharing infrastructure looks to provide a critical minimum connectivity layer for any data across the energy sector by coordinating its concurrent exchange across a multitude of parties.

As a system**,** a data sharing infrastructure will need to provide trusted, secure, and resilient sharing of information. At the same time, it needs to assure that the data exchange happens in line with the data's own risk profile. Throughout the course of this study, we have assessed the coordination needs, risks, threats, and vulnerabilities across both a data sharing infrastructure as a system and the data it exchanges. These observations will need to also look at future assurance challenges around the use of a data sharing infrastructure and the data itself.

An exchange of confidence model will be key to guaranteeing adoption of a data sharing infrastructure, for example, it will need to provide sufficient confidence and assurance that data from organisation x will be secure and accessed correctly, that the connection into node does not introduce vulnerabilities in that organisation and vice versa, and that the node deployed on organisation x will not introduce vulnerabilities across a data sharing infrastructure itself.

Emerging requirements and key themes

The following key themes have been identified that will drive a data sharing infrastructure's future coordination requirements:

- The spectrum of the risk profiles of data exchanged;
- The variety of connectivity demand across potential use cases and their criticality;
- The ownership structure of the data exchanges which remains within the organisation deploying a data preparation node, node;
- The control around request and exchange of data between parties (distributed authentication and authorisation);
- A data sharing infrastructure as an open-source infrastructure;
- A data sharing infrastructure as a distributed architecture or network deployable by any actor in the sector;
- The accountability around security of a data sharing infrastructure;
- The potential skills gap between what is proposed and the maturity of the sector;
- The need for training and awareness around new processes.

Security principles and regulation

A data sharing infrastructure will need to consider alignment with key international security standards and practices. By doing so, it will help ensure that agreed standards are used, which can help reduce vulnerabilities and will build confidence with the users.

Some of these standards and practices include:

- Cyber security in accordance with NCSC guidelines, NIS directive and ISO 27001 while noting also the EU's proposed Cyber Resilience Act.
- Data privacy principles standards for IoT implementation and other in accordance with the UK CPNI.
- Adoption of current sector specific protocols (from Ofgem, ENA, etc) or that might develop or emerge over time.
- Alignment with developing security principles of the National Digital Twin Programme, such as security labelling in accordance with government specifications.
- The use of Privacy-Enhancing Technologies (PETs).

F.2

Critical National Infrastructure (CNI) risks and impacts

Context

Increased interconnectivity of regulated operating environments means that security must be carefully considered and designed into the system

Overview

A data sharing infrastructure will interconnect organisations within the electricity sector, some of which form part of the Critical National Infrastructure (CNI) and may be considered by the UK government and regulator as Operators of Essential Services (OES).

As operators of CNI, cyber threats to all utilities companies, service providers and Network Operators who exchange data via a data sharing infrastructure is an area of particular concern that will need to be appropriately considered and managed by taking a risk-based approach.

It is expected that data will be shared within the UK and overseas, and that depending on the jurisdictions and geographies involved the different categories of data will be subject to different laws/regulations.

Data will be shared between connected organisations comprising of:

- Utilities companies
- Private sector businesses
- Public bodies
- Local authorities
- Third party service providers (who may also use the data to provide services to their customers)
- The general public

In addition to data being exchanged to provide information services, use cases relating to data exchange between organisations and/or members of the public to manage or directly control energy assets are envisaged.

Security related attributes

Initial considerations for security related attributes for a data sharing infrastructure

Overview

An initial list of ten security related attributes reflect the primary use cases, goals, and objectives of a data sharing infrastructure are summarised in the adjacent table.

These security attributes will inform the underlying security controls/services that will need to be implemented using appropriate and proportional technical and/or procedural controls.

Additional security attributes will be identified as the use cases and business model for a data sharing infrastructure develops and matures.

#	Attribute	Definition
1	Available	The information and services provided by a data sharing infrastructure should be available according to the requirements specified in the SLA.
2	Error-free	A data sharing infrastructure should operate without producing/introducing errors.
3	Access controlled	Access to information and functions of a data sharing infrastructure should be controlled in accordance with the authorised privileges of the party requesting the access. Unauthorised access should be prevented.
4	Authenticated	Every party claiming a unique identity for connection to a data sharing infrastructure should be subject to a procedure that verifies that the party is indeed the authentic owner of the claimed identity.
5	Confidential	The confidentiality of information should be protected in accordance with security policy. Unauthorised disclosure should be prevented.
6	Compliant	A data sharing infrastructure should comply with all applicable regulations, laws, contracts, policies and mandatory standards, both internal and external.
7	Legal	A data sharing infrastructure should be designed, implemented and operated in accordance with the requirements of all applicable legislation. Examples include ‘Data Protection’ laws, laws controlling the use of cryptographic technology, laws controlling ‘insider dealing’ on the stock market, and those relating to the resilience of the CNI.
8	Competent	A data sharing infrastructure should protect the reputation of the contributing organisation as being competent in its industry sector.
9	Integrity assured	The integrity of information exchanged via a data sharing infrastructure should be protected to provide assurance that it has not suffered unauthorised modification, duplication or deletion.
10	Non-repudiable	When one party uses a data sharing infrastructure to control the assets of another party, it should NOT be possible for the first party to falsely deny having sent the message, or to falsely deny its contents.
11	Trustworthy	The data sharing infrastructure should be able to be trusted to behave in the ways specified in its functional specification and should protect against a wide range of potential abuses.

Managing risk and ensuring legal and regulatory compliance

A security-minded development of a data sharing infrastructure

External drivers for security

Key security and privacy regulations that should be used to inform the solution developed as part of a data sharing infrastructure include (but are not limited to):

- **Network and Information Systems (NIS) Regulations 2018:** The NIS Regulations set out a series of specific legal requirements that OESs (including some digital service providers) must satisfy to ensure they remain resilient and are able to respond to security threats.

  Depending upon the specific use cases developed, it is possible that a data sharing infrastructure will interact with (or directly control) elements of the CNI which are important for energy import, transmission and distribution, as well as wider infrastructure (possibly including that within homes and offices).

  Where data provided via a data sharing infrastructure is vital to delivering these services, it is possible that its loss/disruption could impact upon energy network availability, resulting in loss of supply to customers, as well as affecting wider market activities.

- **General Data Protection Regulation (GDPR):** Where consumer data is to be shared as part of a data sharing infrastructure (e.g. personal data, usage data etc.) any solution proposed must take into account data privacy/protection requirements.

  Depending upon the use cases developed, this could include sensitive data (such as that from the Priority Services Register) or usage data (which may identify specific pattern of life information). This might also require primary legislation change.

- **Smart Energy Code:** Given that one of the possible sources of data that could be shared via a data sharing infrastructure is smart metering data, it is also important to consider which, if any, elements of the solution will be required to meet the requirements set out within the Smart Energy Code.

Identifying and managing security risks

In addition to these legal and regulatory considerations, another important element to be delivered as a data sharing infrastructure develops is the overarching governance, risk, compliance, and assurance approach, which must be comprehensive and include policies, processes and procedures - covering cyber security (including cyber risk management).

Whilst there are various governance models being considered, the approach to cyber security must be clearly set and applied consistently. It is important that this approach does not become overly burdensome and represent a barrier to entry, but it must effectively manage the risks to the sector, satisfy all legal/regulatory requirements, and ensure any solution is both resilient and “secure-by-design”.

As use cases are developed, cyber risks should be identified. Proportionate and cost-effective mitigation measures should be identified and implemented (including adoption of specific standards, and consideration on open standards). Effective risk management will require a range of controls to identify and protect against cyber threats and system vulnerabilities and detect/respond/recover from cyber incidents. Specialist facilities and cyber tools may also be required to support operations. Their appropriate provision is mutually dependant on governance models,

Additionally, a range of assurance activities may be required for stakeholders connecting to a data sharing infrastructure and the service they provide/consume. For example, organisations having access to control flexibility services might be required to undergo more in-depth security assurance/certification than one providing services to consumers.

Cyber security governance

An overarching security authority will set the policies and standards for a data sharing infrastructure, and establish trust between interconnected organisations

Security Domains

A data sharing infrastructure governance model will define the party responsible for defining and setting the security policies and standards that will need to be adhered to by each organisation connecting to the platform.

Agreeing security policies and standards may be challenging as each organisation will have their own pre-existing set of security services/cyber systems that may not align with a data sharing infrastructure security requirements.

This is further complicated by the involvement of UK and non-UK countries and presents a risk to the implementation of a data sharing infrastructure .

To meet the wide variety of use cases, many different security domains will need to be established that are aligned with the nature of the data service being provided.

Each security domain will have its own set of security policies and standards that will ensure security of the intended use of the data service.

Trust framework

The large number of data services to be provided by a data sharing infrastructure will require many different levels of trust to be determined by the operating company. The strength of the registration process will be dependent on the nature of the data services provided and the location of actors involved (see the diagram):

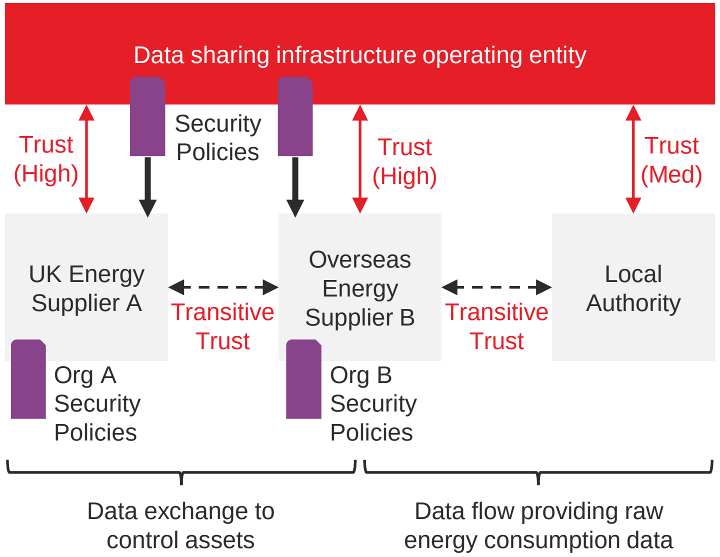
- **Overseas Energy Supplier B** providing operational data on which **UK Energy Supplier A** makes decisions will require a high-level of trust. Both energy suppliers will require assurances on the authenticity of the supplier and integrity of the data.
- **A Local Authority** seeking to connect to a data sharing infrastructure to receive raw energy consumption data will require a (relatively) lower level of trust as they are the recipient of data from a higher trust entity (the Energy Suppliers).

Liabilities and insurance

The nature of some of the use cases envisaged for a data sharing infrastructure may result in significant losses should a successful cyber-attack occur.

For example, if an attacker exploits a vulnerability in the technology components that make up a data sharing infrastructure, and this results in damage to the assets of member organisations, they may seek financial compensation from a data sharing infrastructure operating entity.

Insurance against losses incurred due to a successful cyber-attack on a data sharing infrastructure may be available. However, this is an immature market and even if insurance is available, many policies include many caveats and exclusions.



Market impact

The increased interconnectivity brought about by a data sharing infrastructure could introduce additional cyber security risks

Identifying potential impacts on key stakeholders

The increased interconnectivity that will be supported by a data sharing infrastructure has the potential to introduce a wide range of risks to a number of key stakeholders across the sector, including:

- Markets
- Generation, transmission, and distribution asset owners/operators (including DERs)
- Asset owners/operators from other sectors
- Third party service providers
- Consumers.

As the various use cases are developed and expanded, the potential impacts upon key stakeholders and other sectors should be considered to help inform the development of the cyber security and governance.

As the development of a data sharing infrastructure progresses, more in-depth threat and vulnerability risk assessments should be considered for each of the use cases developed to influence and inform the development of a data sharing infrastructure.

High-level cyber security risks

A data sharing infrastructure represents an attractive target for various 'bad actors' – particularly nation state actors, cyber criminals and terrorist groups.

Vulnerabilities will exist in the system that will need to be effectively controlled. Significant risks identified during this phase of the project include (but are not limited to):

- **Availability of the essential service and system stability:** given the increased interconnectivity, there is a risk of vulnerabilities being introduced into the wider energy network. Whilst it is unlikely these will directly impact the provision of electricity, the possible effects on generation, transmission and distribution assets should be assessed and understood (e.g. should they be unavailable or affect system stability). Given the broader connectivity, and wider attack surface, all risk should be carefully assessed.
- **Impact on markets:** a wide range of data is to be shared via a data sharing infrastructure, some of which will be commercially sensitive. Access to this data must be carefully controlled to ensure market effects are understood, whilst also providing third party services with the access required to develop new offerings.
- **System safety and reliability:** where a data sharing infrastructure may be used to control assets across the energy network (and wider CNI), it is important to consider where control decisions are taken and the impact these may have upon system safety, reliability, and other services. Where assets are owned and operated by third parties, the approvals process for taking control decisions will need to be carefully considered and risk managed. Similarly, where sensitive data relating to the state/operation of the network is being shared, it is important to understand the value of this information and impact of loss/theft.
- **Impact on consumers:** where consumer data is also to be shared across a data sharing infrastructure(this could include usage data, priority services etc.) the solution / architecture that is developed will be required to ensure personal data is protected and only accessed with consent and with a legitimate need.
- **Third party service providers:** data that is used by third party providers to introduce new service offerings into the market or to provide additional services/functionality to consumers (e.g. from energy retailers / product vendors) should be reliable and available when required. Privacy of this data should also be ensured to build consumer confidence in the products and services being offered.

Considerations for future activities

Areas for further investigation as the development of a data sharing infrastructure progresses

Assessing the current landscape

As an energy system data sharing infrastructure develops further, an assessment of existing cyber security technologies, standards, projects and frameworks should be conducted to provide an input into the risk assessment process and to inform the development of resilience requirements for the solution.

Similarly, as specific use-cases are developed, the cyber security risks, and resilience requirements, associated with each can be better understood, mitigations identified, and architectural patterns develop to facilitate the solution.

This will support the project in understanding how data may be shared between stakeholders, how this may be used, and the impact any loss of availability, integrity or confidentiality might have on the end-to-end energy system.

The outputs of these assessments may identify the specific interdependencies between stakeholders and inform the development of the system architecture, technical solution, and future functionality.

Future activities

Throughout the future stages of development, the following key activities should be considered to ensure that cyber security and resilience are considered within the solution from the outset:

- Define security outcomes and principles at the start that must be adhered to.
- Set out expectations for a high-level enduring security risk assessment cycle.
- Identify applicable cyber security and resilience standards and assess the impact on a data sharing infrastructure
- Assess the potential impact of a data sharing infrastructure on the resilience of CNI and critical assets
- Develop high-level risk assessment / attack trees
- Identify use-case specific cyber security and resilience risks
- Define high-level cyber security governance requirements (e.g. data sharing, connectivity etc.)
- Develop high-level architectural patterns to facilitate connectivity between different stakeholders
- Understand the interdependencies / reliance on third party services and any specific security requirements associated with each (e.g. smart metering).

F.3

Security considerations for delivering a data sharing infrastructure

Security considerations for delivering a data sharing infrastructure (1 of 3)

A range of controls will be required to provide cyber-safe, cyber-secure and cyber-resilient data communication services

Overview

The security of a data sharing infrastructure will be achieved via a range of technical, operational and managerial controls proportional to the risk appetite of the operating organisation. These controls should align with best practices and standards, where appropriate e.g., NCSC.

Multiple layers of defence will be provided to ensure that there is no single point of failure in the security measures. The specific technical controls required will vary depending on the use case and the data services to be provided; however, the range of security services will include entity, communication and system services as outlined over the subsequent pages.

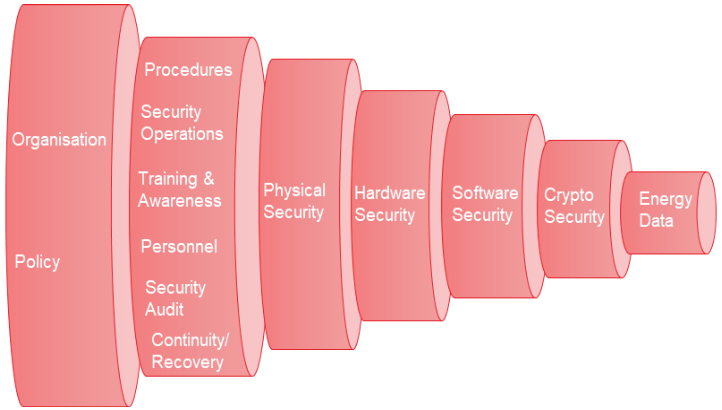
Entity security services

Entities are something or someone that can take action – these can be individuals (people), corporate entities or application/system entities that automate processes and can act on behalf of personal or corporate entities.

Entity security services will include:

- **Entity naming:** Each entity participating in the digital sharing mechanism will need to be identified with a globally unique name and stored in a directory (refer to directory service).
- **Entity registration:** Relationships between node participants can be unilateral (one way), bilateral (two way) or multilateral (many to many). A trust broker will be required to establish trust through a registration process. Trust will vary depending on the data services being provided – a higher level of trust will be required for restricted data services than will be required for unrestricted data services.
- **Public key certification:** Enabling parties on the digital sharing infrastructure to securely communicate via the use of public and private keys to encrypt data. A certification authority will be required to certify the public keys and prevent an unauthorised, unregistered entity from becoming a participant on a data sharing infrastructure. For some future use-cases, the data may require signing off.
- **Directory service:** The directory service is a critical piece of security infrastructure used to authorise access to data services. It provides a trusted repository for all participants of the data sharing infrastructure.
- **Authorisation services:** Prevent unauthorised entities from gaining unauthorised access to the platform. Interrogation of the directory service will underpin authorisation services, however technologies may also include certificates and role associations (to define which data services authorised users have access to).
- **Authentication services:** Required such that one user on the data sharing infrastructure proves to the satisfaction of another that they are really the entity they claim to be. Technologies required may include user tokens and software agents installed on the data preparation node communicating with the data sharing mechanism.

Layered security strategy



Security considerations for delivering a data sharing infrastructure (2 of 3)

A range of controls will be required to provide cyber-safe, cyber- secure and cyber-resilient data communication services

Communication security services

Communication security services are required to protect the transport of energy data between participants of the data sharing infrastructure and mitigate security threats associated with man-in-the-middle attacks.

Data services will be transported across multiple network domains including the data producers LAN/WAN, the public internet, private WANs deployed by certain industry operators (e.g. DNOs) and the networks of data consumers.

Therefore, robust communication security services are required to transport data across these diverse platforms and will include:

- **Message origin authentication:** Using cryptographic techniques to prevent unauthorised parties sending messages pretending to be another party.
- **Message integrity protection:** Preventing eavesdroppers from altering messages during transport.
- **Message relay protection:** Preventing a malicious actor from capturing a message and replaying the same message later.
- **Message content confidentiality:** Preventing message content from unauthorised disclosure by using encryption.
- **Non-repudiation:** Some use cases may require non-repudiation services to prevent a data producer from later attempting to deny that a message was sent to a data consumer.
- **Session authentication:** Required to protect the communications between the data producer and data consumer from being hijacked by a third party (who sends data as though they were the data producer). Securing the session of the lifetime of the data exchange will require a cryptographic key.

Security considerations for delivering a data sharing infrastructure (3 of 3)

A range of controls will be required to provide cyber-safe, cyber- secure and cyber-resilient data communication services

System security services

The system and applications components making up a data sharing infrastructure will require protection from attack and malicious intent. These services are generally concerned with preventing unauthorised access or preventing unauthorised actions by those who have been granted use of the data sharing mechanism

System security services will include:

- **Authorisation services:** Setting up the roles in the data sharing mechanism to ensure that access to data aligns with the security policy for the authorised roles.
- **Access control services:** Controlling access to the physical environment (such as site, buildings and IT equipment rooms), the logical systems/application (using permissions to control access to applications, files, records and databases) and physical hardware platforms and networks (controlling access to servers, switches, routers etc).
- **Audit trails:** Provision of historical evidence of activity on a data sharing infrastructure for monitoring purposes or forensic examination.
- **Trusted time:** Inclusion of a cryptographic time stamps into data units to prevent message delay, replay or re-sequencing by an attacker.
- **Stored data integrity protection and confidentiality:** Security mechanisms such as message integrity protection will be required to protect data stores from unauthorised modification. Confidentiality of data may be achieved via logical/physical access controls and encryption of data stores.
- **Software integrity protection:** Since the data sharing mechanism will interface with the operators of critical national infrastructure, the integrity of the software that makes up a data sharing infrastructure is of critical importance. The production, distribution, and maintenance of software should:
  1. Ensure that software code is developed in a secure manner and that it is cyber tested, certified and approved prior to release.
  2. Ensure that secure distribution mechanisms are in place to enable participants acquire digital sharing infrastructure software only from reputable sources.
  3. Assure that rogue software is not inserted into the system in the form of viruses, worms etc.
- **Stored data integrity protection and confidentiality:** Security mechanisms such as message integrity protection will be required to protect data stores from unauthorised modification. Confidentiality of data may be achieved via logical/physical access controls and encryption of data stores.
- **System configuration protection:** The configuration of the system including the executable software, scripts and configuration data need to be protected from unauthorised changes. Several security mechanisms will be required to achieve this including anti-virus software, use of checksums to check the integrity of files and directories and the use of scanning tools to compare the actual configuration of the system with a stored (baseline) file.

Shared responsibility model

The data preparation node will be deployed across the security domains of the data producers, and these produces will share data via the data sharing mechanism operating entity. Therefore, overall security of the system will be achieved through shared responsibility that will need to be defined, agreed and documented in security policies. Requirements for this may need to be aligned with the government’s risk appetite.

Appendix G

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Technical requirements

Data sharing infrastructure

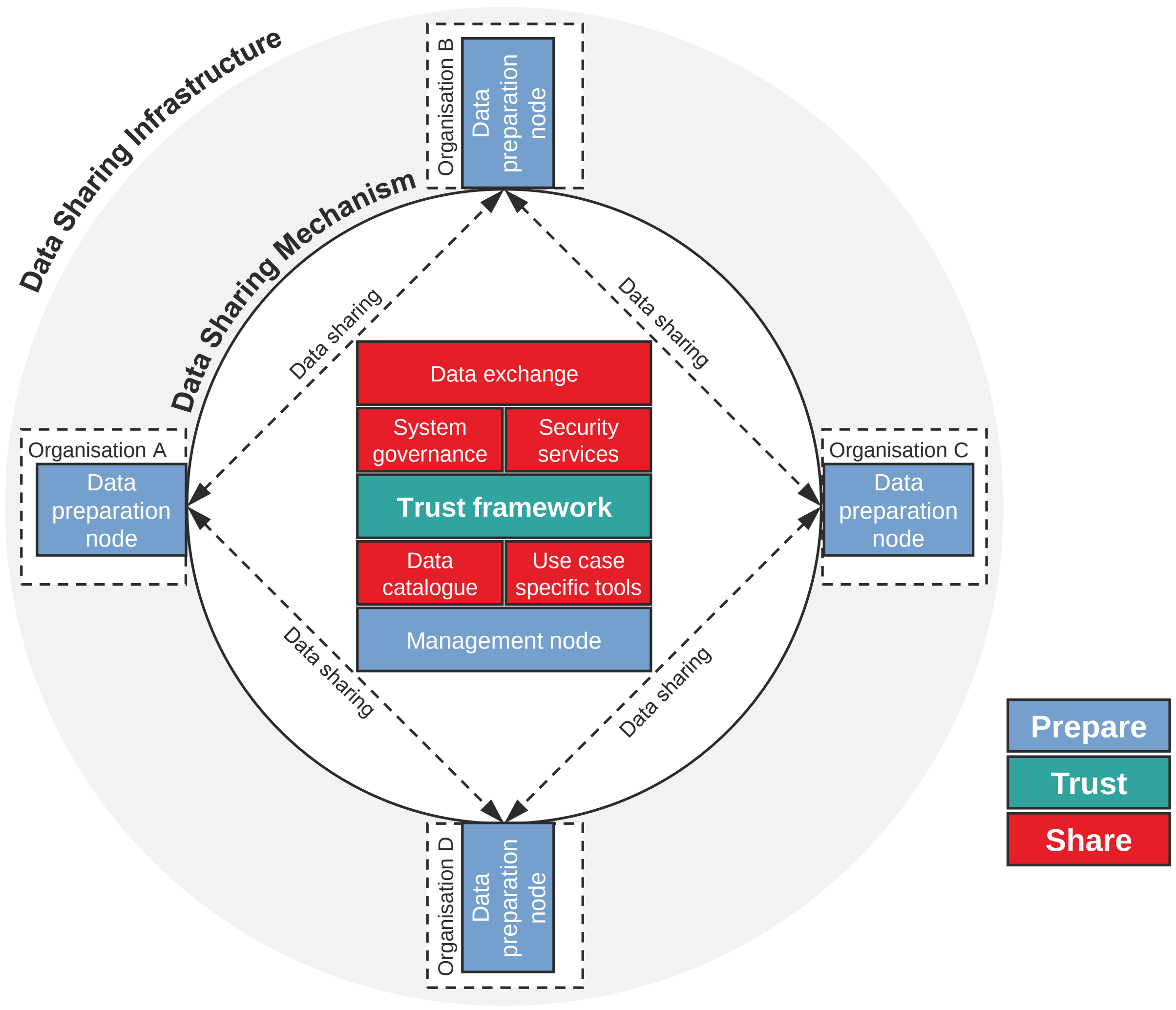
Conceptual overview of a data sharing infrastructure

Overview

As summarised in Section 2.1, a data sharing infrastructure is an approach to enable data sharing across a sector amongst several organisations or participants. To enable the secure, interoperable and effective sharing of data, a range of components are needed deliver the functionalities and services required.

A data sharing infrastructure consists of:

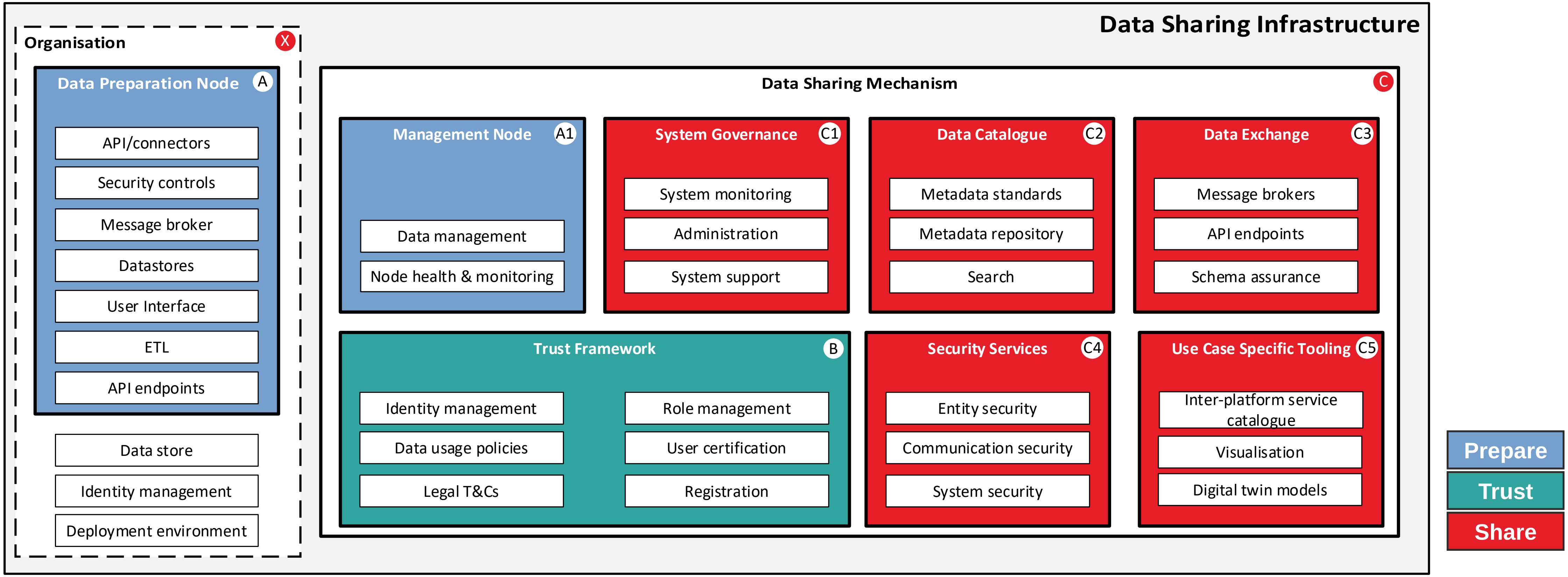
- **Data preparation node (Prepare)**: these nodes are deployed within each organisation to enable them to standardise and prepare their data for sharing. Data is exchanged between nodes via the data sharing mechanism.
- **Trust framework (Trust)**: provides the central assurance across the data sharing infrastructure for data usage, legal, licencing conditions and identities between organisations.
- **Data sharing mechanism (Share):** enables the governance, security, and exchange of data between the organisations. This is delivered by a host of components related to security services, a trust framework, data catalogue, system governance and data exchange via message brokers and APIs.



Functional components of a data sharing infrastructure

Diagram of the functional components of a data sharing infrastructure

A data sharing infrastructure consists of several functional components. Each of these components are detailed on the subsequent page using the numbers in the diagram below.



Functional components of a data sharing infrastructure

Description of the functional components of a data sharing infrastructure

As summarised in Section 3.1, the following functional component descriptions correspond with the numbers on the diagram on the previous page.

X. Organisation: Organisations deploying a node will require a deployment environment (cloud, on-premise, hybrid) to deploy the node.

Their datastores will need to connect to the node for the transformation and publishing of data, and they will need identity management services for internal security authentication and authorisation for their users.

A. Data preparation node: The containerised application node with a set of components to enable the standardisation and publishing of data.

A high-level design is provided in Appendix G.1.

A1. Management node: Performs health & monitoring for data preparation nodes across a data sharing infrastructure and performs data management e.g., reference data management.

B. Trust framework: Provides the technology and legal functions to ensure assurance and compliance when exchanging data between nodes and actors.

This includes the technology elements such as identify management, role management, registration portal, and the legal elements such as data usage policies, legal conditions, and certifications.

C. Data sharing mechanism: provides a range of security, governance, cataloguing and data exchange services to enable sharing of data between nodes.

C1. System governance: Governance of the data sharing mechanism including administration, monitoring of data and system use, and system support.

C2. Data catalogue: Provides the metadata repository to host metadata in required standards to enable search by organisations.

C3. Data exchange: Provides the tools to facilitate the transmission of data between nodes. This includes API endpoints and message brokers i.e., data streaming and publish-subscribe sharing.

Schema assurance is also used to validate and check for schema conformity when data is published and consumed across the nodes.

C4. Security services: Security controls and techniques to facilitate the secure sharing of data across nodes. This includes entity security, communication security and system security.

C5. Use case specific tooling: tools and applications offered by the data sharing mechanism to deliver specific use-cases e.g. digital twin models marketplace to share digital twin models, and visualisation and analytical tools, and an inter-platform service catalogue for additional interoperability services.

G.1

Technical user journey

Introduction

Overview of the technical user journey

Overview

This appendix provides details for the technical user journey.

The technical user journey aims to bring the diagrams and high-level design to life, by taking the MVP user requirements from five initial use cases in Appendix C and presenting them in the style of a nine-step technical user story.

For each of the nine steps, the required MVP components and functionalities are described to deliver that step. This is to illustrate what components are required and their corresponding function in the data sharing infrastructure.

The nine steps are divided into two parts: provisioning data for sharing and accessing shared data.

- **Steps 1-6:** The activities pertaining to provisioning data for sharing. These are the activities an organisation will perform to prepare and publish their data for sharing.
- **Steps 7-8:** The activities pertaining to a data consumer accessing the data provisioned by a data producer in step 1-6.

Through the steps, there are instances where additional diagrams are presented to illustrate some of the concepts for the MVP functionality.

These functionalities are not intended to be at a low-level of detail due to the nature of the feasibility study. There are instances where some low-level examples and options are given to provide clarity on the functionality, but detailed design decisions will need to be agreed at the design stage for the project.

High-level designs of the data sharing infrastructure

A high-level design for the MVP data preparation node with accompanying descriptions is provided in Appendix G.2.

This feasibility study intentionally only developed a high-level design for the data preparation node. It did not create high-level designs for the data sharing mechanism or trust framework.

This is because the original scope of this feasibility study was to detail the technical architecture of the data preparation node (previously referred to as the "digital spine").

During this feasibility study it was realised that the wider data sharing infrastructure also had to be considered, and so outline designs for this were developed and tested.

Recommendations for further development of the other components is highlighted in Appendix O.

Definition of a “Minimum Viable Product” (MVP)

Outline definition of the scope of an MVP functionalities

Overview

The term "MVP" was coined by Eric Ries, the author Lean Startup. Ries defines an MVP as "*the version of a new product which allows a team to collect the maximum amount of validated learning about customers with the least effort*.”

For the purpose of this feasibility study, the definition of an MVP starts with a data sharing infrastructure functional architecture. This version of the MVP was just enough to be tested with key stakeholders who then provided feedback for future development. It allowed the team to hypothesis with stakeholders quickly, garnering valuable feedback that allowed the quick iterations on the functional architecture.

From the stakeholder engagement it was noted that the challenge of creating a data sharing infrastructure was both a social and a technical challenge.

The exercise of engaging stakeholders with a functional architecture helped ensure the social aspects of the implementations are considered early on, helping to enable a wider adoption of the proposed tool without writing a single line of code.

MVP functionality

It became apparent from the use cases and user research captured in Appendix C that in order to meet the needs of the users, a data sharing infrastructure should be conceived as an ecosystem that facilitates data sharing.

In order to deliver a data sharing infrastructure, the requirements gathered from user research were categorised within three groups:

- **MVP functionality**: Capability gaps that need to be met for users to carry out the data exchange. This pertains to the delivery of the first version of a data sharing infrastructure and aims to the initial use cases.
- **Extended functionality**: Potential capability gap that could be addressed to ensure better/effective sharing of data. These refer to components and requirements outside the scope of the MVP and could be delivered through future iterations of a data sharing infrastructure.
- **Enablers**: Governance and process gaps that need to be met for users to use a data sharing infrastructure to exchange and access data effectively e.g. organisations needing to identify data they to share as per step 3 in the technical user journey Appendix G.1.

Evolving the MVP

Based on the user needs captured for the five use-cases, an outline MVP design was created in Appendix G.2.

This was achieved by collating each of the key user stories across a nine-step process for using a data sharing infrastructure, then addressing them with a functionality description to meet the user’s MVP requirements.

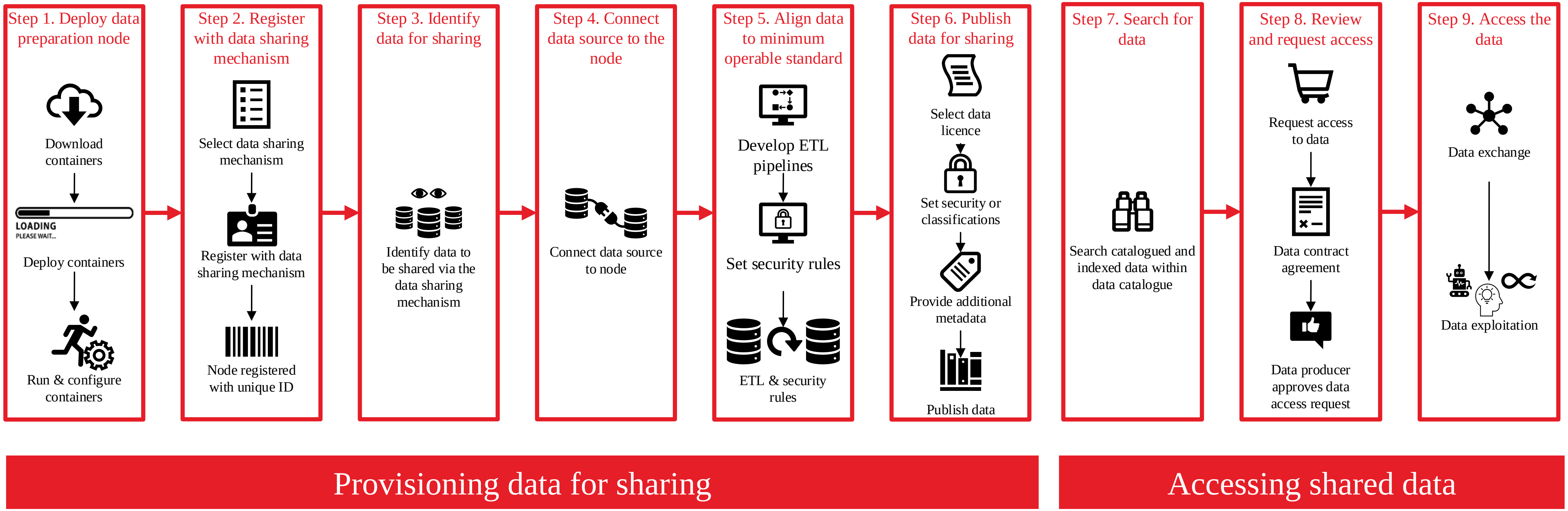
This was done by starting with a conceptual overview of the main functionalities of a data sharing infrastructure, followed by a more detailed view of the required components and applications within a data sharing infrastructure. Then, a conceptual design for the data preparation node illustrating its main functionalities.

The functionalities are then articulated through the nine-step technical user journey, where each of the functionalities is provided in detail and how they pertain to that step for using a data sharing infrastructure.

MVP functionality as part of the user journey

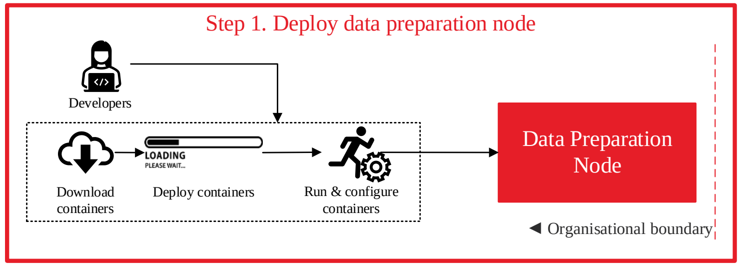
Outline of nine steps a typical user will undertake when interacting with a data sharing infrastructure

The nine steps of the user journey are divided into two parts: provisioning data for sharing and accessing shared data. Each step is detailed over the following pages.



Step 1. Deploy the cross-sector data standardisation (1 of 2)

Deployment of containerised node application



Functionality description

Deployment of data preparation nodes will be through a containerised solution i.e., software will be packaged and distributed into self-contained units that can be deployed to run consistently across different computing and deployment environments, such as cloud, on-premise, hybrid, and others.

The data preparation node container will include all the application code and libraries, and it will leverage system-level virtualisation to provide portability and consistent execution.

Users will download a data preparation node container, deploy it in their chosen environment, and then run, and configure the container and its code packages. After it is configured, the data preparation node can be registered with data sharing mechanism(s) (step 2).

The container will also contain microservices associated with the individual components that the data preparation node application will offer e.g., ETL component, message brokers. This offers a way to decouple the individual components, providing users with the option to choose the services they need from the application.

This means that if organisations already have established data pipelines, which already standardises their data into an interoperable format, then they are not forced to use the ETL functionality of the data preparation node. Rather, they push their standardised data into the data preparation node for publishing to the data sharing mechanism (more details in step 5).

An illustration of this has been provided in the next page. A container management service is used to deploy the data preparation node application. Docker, which is an open-source containerisation platform is given as an example, but other containerisation platforms may also be appropriate.

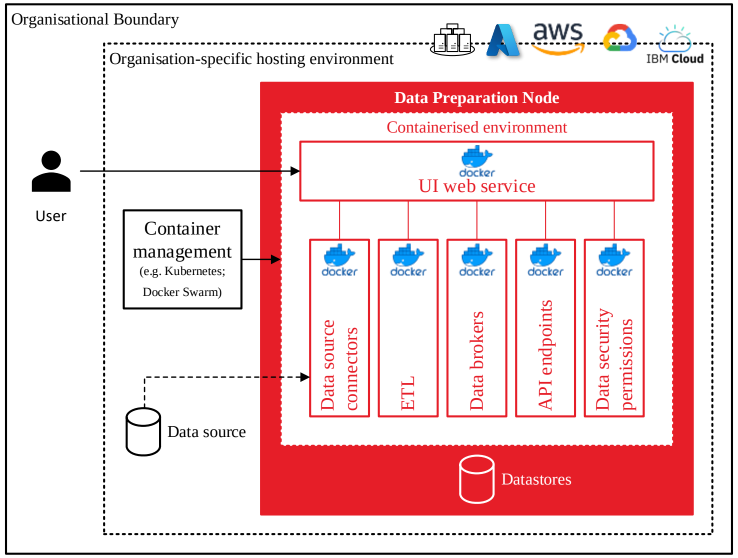
Containerising a software application is like building a toy car from a model kit, where the container represents the kit with all the necessary parts and instructions, ensuring easy deployment and consistent execution across various platforms.

This step requires the following components

- Containerised deployment
- Containerisation management

Step 1. Deploy the cross-sector data standardisation (2 of 2)

Documentation & support



Functionality description

Installation for a data preparation node will come with appropriate instructions and manuals detailing how to deploy, maintain and operate the node. In addition, it will detail ways to raise issues, SLAs, update schedules, future roadmaps and software and remediation steps. These may include:

Documentation & manuals: step by step instructions on how to install, configure and operate the software, including system requirements, setup procedures, best practices etc.

FAQs: online FAQs section, including articles, guides, troubleshooting etc.

Tutorials: tutorials and instructions in various formats e.g., PDFs, videos, interacting online guides etc.

Support forums: dedicated support portal and community forums where users can seek advice, ask questions and share experience.

Service request ticket: users can directly contact the software provider's by submitting service request tickets or reaching out through emails, chat etc.

Software update release: release notes on patches, updates and new versions are provided to users. Details for this includes changes to the software, bug fixes, new features and planned maintenance downtime.

Service Level Agreements (SLA): agreement between the service provider and the customers that define expected level of performance, quality and availability.

Technical specifications: details for the technology specifications and required operating software for the user.

Security policies: for using the tool, some of which also be including in the SLAs.

Additional documentation for using the data sharing mechanism, including the trust framework will be provided by the entities delivering those components.

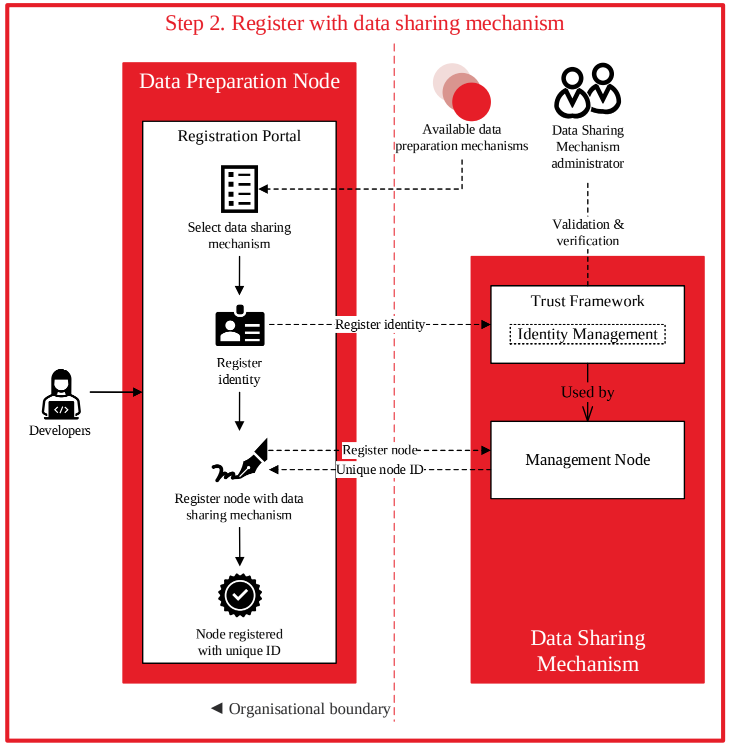
This step requires the following training material

- Documentation & manuals
- FAQs base
- Tutorials
- Support forums
- Software updates release notes
- Service request tickets

Step 2. Register with data sharing mechanism (1 of 3)

Registering with the data sharing mechanism

1 2 3 4 5 6 7 8 9



Functionality description

Organisations wishing to connect their data preparation node to the data sharing mechanism will need to do so via a registration portal. They will need to confirm their identity and additional details so that they can be registered with an entity/identity management directory, as part of the trust framework.

Registration process would entail of the following steps:

1. Initiation: users visit the registration portal in the data sharing mechanism.

2. Registration information: users provides necessary information for registration e.g., organisation, point of contacts, security questions, identity etc.

3. Validation & verification: validation checks are conducted by the trust framework to ensure accuracy and security of user, this may include manual review by administrators, document scanning etc. Timeframes for completion of these checks are dependent on the technical solution and business processes, which will be developed in the next phases of design.

4. Terms & Conditions: user is required to review and accept T&Cs, legal agreements etc.

5. Data preparation node registration: the user's data preparation node is assigned a unique ID and is registered with the trust framework. The node is also registered with a management node in the data sharing mechanism.

6. Management node: the management node will undertake monitoring of other data preparation nodes across the network, checking for health & performance. This could be visualised through a health dashboard to show which nodes across the network are online or unavailable. Furthermore, the management node may also perform functions related to data management e.g., reference data management. The management node will be operated centrally as part of the data sharing mechanism, and will need to be secured, scaled and governed appropriately by the governance entity for that data sharing infrastructure.

Step 2. Register with data sharing mechanism (2 of 3)

Registering with the trust framework and security services

Functionality description cont.

Registration of an organisation's node will make it part of a network of nodes associated with a data sharing mechanism. Organisations assigned with a node are added to an entity/identity management directory in the data sharing mechanism.

Role assignment: Once an organisation's identity is verified, they are assigned appropriate access roles and permissions based on their identity. This is done through issuing of relevant certification to the organisation.

Trust framework: the organisation's identity are associated with the trust framework. The trust framework will ensure that data shared using the nodes have the correct data licenses, legal T&Cs and data contracts in place before it is consumed (more details in step 6).

User authentication: only registered and authenticated organisations for that data sharing infrastructure can share data. The authentication and authorisation is handled by the security services in the data sharing mechanism.

This step requires the following components

- Trust framework
- Security services
- Management node

Step 2. Register with data sharing mechanism (3 of 3)

Deployment of multiple nodes

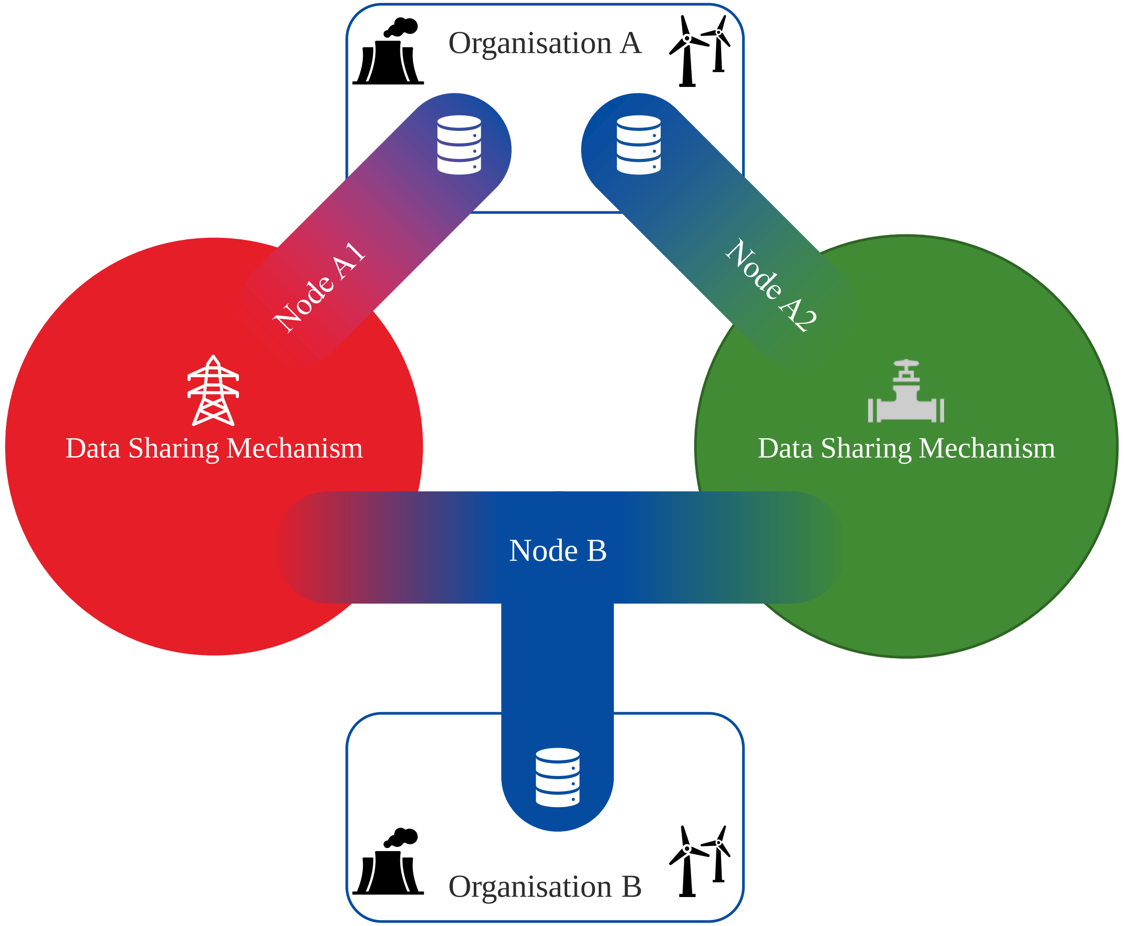
Functionality description

The registration process will allow organisations to register once, but with the ability to have multiple instances of the data preparation node e.g., an energy organisation may deploy *node_gas* and *node_electric* etc. This empowers an organisation to architect a deployment model that better aligns to their operational and IT models (either combined or separate approach to data management and sharing).

Organisations are also given the ability to register one node across multiple networks/data sharing infrastructures, where they choose where to share their data.

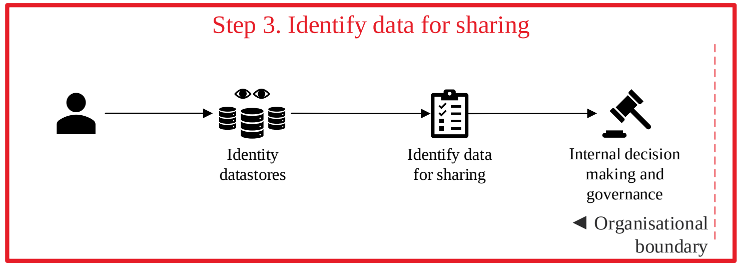
Different data sharing infrastructures may be subject to different governance, rules & processes. Therefore, 'Node B' which is sharing across two data sharing infrastructures may need to be registered with two trust frameworks (for different data handling agreements) and two data catalogues (which will be subject to different governance oversight and administration by the appropriate governing bodies). The data sharing infrastructure may also include different metadata and data standards for data sharing.

This is illustrated in the diagram opposite.



Step 3. Identify data for sharing (not a technical MVP function)

Governance and process enablers to identify data for sharing



Functionality description

Organisations will need to identify the data they wish to share and where that data is stored across their IT estate. Furthermore, they will need to understand a host of security, compliance, regulatory, licensing, privacy and commercial implications for sharing their data. Organisations will be expected to have an internal decision making and governance process to manage this, thereby enabling them to set the correct security controls, data licensing agreements, data contracts, legal agreements etc., for their data for when they are ready to share across a data sharing infrastructure.

This may also include characteristics about the data, including its quality, as there may be a minimum data quality standard for each associated dimension e.g., timeliness, consistency, accuracy etc. that organisations will need to meet for sharing of datasets, which will vary depending on the use-case. It is expected, at least for the MVP, that organisations will use their internal tooling and processes to measure their data quality to ensure it is fit for purpose, however, it may become an MVP functional requirement during the next phase of work.

Whilst it isn't scoped as an MVP requirement, future iterations or components of the data preparation node may include data profiling and data quality components, thereby enabling organisations who have less developed IT capabilities to perform those checks using the node.

Potential future components for identifying data

Data discovery and profiling: analysis of a dataset's structure by identify missing values, duplicates and other properties associated with pre-defined data quality rules

Data quality assessment: evaluation of the quality of the data based on pre-defined data quality rules e.g., completeness, accuracy, consistency, validity, timeliness and accuracy. Pre-defined rules and thresholds helps to assess if the data meets the specific criteria for sharing.

Data classification: automatic classification and tagging of the data based on predefined rules or patterns associated with sensitive elements.

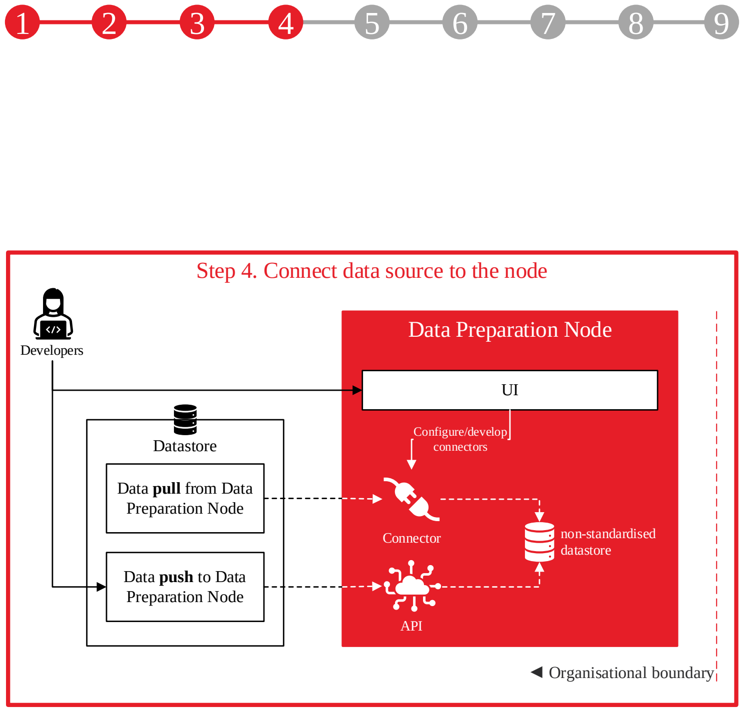
Data cleansing and standardisation: standardisation and cleansing of the data to eliminate errors and inconsistencies e.g., removing duplicates, correct formatting errors etc., to meet the required standard.

Reporting: reporting and visualisation to present findings of the data quality assessment, which can be communicated with data consumers as part of Step 6.

Given the open-source implementation pathway expected, third parties could build these capabilities and provide them to the market.

Step 4: Connect data source to the node

Connecting data sources to the data preparation node



Functionality description

After the user has identified the data that they want to share, they can use a pre-configured API or connector to establish a connection from their datastores to the node.

The user can then publish their data to the node, which will be extracted into a non-standardised datastore. The data in this store can then undergo the desired transformation through the node's ETL component (more detail in step 5).

Details for APIs/connectors are provided:

- **API:** programmatically interact with the node to push data into it. The API will expose the functions, rules and endpoints to send the data from the source system to the non-standardised datastore for subsequent transformation as part of the ETL pipeline. This will require API requests with the data payload being sent to the API endpoint using supported data formats e.g., XML, JSON etc. This approach offers the user a higher flexibility of custom data ingestion workflows, as they will have the ability to customises the timing, format and data being sent to the datastore.
- **Connector:** connectors allows direct integration with a data source to pull data into the node. This will be a pre-built module that handles the data retrieval between a source system and the node. This will include connection details and source-specific details depending on the user. In addition, it will include specifics for the retrieval process, application of filters, and fetch requests for that data which may be hosted in database, file system, cloud service etc. The source systems will need to be identified so that connectors would work on common systems e.g., SAP, object stores etc. Otherwise, there may be the need to develop connectors for bespoke systems which will not be reusable.

APIs and connectors could be standardised for consistent push/pull of data between the datastore and the node, however this would be most appropriate for common use cases. Where bespoke datastores or formats are used by an organisation, generic APIs and connectors could be used, with the node's own ETL pipelines standardising the data (see step 5). These may also require additional subcomponents such as common data models and libraries.

This step requires the following components

- API(s)
- Connectors

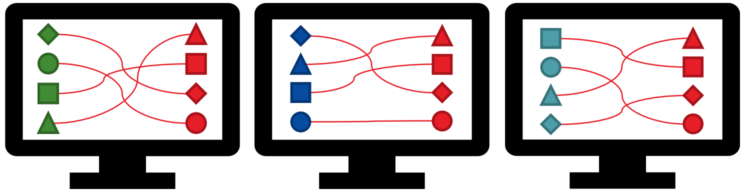
Step 5. Align data to a minimum operable standard (1 of 2)

Transformation of data using an ETL component

Functionality description

The data preparation node will have an ETL component with functionality to enable users to transform their data into a minimal interoperable standard specific for sharing across a data sharing infrastructure. The ETL component will include extract, transform, load functionalities that will enable users to map their data to a specific standard.

Users can also build and configure their own transformation mappers and logic for other data standards to be used. They can then integrate these additional components into the node's technology stack as sub-containers, enabling them or other organisations to deploy and use.



The ETL component provided within the node will be open-source technology, and it will provide the engine to execute bespoke ETL pipelines developed by the user. Details of the technology to be used will be developed in the next phase of design.

High-level overview of the ETL function

Extraction

- Connect to the non-standardised datastore, establish connection, and retrieve data.

Transform

- Data cleaning: data validation, formatting and standardisation.
- Data mapping: map the source data to a target schema or model.
- Data transformation: apply the transformation to the data to the target format.

Load

- Create target tables, field and relationship for target system to house the transformed data in the standardised datastore.
- Insert transformed data into system i.e., appending new data, updating existing records, creating new records etc.

The ETL pipeline, including the data mapping and transformation logic is saved, thereby enabling users to repeat the process with a select & click functionality as part of the UI, rather than having to rewrite the scripts and logic each time.

Using organisation's incumbent ETL components

Where an organisation has an ETL component that is incumbent and already used, it will be possible for the data to be transformed outside of the Data preparation node and loaded directly into the relevant datastore within the node.

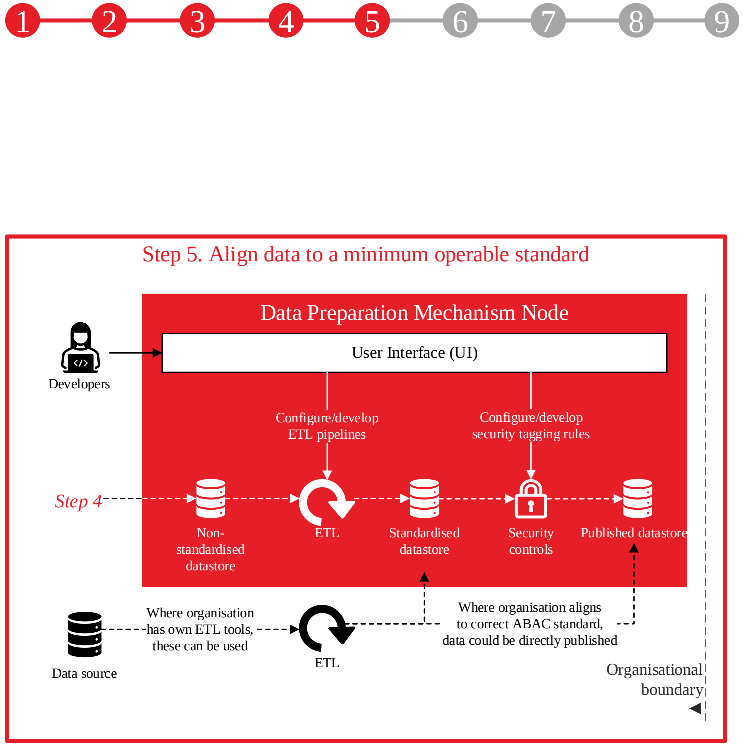
The organisations' incumbent ETL components are expected to meet appropriate level of security due to their pre-existing and established hosting and connectivity to data sources.

This step requires the following components

- ETL component
- Datastore

Step 5. Align data to a minimum operable standard (2 of 2)

Configuring the node using a User Interface (UI)



Functionality description

The data preparation node will have an intuitive UI where users can interact with the node and configure its components. Users can configure their ETL pipelines and set the standardisation target for their data. In addition, they will also be able to set security controls on their data prior to publishing it.

The UI should also offer links to supporting material for the minimum set of standardisation that the data should align to, this includes relevant material for the data model and how it is used.

The target database will have a set structure and format for accepting data. Enforcing conformance to this for anything loaded into the database will ensure that non-conformant data cannot be loaded, and therefore the output for ETL process will be deemed incorrect for the standardisation required.

Elements of the UI could include:

- **Menu bar**: set of menus with various options & commands to access the features and functionalities of the node.
- **Navigation panel**: panel enables users to navigate between different section or components of the node.
- **Main area**: workspace of the UI where the primary content and functionalities of the tool is displayed, and users can perform actions pertaining to the ETL pipeline and security controls.
- **Status bar:** provides status of workflows including error messages, notification or other relevant information for workflows being conducted by the node
- **Documentation & manual**: access to documentation, manuals and supporting material.

The design of the UI should meet relevant accessibility standards and legislation.

This step required the following components

- User Interface (UI)

Step 6. Publishing the data for sharing (1 of 7)

Selecting data usage characteristics for the data

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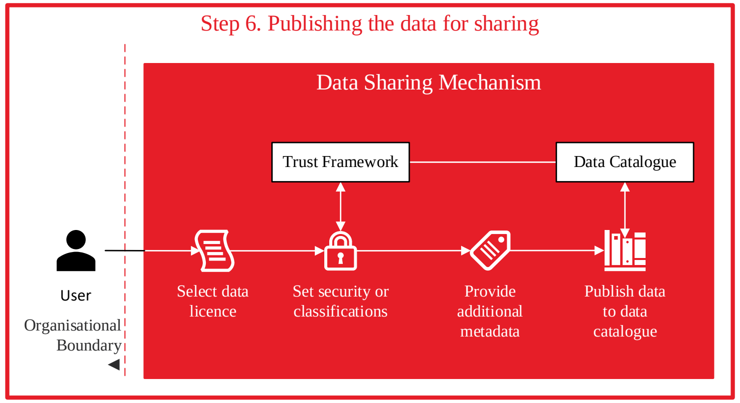


Data publishing functionality description

As part of publishing data to the Data Preparation Node, users will need to select the appropriate data usage characteristics for their data to describe how it should be suitably handled.

Users will need to assign the correct data licensing conditions, data contracts, and legal T&Cs to their data, through the trust framework. This will ensure that the data handling conditions are met are before the data is shared between participants.

Users will assign these conditions directly through the trust framework:

1. Data usage conditions: users select the appropriate data usage conditions that aligns with their desired level of data use. This may include the terms & conditions, restrictions and commercial usage of the data.

2. Licensing conditions: the data producer can communicate the licensing conditions for their data across a data sharing infrastructure through the trust framework This will make it clear for organisations registered with that network what the usage conditions are.

The data usage conditions could also be communicated and enforced through metadata fields associated to the data, which are captured in the data catalogue. This may include fields such as:

- **Data:** origin, structure etc.
- **License types**: fields specifying the type of license and conditions.
- **Usage permissions**: edit, contribute, or read permissions; e.g., edit permission allows user to modify the data, and/or use for commercial purposes etc.
- **Attribution**: how the data should be attributed to the original owner.
- **Security:** any security or classifications for the data.

This step requires the following components

- Trust framework
- Data usage conditions

Step 6. Publishing the data for sharing (2 of 7)

Machine readable data usage conditions

Trust framework functionality description

The trust framework will ensure that data consumers meet the data usage conditions through the formalisation of data contract agreements. To gain access, data consumers will need to accept the T&Cs for usage of that data, which can include the rights, obligations and restrictions for the use of data (as per step 8).

In addition, the trust framework will manage and retain the data licenses used across a data sharing infrastructure. They are made machine readable using standardised formats and metadata that can be read and processed by machines.

This may include:

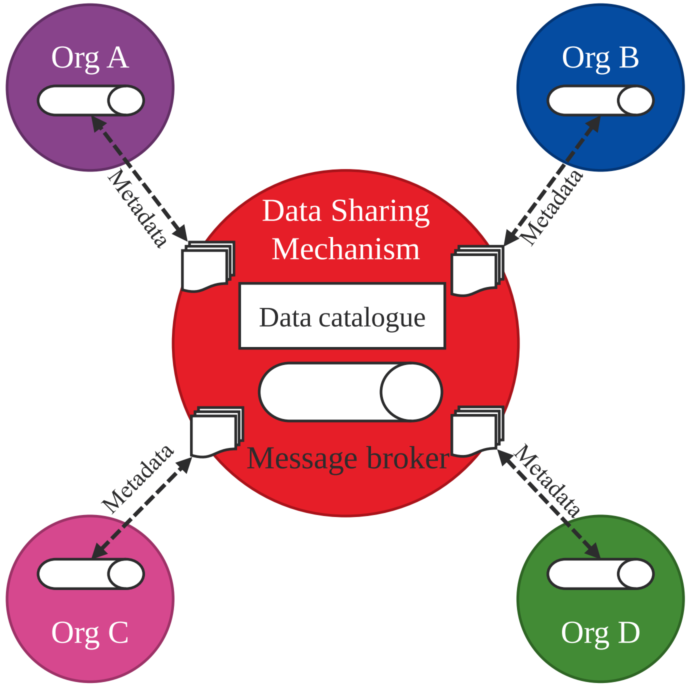
- **Standardised formats:** the licenses are presented in formats appropriate for expressing licenses, including permissions, constraints and obligations. This may be done through XML-based languages.
- **Metadata:** accompanying information for the data usage conditions. Typically, in a structured format such as JSON-LD or RDF. The metadata will include information like permissions, license type, attribution etc. (as per previous slide).

This step requires the following components

- Standardised formats for data licenses as part of the Trust framework

Step 6. Publishing the data for sharing (3 of 7)

Publishing metadata to a data catalogue



Data catalogue and broker functionality description

Data producers will also need to publish relevant metadata so that it can be indexed and catalogued in a data catalogue, where data consumers across a data sharing infrastructure can then search and request access to the producer's data (as per step 7 and 8). The metadata should be provided in an approved standard e.g.. Dublin Core so that it can be appropriately managed and used.

The data sharing mechanism will have a service for data exchange, which will encompass message brokering techniques and API endpoints. Each Data Preparation Node will have their own message brokers, with the data sharing mechanism hosting a central broker. This collection of brokers will facilitate the transmission of data across a network of nodes for that data sharing infrastructure (step 9).

Metadata from the node's message broker will be published to the data sharing mechanism via a central broker, which will update and populate the data catalogue with the relevant metadata. This will enable a seamless and efficient experience for providing and updating metadata in the catalogue, where the message brokers can manage this in the automatically.

Alternatively, an option would be for users to manually update the metadata fields in the data catalogue as part of the publish step. This option would be more manually intensive but shouldn't be ruled out, depending on the requirements from the design phase.

This step requires the following components

- Data catalogue
- Message brokers

Step 6. Publishing the data for sharing (4 of 7)

Setting security controls on the data

Functionality description

As part of publishing, security controls are also set on the data to ensure that the right permissions and controls are in place for when it is shared.

This may include additional access control permissions that the data is tagged with to enable fine-grained access control, so that users can describe what data they want to share and how much of it they want consumers to see.

This could be achieved using a decentralised security model i.e., distributing the implementation and control of identity and access management by enabling each organisation to manage their own authentication and authorisation to their data (if for example they are doing peer-to-peer sharing).

Consideration will need to be made for how this will work in unison with the identity groups and data usage permissions in the trust framework.

In addition to the access control permissions set to the data, security controls may also include integrity protection and content confidentiality. This may be required for particularly sensitive datasets that data producers deem appropriate and necessary, which they would have identified as part of step 3.

These controls will be managed by the communication security services Appendix F.3, which includes controls for elements around message integrity protection, relay protection, non-repudiation etc. Application of different layers of security will be determined by the use cases.

This step requires the following components

- Data usage policies as part of the trust framework
- System Security

Step 6. Publishing the data for sharing (5 of 7)

Data exchange through API endpoints and message brokers

Functionality description

Data ready to be shared from the data preparation node will be published to the data sharing mechanism via secure and approved protocols. This may include API endpoints and message brokers, where the data can be shared with consumers. The data exchange will need to accommodate for sharing of both static and dynamic data with multiple producers and consumers, where consideration will need to be made for asynchronous data sharing, event-driven architectures, scalability, decoupling and latency.

This is made up of several components:

- **API endpoints**: producers will expose API endpoints for their nodes where they can be accessed by authorised users. Consumers will need to make HTTPS requests to the data and may need to periodically poll or refresh the API endpoints to fetch the latest data (making it good for some use cases but not for use cases involving highly dynamic data with multiple consumers fetching data from one node). The API endpoint will sit behind an API gateway which will be provisioned with the node's containerised solution.
- **Message brokers:** enables the sharing of dynamic data, whereby producers can establish pub/sub messaging of data with multiple consumers for asynchronous messaging. They can also be used for data streaming, where data is exchanged in near real-time. Message brokers can typically handle high volumes of data, are scalable and can offer low latency for exchange.
- **Schema assurance:** When data is published from the to the data sharing mechanism, and conversely when data is ingested from the data sharing mechanism into the node, a schema assurance process will need to occur. This may entail of schema validation checks using a schema registry in the data sharing mechanism, and additional assurance checks from the output of the ETL pipeline to make sure the data meets the required standard for interoperability.
- **Audit & monitoring:** Data published to the data sharing mechanism may need to be audited & monitored by the security services. Information around when the data is accessed and who accessed it may be captured to mitigate and resolve data misuse.

Details for the different types of data exchange, and the differences between API endpoints, message queues (pub/sub) and data streaming is provided in the next sides.

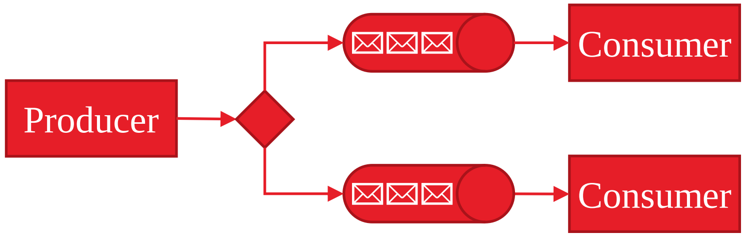
This step requires the following components

- API endpoints
- Message brokers
- Schema assurance
- Security services

Step 6. Publishing the data for sharing (6 of 7)

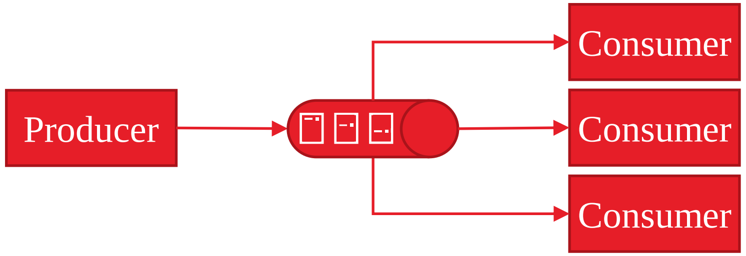
Summary of integration approaches for publishing data

Message Queueing (pub/sub)



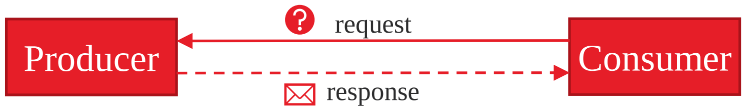
- Message queues are designed to store and transmit messages between distributed components.
- Message queues are suitable for scenarios where the primary concern is reliability, as they offer guaranteed delivery and message persistence.
- To ensure the broker doesn't drop messages that haven't been delivered yet, the queue needs to persist. Durability and persistency are two important qualities to look for in a message queue.
- Using queues is ideal for ensuring for messages comprising of complete datasets are delivered and where latency is not a concern. Depending on the technology choice, messages could just be changes/deltas to dataset (rather than the complete dataset).

Data Streaming



- Streaming focuses on real-time data processing and analytics.
- Streaming excels in situations where real-time analysis and processing of data are crucial, as it offers low-latency data transfer and allows for data analysis across multiple time windows.
- Active subscribers will always get the message and new subscribers can access the logs file and read messages from any point in time.

API Endpoints



- Web APIs (Application Programming Interface) allow for a consumers to request on-demand data from the producer.
- Data is returned in near real-time as part of a synchronous transaction.
- Consumers will not know if there is an update to the data since they last they received it until they make a new query.
- Often used ad hoc as the data is required, or via frequent polling of API endpoints to retrieve latest data.

Step 6. Publishing the data for sharing (7 of 7)

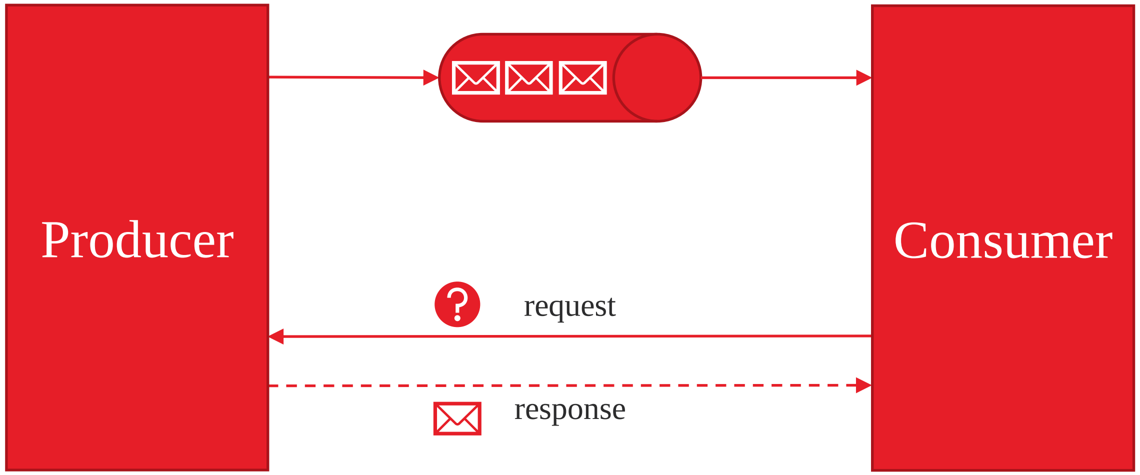
Summary of integration approaches for publishing data

Combining patterns

The integration approaches on the previous slide are not exclusive. It is plausible to combine patterns:

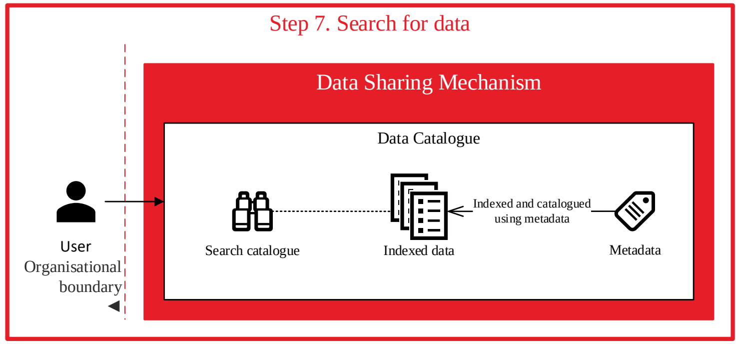
- Message queues to inform consumers of updated datasets being available.
- Web APIs to request the updated data when required by the consumer.

The type of data exchange pattern will depend on a number of factors to determine which is most suitable, including the requirements for the use-case (including non-functional requirements), the type of data being shared and the number of consumers that a producer is sharing with.



Step 7. Search for data

Searching for data using the data catalogue



Functionality description

Data across a data sharing infrastructure will be catalogued and indexed using a data catalogue in the data sharing mechanism (as part of step 6).

Data consumers can then access the catalogue and search for the data they are interested in across the data sharing infrastructure network. The metadata will be presented in an approved standard e.g., Dublin Core to enable appropriate management and use. The catalogue will present a range of metadata associated with a dataset, including information of what the data is, where it is come from, who the data owner is, data usage conditions etc. This will provide data consumers with enough information to decide if they want to request access to and consume it (steps 8 and 9).

This step requires the following components

- Data catalogue
- Search functionality
- Metadata standards

Step 8. Review & request access

Requesting access to the data and approval

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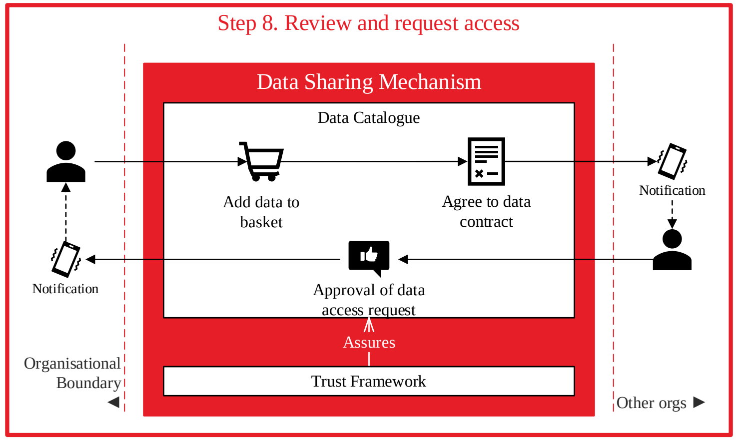

Functionality description

After the data consumer has searched and found their data, they can request access to it. Depending on whether the data is open, shared or closed, requesters may need to provide some mandatory information for the nature of the request and intended use.

The data producer will receive a notification of this request so that the data producer can triage the request and determine the approval/denial effectively. The approval process could auto-approve requests based on conditions set by the data provider. Rejections to the request will be accompanied with the rejection reasons.

The approval process will be managed by the trust framework, where the data usage conditions, and T&Cs are handled. The requester will need to agree to the conditions and formalise the exchange with a data contract.

It will be the responsibility of the organisation requesting and receiving the data to ensure compliance to the usage conditions and T&Cs. A suitable audit process may be required, and the details of this will be developed in the next phase of design.

The granting of access could be timebound, invoking a regular review cycle for both consumer and producer to confirm the ongoing need to receive the data and the agreement to share the data, respectively.

The security controls for the data, including access control permissions and other controls as specified in step 6, will also come into effect for the exchange process through the security services.

There may be instances where a data consumer may already have the correct permissions and identity, in which case depending on the data usage conditions, they can begin consuming the data without needing to go through the formal request process.

This step requires the following components

- Trust framework
- Data catalogue
- Security services

Step 9. Access the data (1 of 4)

Consuming data into the Data Preparation Node

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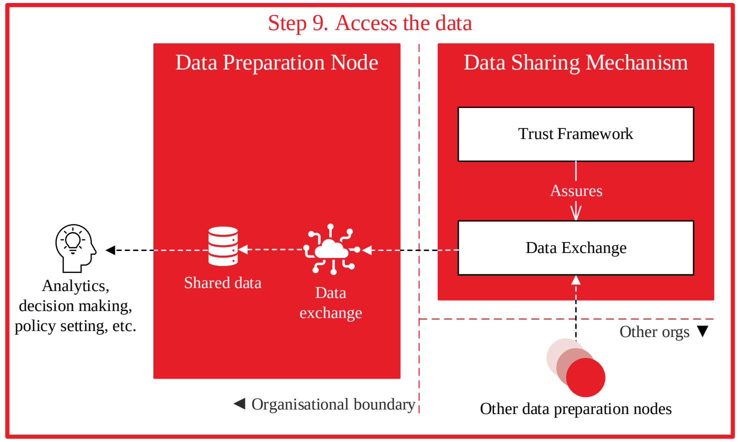


Functionality description

Data is accessed and consumed though the node's API endpoints and message brokers (described in step 6). The data is consumed in the interoperable standardised format that it was published in (as part of step 5).

Before the data is ingested, it will undergo some schema assurance checks to ensure validation of the ingested data.

Once the data is ingested, it will be stored in a 'received datastore' within the node. This data can then be exploited from the datastore into the organisation's own data pipelines/datastores for decision making and analytical purposes – depending on the specific use-case. The exploitation of this data from the node into the organisation is done through API and connectors (described in step 4).

The API endpoints should be designed to provide the data in specific formats e.g. JSON or XML, depending on the data. If the data accessed through a message broker, then the data will need to be converted to a serialised format like Avro, JSON or Protobuf, and will need to provide the schema definition along with the data.

The exchange of the data between nodes may either be centralised or decentralised (or a mixture of both) depending on the use-case. The data between data preparation nodes may be shared peer-to-peer, in which case the message brokers will exchange the data directly between the data preparation nodes, or they can be exchanged with a central broker in the data sharing mechanism, where the central broker will then orchestrate the sharing of the data with consumers. These options are described in further detail on the next slide.

This step requires the following components

- API/connectors
- Message brokers
- Schema assurance
- Received datastore

Step 9. Access the data (2 of 4)

Options for data exchange architecture

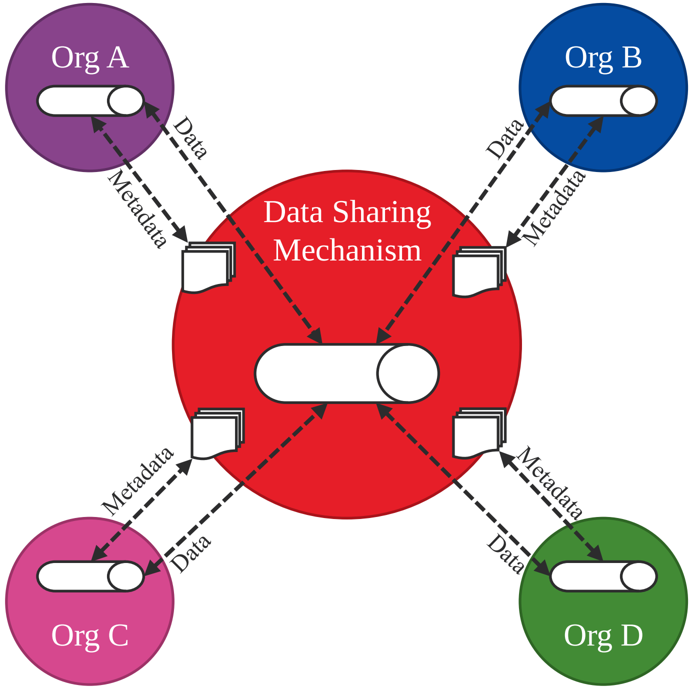
Centralised data exchange

Adopting a centralised data exchange model will see all metadata and data passed via the data sharing mechanism.

The data sharing mechanism will coordinate the brokering of messages between the data preparation nodes. This may be useful if organisations do not have mature IT infrastructures to set up and provision their own message brokers for peer-to-peer sharing.

Some of the characteristics for this includes:

- Central orchestration of data movements between data preparation nodes via a broker within the data sharing mechanism boundary.
- Allows for assurance and compliance checks relating to approved data sharing agreements to be coordinated by central data exchange mechanism locally.
- Direct oversight of data movements by data sharing mechanism.
- Increased latency with additional ‘hops’ taken by the data.



Step 9. Access the data (3 of 4)

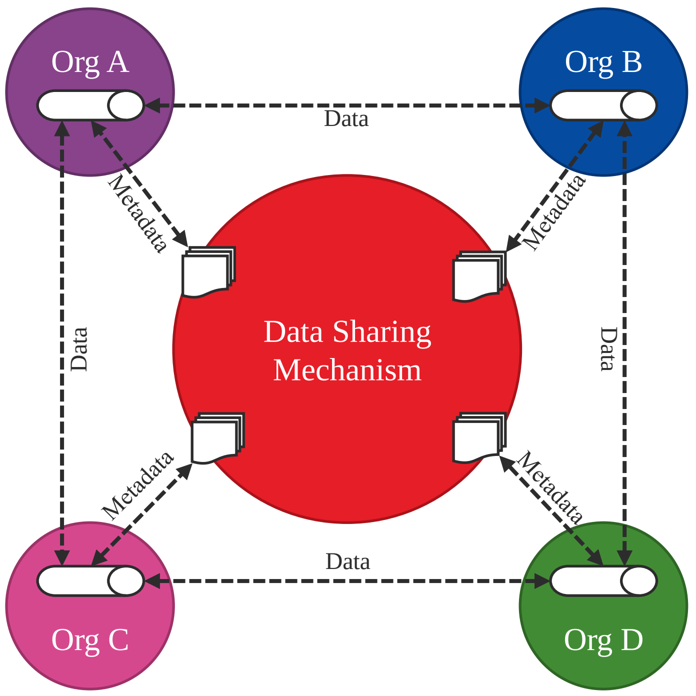
Options for data exchange architecture

Decentralised data exchange

Adopting a decentralised data exchange model will see data passed between each data preparation node directly on a peer-to-peer network, with the data sharing mechanism managing the assurance and compliance for the data sharing. This could be achieved through API endpoints where entities are sharing their data through a point-to-point exchange i.e., avoiding the need for central brokering. Metadata is still exchanged and managed centrally via the data sharing mechanism. Some of the characteristics for this includes:

- Decentralised orchestration of data movements between nodes with a peer-to-peer data exchange mechanism.
- Centralised trust and assurance capability within the data sharing mechanism used by node as part of data exchange.
- Less direct oversight of data movements by data sharing mechanism with reliance on relevant information being provided by each node.
- Reduced latency in data movements due to direct node to node integrations.

This type of exchange will enable the nodes to act autonomously between themselves for data exchange. However, the data sharing mechanism will still perform functions for permissions, trust, transaction of metadata, and monitoring of nodes but there may be some security and governance services which cannot be offered centrally through the data sharing mechanism if the data exchange is conducted peer-to-peer.



Step 9. Access the data (4 of 4)

Exchanging data securely

Functionality description

The exchange of data between nodes across a data sharing infrastructure will have a range of security requirements pertaining to access control, confidentiality, legal, compliance, trustworthiness etc. These are covered in more detail in Appendix F.3.

These requirements should be met by a host security services, including:

- **Entity security:** directory services, authorisation & authentication etc.
- **Communication security services:** message integrity protection, message content confidentiality etc.
- **System security services:** access control, audit trails, trusted time etc.

Some of these controls will be subject to the specific use-case and the requirements for that data i.e., some use-case will require restricted data services and others may require unrestricted data services.

Audit trails and security information should be collected centrally by the governance function for monitoring and remediation purposes. The details of this will be developed in the next phase of design.

In addition to the security services, the trust framework will also work in parallel to ensure that the data usage conditions are being met. A combination of the security services, trust framework, and system governance will work together to enable the secure and compliant sharing of data.

This step requires the following elements

- Security services
- Trust framework
- System governance

MVP functionality as part of the user journey

Mapping of the nine steps to the conceptual architecture components

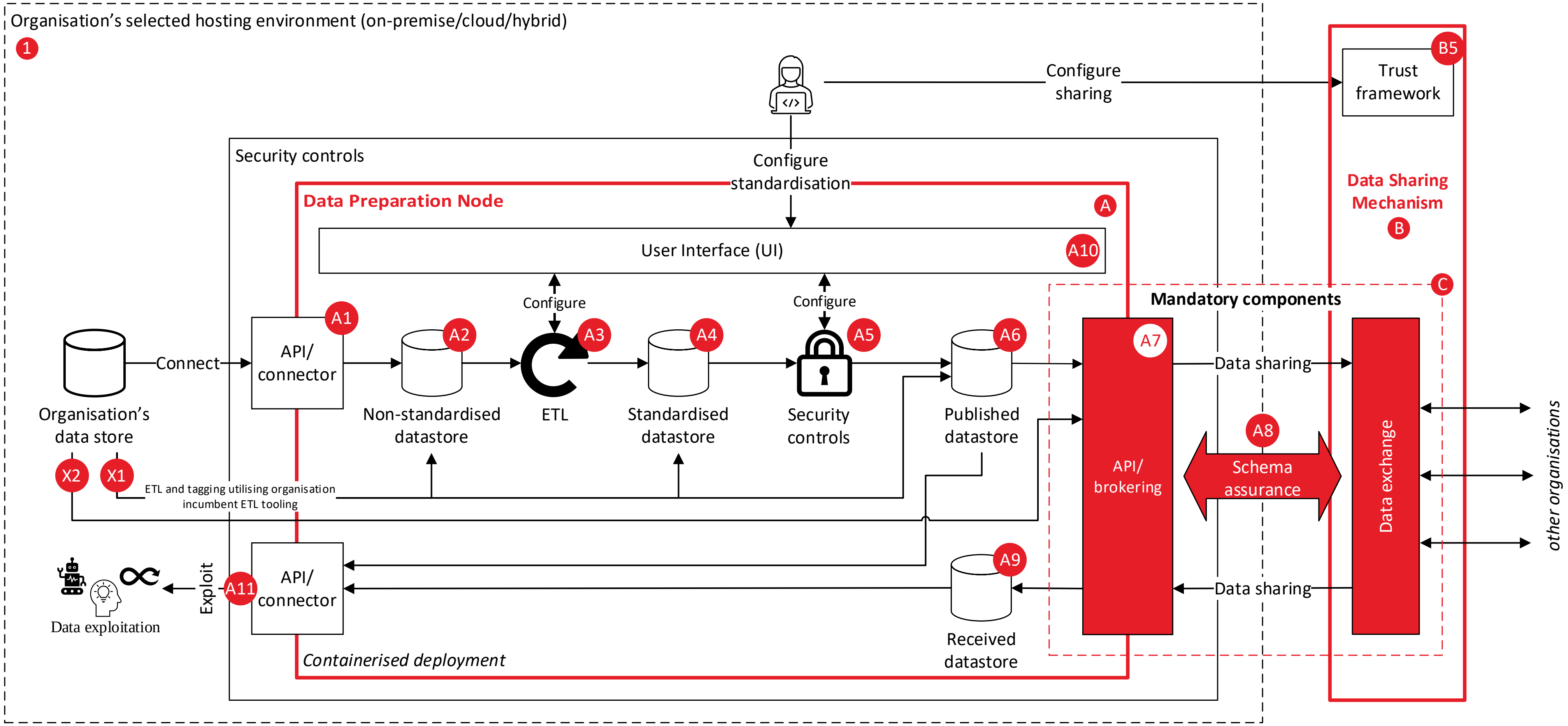
	Provisioning data for sharing						Accessing shared data		
	Step 1. Deploy data preparation node	Step 2. Register with data sharing mechanism	Step 3. Identify data for sharing	Step 4. Connect data source to the node	Step 5. Align data to minimum operable standard	Step 6. Publish data for sharing	Step 7. Search for data	Step 8. Review and request access	Step 9. Access the data
A. Data Preparation Node									
A1. API/connectors				✓					
A2. Non-standardised datastore				✓	✓				
A3. ETL					✓				
A4. Standardised datastore					✓				
A5. Security controls					✓				
A6. Published datastore					✓				
A7. API/brokers						✓			✓
A8. Schema assurance						✓			✓
A9. Received datastore									✓
A10. User Interface (UI)		✓		✓	✓				
A11. Exploit data									✓
B. Data Sharing Mechanism									
B1. Management node		✓						✓	
B2. System governance		✓				✓	✓	✓	✓
B3. Data catalogue						✓	✓	✓	
B4. Data exchange									✓
B5. Trust framework		✓				✓			✓
B6. Security services		✓				✓	✓	✓	✓

G.2

High-level design of the data preparation node

High-level design - data preparation node

High-level design of the data preparation node



High-level design - data preparation node

Descriptions of the high-level design of the data preparation node

Overview of the high-level design

The following functional component descriptions correspond with the numbers on the diagram on the previous page.

X. **Hosting environment**: the hosting environment where the organisation will deploy the data preparation node.

X1. **Organisation's incumbent tooling**: the organisation may use their own ETL component and security tools to assign their own security controls to the data rather than using the data preparation node components.

X2. **Publishing to API endpoints/message broker:** if the organisation does not need to use any of the optional functionalities of the data preparation node, then they can publish their data straight to the API endpoint/message broker (albeit it meets the required data standard and security controls).

A. **Data preparation node**: containerised application node deployed in the organisation's environment

A1. **API/connectors**: connectors & APIs to connect and ingest data from the organisation's datastores into the node.

A2. **Non-standardised datastore**: to host the data that requires transformation through the ETL pipeline.

A3. **ETL**: ETL component to transform the non-standardised data into the required format.

A4. **Standardised datastore**: to host the transformed data from the ETL pipeline.

A5. **Security controls**: security controls including permissions & other security services set on data.

A6. **Published datastore**: to host the data that is ready to be published to the data sharing mechanism.

A7. **API/brokering**: published and ingested data is exchanged across the data sharing mechanism with other organisation via API endpoints and message brokers (e.g., pub/sub and streaming data).

A8. **Schema assurance**: outbound and inbound data undergoes schema assurance to ensure that the data schema conforms to the correct standard for sharing.

A9. **Received data**: to host consumed data from other organisations.

A10. **User Interface (UI):** users interact and configure the data preparation node including the ETL pipeline and security controls through the UI.

A11. **Exploit**: the organisation's own standardised data and the data received from other organisations' nodes is ingested into the organisation via APIs and connectors for decision making and analytical purposes (depending on the use-case).

B. **Data sharing mechanism:** provides a range of security, governance, cataloguing, tooling and data exchange services to enable the sharing of data between nodes.

B5. **Trust framework:** users will need to provide the correct data usage conditions for the data they wish to publish using the trust framework in the data sharing mechanism.

C. **Mandatory components:** organisations will need to use the API endpoints & message brokers which the node provides to enable sharing of data across the data sharing mechanism. This will also require schema assurance checks to validate the data. Users may wish to use their own tooling and datastores if they have established data pipelines and mature IT capabilities, but they will need to publish the data via the node's APIs and message brokers to assure and secure the data.

G.3

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Organisational considerations for a data sharing infrastructure

Organisational considerations for technology

Current organisational considerations for a data sharing infrastructure

Overview

Through stakeholder engagement and the development of the high-level design of a data sharing infrastructure, the following organisational considerations were highlighted

- **Disparate datastores:** organisations may have data spread across multiple disparate IT systems and datastores. This may prove challenging for when they need to identify where their data is for sharing and to potentially having to establish multiple connectors and APIs to the node**.**
- **IT maturity & skills:** deploying and operating data preparation nodes for sharing across a data sharing infrastructure will require a certain level of IT skills to ensure that organisations are deploying and configuring the tool effectively.

  Whilst some of the complexities related to the ETL pipeline and data exchange may be abstracted from the users, an understanding of these underlying technologies would be useful to ensure effective and appropriate use.
- **Propriety datastores :** if organisations have data stored in propriety and custom data stores and formats, datastores, then this would add additional complications to the ETL/connectors required because bespoke connectors and APIs may need to be established (as opposed to using reusable connectors and APIs for commonly used systems).
- **Existing data pipelines and capabilities:** some organisations may have established ETL pipelines. In which case, they could use their incumbent tooling for the data transformation and load it into the data preparation node's datastore, ready for onward sharing across a data sharing infrastructure.

  Organisations should not need to replace their existing capabilities with the data preparation node but rather the data preparation node should offer the blueprint for data preparation that organisations can choose to do themselves (if they have the capability).
- **Security & data sharing:** Overall security of the system will be achieved through shared responsibility between the participants and a data sharing infrastructure that will need to be defined, agreed and documented in security policies.
- **Costs:** deploying, maintaining and using a data preparation node will incur computing costs for hosting the application, especially if the application needs to be exchanging energy data 24/7. Organisations should be aware of these costs so that they can appropriately accommodate for it.
- **Engineering costs:** in addition to the computing costs to deploy and run a data preparation node, organisations may also incur engineering and development costs required to use the node.
- **Resiliency:** organisations hosting a data preparation node will require a suitable level of resiliency to keep their node online to continue data exchange with consumers. Certain data contracts and requirements for exchange may entail of streamed data or system critical datasets, which will require high data preparation node availability and uptime.

  Organisations will need to deploy the node in a resilient environment where the expected level of uptime can be maintained (depending on the requirements). There may need to be SLAs or agreements in place between the data producers and a data sharing infrastructure for their resiliency, availability and quality of their deployment environment to host the data preparation node.

Organisational considerations for people

Current organisational considerations for a data sharing infrastructure

Overview

Through stakeholder engagement and the development of the high-level design of a data sharing infrastructure, the following organisational people and process considerations were highlighted:

- **Establishing a culture for data sharing & collaboration:** participation with a data sharing infrastructure will require organisations to foster a culture for data sharing and collaboration. This may entail of adopting a 'data as a product' thinking, where the data is prepared, managed and shared with other consumers as a product.
- **Identifying data to share:** organisations will define internal governance and process procedures to understand what data they want to share, and the required usage policies, security controls and T&Cs associated with that data.
- **Ensuring appropriate data quality & trust:** data that is shared using the data preparation node will need to have an acceptable or well understood data quality and trust. Data quality controls are not scoped for the MVP, this will mean that organisations will need to perform data quality checks so that the different quality dimensions related to accuracy, consistency, timeliness etc., can be understood before sharing with data consumers.

Establishing a trust framework

In addition to ensure a scalable and flexible data sharing infrastructure, organisations will need to establish and register with a trust framework. Through stakeholder engagement, it is expected an organisation will be registered to multiple trust frameworks based on use cases, commercial arrangements, and security factor - allowing organisations to share data more widely. This will drive trust frameworks to be tailored for different data sharing infrastructures. Therefore, each organisation needs to consider:

- **Data sharing agreements & data contracts as part of the trust framework:** related to the point on resiliency, certain agreements and data contracts may need to be place between data producers and consumers for specific use-cases and datasets. For example, sharing of critical datasets and agreements being in place that the data producer will supply this within the agreed timeframe and other agreements on data lifecycles and deletion policies.
- **Role of the organisation:** As part of the trust framework, the organisation needs to agree to a role which will help data sharing mechanism operator manage authorisations when interacting with the data sharing mechanism.
- **Confidence and buy-in to data sharing infrastructure:** ensuring the registration and subscription to a data sharing infrastructure is aligned with the organisations risk profile and internal IT and security requirements. This can include "Know Your Customer" guidelines and regulations, and role management for organisations interacting with the data sharing mechanism.
- **Accountability agreements**: related to data sharing agreements, organisations need to identify their liabilities, and conditions for the data consumers to ensure organisations understand the implications for sharing and receiving data using a data sharing infrastructure.

Appendix H

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Delivery pathways for a data sharing infrastructure

Delivery pathways for a data sharing infrastructure

Options for the potential long-term delivery and management of the data sharing infrastructure

Overview

This appendix conducts a high-level review into the potential delivery pathways to develop and deploy a data sharing infrastructure for the energy system.

It considers:

- Approach for determining delivery pathways
- Delivery options
- Approach considerations
- High-level assessment of options
- Proposed delivery pathway

This appendix also outlines the ways in which a data sharing infrastructure can be procured and developed by government and industry collaboration for wide societal benefit.

Options for enabling a data sharing infrastructure can be found in Appendix K with details on potential funding routes for a governance mechanism in Appendix I.4.

Key findings

Through stakeholder engagement (Appendix A) and learnings from other data sharing infrastructures (Appendix D) several delivery options were identified for the implementation and steady state operation phases of a data sharing infrastructure.

Each of these options can support the delivery of the three key aspects: **Prepare, Trust, and Share**.

A selection of options for the implementation and steady-state phases for all three aspects of the data sharing infrastructure is defined as a pathway. There are 8,000 combinations of pathway, each assessed against ten considerations.

The highest scoring pathway has been described in detail, but it is not the only option for enabling a data sharing infrastructure.

Further assessments should be undertaken to evaluate these pathways against policy, funding, capability, and value reflections.

H.1

Approach to determining delivery routes for a data sharing infrastructure

Approach

An overview of the approach for assessing delivery routes of a data sharing infrastructure

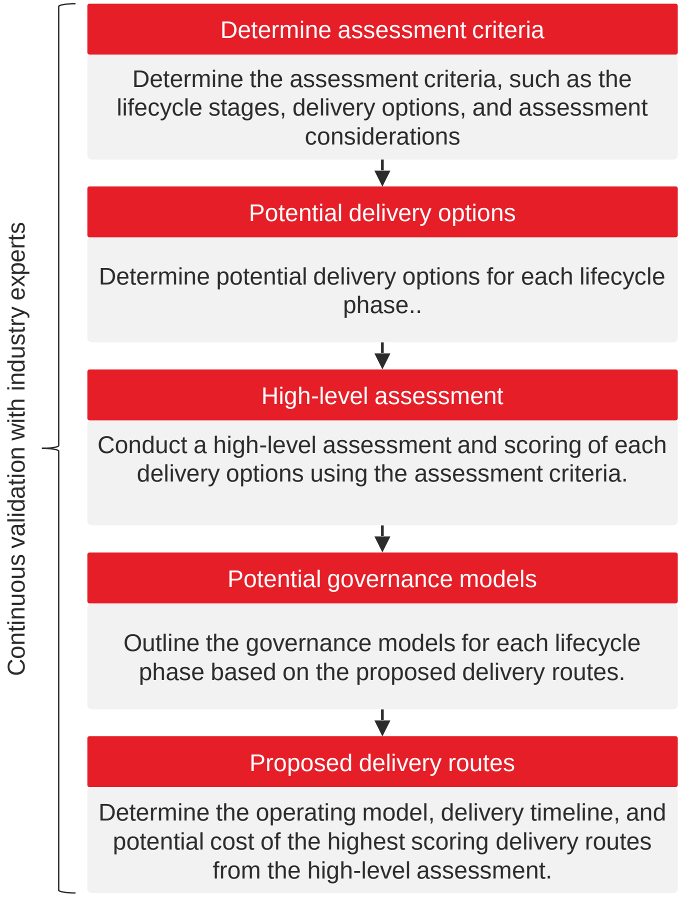
Overview

The feasibility study has identified three functional components that make up a data sharing infrastructure:

1. **Prepare**
2. **Share**
3. **Trust**

Each of these functional components have been evaluated understand the potential delivery route, and assessed using various criteria to determine the route that are most likely to be successful.

The approach used is summarised in the adjacent diagram and detailed over the subsequent pages.



Summary of approach to determine potential delivery routes

Lifecycle phases

It is considered that a data sharing infrastructure has two lifecycle phases:

- **Implementation:** The delivery lifecycle encompasses the series of stages and processes involved in bringing the functional components from conception to implementation. It typically begins with requirements gathering and analysis, followed by design and development, testing and quality assurance, and deployment.
- **Steady-state operation:** Once the functional components has been deployed and all major development and implementation activities have been completed, it enters the steady-state.

  During this phase, the focus shifts from active development to maintenance and support activities. The goal is to ensure the functional component operates smoothly, meets performance expectations, and remains reliable for its users. The steady-state lifecycle involves activities such as monitoring, bug fixing, performance optimisation, security updates, and user support. Continuous feedback from users and stakeholders helps identify areas for improvement and guide future enhancements.

Approach

An overview of the approach for assessing delivery routes of a data sharing infrastructure

Delivery pathway evaluation

For each of these lifecycle phases there are several potential delivery reflections:

- **Built or Buy**
- **Public or Private**
- **Open or Proprietary**

It is assumed that the organisation or vendor chosen to provide the implementation and steady-state operation phases can, at a high-level, meet the requirements as set out in Appendix C and the technical requirements in Appendix G.

This assessment aims to help government to identify the delivery pathways that are most likely to be successful, rather than a full assessment of the ability for that option to deliver.

Assessment considerations

To evaluate potential delivery routes and identify the most feasible options for the successful delivery of a data sharing infrastructure, a set of assessment considerations covering people, process, data and technology and services has been used.

These assessment considerations were identified through evaluating the needs of government, the sector, and the requirements identified in Appendix C and the technical requirements in Appendix G.

The assessment considerations are categorised as either applying similarly to both the implementation and steady-state operation phases or varying between phases.

These assessment considerations have been integrated into an evaluation matrix to enable a consistent and holistic assessment of the potential delivery routes. This allowed for the prioritisation of the most feasible for the implementation and steady-state operation phases.

The assessment considerations are summarised in the adjacent table.

Assessment consideration	Considerations that apply similarly to both phases	Considerations that vary between implementation & steady-state phases
Adoption	Yes	
Flexibility and scalability	Yes	
Monopoly risk	Yes	
Social value	Yes	
Dependencies	Yes	
Governance		Yes
Skillset		Yes
Timelines		Yes
Costs		Yes
Supply chain		Yes

H.1.1

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Delivery options

Summary of delivery options

Overview of the delivery options for the implementation and steady-state operation lifecycle phases

Overview

There are various routes and options for organisations and government to take when embarking on long-term projects or initiatives, each with its own benefits, disbenefits, and considerations.

Through workshops, stakeholder engagement, and subsequent prioritisation, four delivery routes were identified for the implementation phase and five delivery routes were identified for the steady-state operation phase.

These delivery routes are summarised to the right, with descriptions for each given on the subsequent pages.

Varying delivery routes for the two lifecycle phases

The implementation phase routes are various configurations of industry expertise and technical capability that is assembled to deliver the implementation of a data sharing infrastructure, building on the findings and outcomes of this feasibility study.

The steady-state operation phase routes are various configurations that enable appropriate organisations, with relevant experience and capability, to manage and maintain a data sharing infrastructure.

The long-term management of a data sharing infrastructure, regardless of technical implementation, will require a stable governance arrangement, particularly if it provides a foundation of data sharing in the sector.

Phase 1 - Implementation

- **Options 1A:** Independently-led industry consortium
- **Options 1B:** Publicly-led development
- **Options 1C:** Technology provider builds it
- **Options 1D:** Directly procure an existing solution and/or services from an organisation with relevant experience

Phase 2 – Steady-state operation

- **Options 2A:** Solution given to existing energy sector strategic entity
- **Options 2B:** Solution given to a national-level strategic entity
- **Options 2C:** Solution given to an energy sector operational entity
- **Options 2D:** Create a commercial agreement to support operation, maintenance, and further development of the solution
- **Options 2E:** Solution owned and operated by a private entity

Potential implementation phase delivery options (1 of 2)

Summary of the identified delivery options for the implementation phase

Option 1A: Independently-led industry consortium

An independent consortium, selected through a public procurement held by government, develops one or more parts of the data sharing infrastructure. As with large capital infrastructure projects, a consortium is considered more appropriate as it de-risks delivery and it is also likely that no one organisation will have all the skills necessary. The consortium can be made up of industry experts, energy sector licensees, and technology or software development firms. They are awarded the remit to "build" a data sharing infrastructure to the specifications set out in a tender provided by DESNZ or an existing industry body with the remit to manage the sector or all sectors longer term.

Considerations for option 1A

An independently-led industry consortium is likely to provide a well-rounded approach to alignment between both industry change programmes and cooperation between market participants.

This approach is likely to align relatively well to meeting government objectives, though may prioritise sector needs above the objectives unless otherwise directed. IP considerations of the work are likely to receive appropriate scrutiny given the varied make up of a consortium.

Option 1B: Public-led development

A public-led approach to develop a part of the data sharing infrastructure proposition. This could be delivered through a 'publicly owned' organisation for the benefit of the sector. They choose to either develop the capability themselves or procure it.

The organisation is wholly responsible for costs, delivery, and development on behalf of the sector, with a governance route for who 'owns and operates it' clear at the outset of project development. Public-led organisations can include operational entities such as ElectraLink.

Considerations for option 1B

This is likely to provide a well-rounded approach and alignment between both industry change programmes and cooperation between market participants. It is considered that it will align with government objectives given its ownership structure.

Option 1C: Technology provider builds it

A tender is released to the large technology companies (for example, AWS, Microsoft, IBM, Google, etc), who then develop one or more functional components of a data sharing infrastructure.

The tender sets out expectations for IP and proprietary technologies of solutions required for a data sharing infrastructure.

Expectations are set for the level of documentation and possible ongoing support for the development of additional needs or use cases.

Considerations for option 1C

A technology provider led approach is less likely to take into account industry change programmes and cooperation between market participants.

This approach could align relatively well to meeting government objectives, if explicitly directed to do so.

IP considerations of the work are will need to be addressed early, given the risks of monopolies developing or proprietary solutions being 'locked in'.

Potential implementation phase delivery options (2 of 2)

Summary of the identified delivery options for the implementation phase

Option 1D: Directly procure an existing solution from an organisation with relevant experience

As articulated in Appendix G there are technology solutions currently available the market, which are either open-source or proprietary, that provide some or all the functionality required for a data sharing infrastructure.

These solutions could be directly procured, with any additional technical architecture needed being developed using open-source approaches.

Considerations for option 1D

Using solutions that already exists is unlikely to prioritise alignment between industry change programmes and cooperation between market participants in the same way as other routes, unless expressly directed to do so.

This approach is likely to align relatively well to meeting government objectives if given express direction to meet them. IP considerations of the work will need to be expressly set out early in the project.

Potential steady-state operation delivery options (1 of 2)

Summary of the identified delivery options for the steady-state operation phase

Option 2A: Solution given to existing energy sector strategic entity

The data sharing infrastructure solutions are provided to an existing organisation within the energy sector with a strategic remit for the sector.

The organisation is then tasked with the operation, maintenance, future development, and governance responsibilities. This may be underpinned by licensing agreements to facilitate cost recovery or regulatory remit to enable the function as a government service offering to the public. An example of a sector specific strategic entity is the potential role of the Future System Operator (FSO).

Considerations for option 2A

An existing strategic entity is likely to provide a well-rounded approach to alignment between both industry change programmes and cooperation between market participants given their role in the sector.

This approach likely has the fewest dependencies associated with meeting government objectives, given its strategic role in the sector.

Option 2B: Solution given to a national-level strategic entity

The data sharing infrastructure solutions are provided to an existing, or new, strategic entity which has a national-level remit. Within the UK context, primary or secondary legislation is likely needed to enable this approach if a new body were to be created. Options include, for example, creating a UK open-source foundation, granting power to an existing body or utilising an international agency such as the IEA.

This route could be supported by an existing energy sector governance function within the sector, with accountability to the national-level strategic entity.

Considerations for option 2B

A non-energy strategic entity may struggle initially to provide a well-rounded approach to alignment between both industry change programmes and cooperation between market participants given its new role in the sector.

This approach is likely to align relatively well to meeting wider government objectives across sectors given expectations of that organisation. IP considerations of the work may have difficulty aligning to needs of sector.

Option 2C: Solution given to an energy sector operational entity

The long-term operation of the solution is granted to an existing body within the energy sector with expertise in data and process management. Examples include Elexon.

This operational entity would utilise the code administration process to facilitate the governance, cost recovery and general management of the implementation of a data sharing infrastructure. The strategic focus of how the solution should be developed may be supported by a specific role, for example one set out for the Future System Operator (FSO).

Considerations for option 2C

An operational entity should provide a well-rounded approach to alignment between both industry change programmes and cooperation between market participants given its existing role in the sector.

This approach is likely to align relative well to wider government objectives across sectors given existing expectations of that organisation. Although additional governance changes may be required.

Potential steady-state operation delivery options (2 of 2)

Summary of the identified delivery options for the steady-state operation phase

Option 2D: Create a commercial agreement to support operation, maintenance, and development

Where a private firm has developed a solution (either open-source or proprietary) and a data sharing infrastructure has been developed on top of that solution, a commercial arrangement could be brokered whereby a tender is created for an organisation to have the commercial and legal status of managing the software on behalf of the sector.

For example, an energy sector organisation owns the contract with a third-party, for the third-party to develop and manage on behalf of that organisation.

Considerations for option 2D

A third-party facilitating management of the data sharing infrastructure is unlikely to provide a well-rounded alignment of industry change and market cooperation. Given the commerciality of this arrangement, it is also unlikely, unless expressly set out, to help support government and regulator objectives in a way that is 'core' to the organisations remit. IP considerations may also be challenging to arrange with a third-party managing the data sharing infrastructure.

Option 2E: Solution owned and operated by a private entity

Where the solution is to be led by private enterprise, it would be expected that cost structures akin to a Software as a Service models (SaaS) would be used by the entity to recover costs against market participants that utilise the tooling.

In this instance, government may choose to select an organisation who can then recover costs from those in the sector, or a mechanism like the DCC is brokered where they are responsible for delivery and ongoing management of the products and services.

Considerations for option 2E

In this scenario, the data sharing infrastructure is unlikely to provide a well-rounded alignment of industry change and market cooperation. Given the commercial nature of this arrangement, it is also unlikely, unless expressly set out, to help support government and regulator objectives in a way that is 'core' to the organisation's remit.

IP considerations may also be challenging to arrange, given a private entity is likely to seek profit maximisation.

H.1.2

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Adoption considerations

Adoption considerations

Considerations that are similarly applicable across both the implementation and steady-state operation phases

Implementation and steady-state operation phases

Ability of the user and/or organisation to use a data sharing infrastructure to meet their needs without significantly changing the status quo, maximising the likelihood of its successful adoption into business-as-usual practices. This consists of three elements:

- Technology
- Accessibility
- Training

For each of these elements it is considered that there is an ability for the provider/vendor to implement feedback mechanisms to support evolution and continuous improvement.

- **Technology:** Ability of the user and/or organisation to use a data sharing infrastructure to meet their needs without significant changes to their technology stack.

  This considers:

  - Ability of the option to be technology stack agnostic and using widespread tools e.g., use Cloud services, use common programming languages.
  - How does the option minimise requirements for organisations to invest in new systems or technologies e.g., software licences.
  - Enabling customisation or interfacing where economically possible.

- **Accessibility:** Level of accessibility and adaptions required to the solution to ensure a data sharing infrastructure meets the needs of users with varying knowledge, infrastructure access, vulnerabilities, and disabilities.

  This considers:

  - Minimising the requirements to make significant changes to the work force in order to interact with a data sharing infrastructure.
  - Has the ability to ensure support is offered to all users and customers regardless of knowledge level and accessibility needs.
  - Can support multiple ways to engage with data and information e.g., API, user interface.

- **Training:** The level of training users require to engage with the solution and the ability of the provider to facilitate this.

  This considers:

  - Develop and/or deliver training sessions, user manuals, video tutorials, or any other resources that help users understand a data sharing infrastructure's functionality and features in plain English.
  - Develop and/or deliver custom material for different types of users and stakeholder groups e.g., Executive or day-to-day users.
  - Incrementally build the training to support the sector.

Flexibility and scalability considerations

Considerations that are similarly applicable across both the implementation and steady-state operation phases

Implementation and steady-state operation phases

Ability of the provider/vendor to deliver against and adapt to increasing complexity of the market and therefore the needs of a data sharing infrastructure.

This should consider ability for the system and provider/vendor to:

- Manage the expected increase in user types and use cases e.g., Demand side response service providers
- Manage the increase in the number and complexity of data sources including types of standards.
- React and adapt to changes in user needs in timely ways and deliver updates and adaptations to meet the evolving needs of the market.
- React to increased threats to the energy system from climate change, geopolitics, cybersecurity, and increasingly common mode failures.

Monopoly risk considerations

Considerations that are similarly applicable across both the implementation and steady-state operation phases

Implementation and steady-state operation phases

Risk factors posed by the implementation or steady-state phases, including for example:

- Vendor lock-in and whether this commits to a long-term engagement with a single provider or group of providers. Alternative ability for the route to enable multiple future providers to engage with and support the programme.
- Reliance on proprietary technology and whether considerations need to be made around accessibility of technology to all e.g., nationalisation of existing technology.
- Dependency on a single entity for funding or delivery management where independent factors could cause a failure e.g., changing priorities, lack of cross industry requirement, priority considerations, resource limitations, or data monopoly.

Social value considerations

Considerations that are similarly applicable across both the implementation and steady-state operation phases

Implementation and steady-state operation phases

Ability for provider/vendor to deliver a granular system, market data and service that:

- Can be accessed and interpreted by third parties, including academics and SMEs, minimising access barriers.
- Supports development of new innovations to support the increasingly complex needs of the system and market.
- Reduces the time and cost before it can provide value to the UK economy, support user needs, support organisational research, and foster innovation.
- Provides a solution that minimises use of proprietary technology, risk of lock-in and ongoing data monopolies.
- Provides additional benefits to support innovators and academics in addition to the industry to accelerate a low carbon transition.
- Create new businesses, new jobs and new skills.

Dependencies considerations

Considerations that are similarly applicable across both the implementation and steady-state operation phases

Implementation and steady-state operation phases

The ability for the provider/vendor to fulfil the required dependencies set out by regulatory and government bodies for example:

- Ensuring alignment between various industry change programmes such as half hourly settlement.
- Fostering cooperation and action by a wide range of market participants across different licensing and code frameworks.
- Creating the right conditions for the IP of the work to be usable as appropriate by a wide range of organisations through contractual arrangements, licence terms or other mechanisms.
- Meeting legal requirement set out by government and the regulator, such as the net zero power sector target.

Governance considerations

Considerations that vary between the implementation and steady-state operation phases

Implementation phase

Ability for optimal governance including engaging with required stakeholders to develop the data sharing infrastructure.

This covers:

- Ability of the governance mechanism to meet the complexity and breadth of involvement required including engagement with the required stakeholder groups.
- Ability to own and manage governance, minimising costs and complexity whilst ensuring requirements in Appendix C and the technical requirements in Appendix G are met.
- Ability for governance mechanism to be transferred to steady-state delivery route with minimal disruption.

Steady-state operation phase

Ability for successful governance of a data sharing infrastructure and support further development or management of the solution in line with the requirements once operationalised covering:

- Ability for the governance mechanism to ensure continuity and minimise disruption in transfer from implementation to steady-state operation phase.
- Ability to manage feedback mechanisms and stakeholder engagement at requirement levels and with relevant industry groups including management of structural trust challenges
- Ability to own and manage governance, minimising costs, complexity and draw on government resource
- Foster innovations to improve access to existing markets and create new markets and business models to respond to changing energy technologies.

Skillset considerations

Considerations that vary between the implementation and steady-state operation phases

Implementation phase

The availability of the correct skills to deliver a data sharing infrastructure functional components, and ensuring those responsible for the delivery have the relevant:

- Domain experience, such as cyber security, to ensure it is fit for purpose and recognises the nuances of user requirements and sector minimising dependency on government or stakeholder resource.
- Sufficient relevant employee resources spanning people, process, and technology to ensure resilient delivery.
- Innovative ways of working, capable of adapting to changing requirements and supporting the needs of the sector in delivering a data sharing infrastructure.

Steady-state operation phase

The availability of the correct skills to support the steady-state operation and ensuring provision of the necessary support management, and maintenance services, considering factors such as:

- Availability of suitable technical support, road mapping and development skills to manage the system and further development.
- Ability to provide required training materials, documentation and support required to enable users to engage with a data sharing infrastructure.
- Ability to ensure the necessary uptime, response times and bug fixes to reduce risk of system failure and potentially market failure as a result of using a data sharing infrastructure.
- Commitment to provision of timely software updates, ongoing assistance, and continuous improvement through engaging with the users.

Timeline considerations

Considerations that vary between the implementation and steady-state operation phases

Implementation phase

Ability to ensure timely implementation covering:

- The mobilisation period required to ensure design meets the user, governance and technical requirements set out in Appendix C and the technical requirements in Appendix G.
- The time to build or customise the relevant aspect of a data sharing infrastructure so that it meets these requirements.
- The ability to minimise time required to hand over to steady-state operation phase.

Steady-state operation phase

Ability to manage, customise, adapt and update the system to meet the user and industry needs. For example, considering:

- System uptime and response time management.
- Integration of feedback and adaptation of technology and supporting resources.
- Ability to engage the correct stakeholder groups to enable augmentation of a data sharing infrastructure to support new use cases and drive continuous improvement.

Cost considerations

Considerations that vary between the implementation and steady-state operation phases

Implementation phase

Value for money to the government and consumers for the implementation of the data sharing architecture. Considering how the delivery route minimises the draw on government resources by:

- Providing relevant domain expertise and understanding of requirements of a data sharing infrastructure to minimise mobilisation resource and dependency on programme management by government.
- Having the demonstrable ability to leverage existing relationships and engage with the relevant industry stakeholders to ensure successful delivery including industry supported funding mechanisms.
- Demonstrating innovative and efficient ways of working that minimise delivery costs.

Steady-state operation phase

Value for money to government and consumers for the operations and management of a data sharing infrastructure. Considering how the delivery route minimises draw on government resources by:

- Maximising cost recompense from industry/users.
- Minimising draw on government and industry time through provision of the relevant domain and technical expertise to support steady-state.
- Demonstrating innovative and efficient ways of working that minimises ongoing costs.

Supply chain considerations

Considerations that vary between the implementation and steady-state operation phases

Implementation phase

Reliability and track record of delivering similar solutions in the energy sector. Consider factors such as the provider/vendor:

- Reputation and its potential impact on the success or failure of implementation
- Financial stability and ability to maintain business continuity.
- Resilience and ability to meet contractual obligations.

Steady-state operation phase

Reliability and track record in steady-state management of similar solutions in the energy sector and/or expected long term resilience of the option. Consider factors such as the provider/vendor:

- Likelihood of long-term availability of continuous resource to support further development or management of a data sharing infrastructure and support integration of future stakeholders or providers.
- Financial stability and ability to maintain business continuity.
- References, and ability to meet contractual obligations.

H.2

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High-level assessment of the potential delivery options

Programme of works execution considerations

Summary of how the programme of works for implementing and operating a data sharing infrastructure could be executed

Overview

There are various delivery routes for the implementation and steady-state operation of a data sharing infrastructure.

There is also a consideration of how the overall programme of works for implementing and operating the three functional components of a data sharing infrastructure could be executed.

It is considered that there are two approaches:

1. **Delivered together as one programme:** The three functional components are implemented and operated as one combined programme by one service provider.
2. **Delivered separately as three parallel programmes:** The three functional components are implemented and operated as three parallel and interconnected programmes, by more than one service provider, with overall separate programme management function.

An outline of these two approaches in given on this page, with the summary of the recommended approach for consideration on the next page.

1. Delivered together as one programme

In this approach the three functional components are implemented and operated as one combined programme by one service provider or consortium.

This "*one customer, one service provider*" approach would minimise the need for continuous alignment between service providers across the lifecycle phases.

However, as observed with large capital infrastructure projects and other "digital spine" implementations in other sectors, a single provider or consortium can introduce risk of single point failure and create a burden on a single service provider or consortium.

Therefore, a robust programme governance, programme controls, and escalation mechanisms will be required to manage competing priorities and mitigate any "*I have started, so I will finish*" mindsets - where decisions are not always made in the best interest of the overall programme.

2. Delivered separately as three parallel programmes

In this approach the three functional components are implemented and operated as three parallel and interconnected programmes, by more than one service provider, with an overall separate programme management function.

This "*one customer, multiple service providers*" approach would de-risk the single point of failure.

However, it would increase the complexity of procurement – requiring multiple service providers or consortiums.

It would also introduce a requirement for effective overall programme management to ensure alignment and integration between the three programmes, which would likely be best provided by a separate provider to those delivering the three programmes.

High-level assessment of the potential delivery options

Summary of the approach and evaluation scoring for the delivery options

Overview

This assessment has intentionally considered the three functional components being *delivered separately as three parallel programmes* (see the previous page for more information).

This is because considering this approach provides an understanding of how each functional component could be delivered, and the delivery options that are most likely to be successful. It also does not preclude them being delivered as one programme.

The high-level assessment intentionally does not consider the overall separate programme management function.

The adjacent tables outline the evaluation criteria used in the assessment, and the evaluated assessment considerations for each delivery option. The summary results of the high-level assessment are given on the next page, with the details of each assessment given in the following appendix subsections.

Evaluation scoring criteria

Each assessment consideration is scored using the below scale. The scoring is applied with equal weighting to each assessment consideration. The sum of each assessment consideration's score then provides the total score for that delivery option.

The scoring was conducted through workshops and consultation and validation with industry experts.

Score	Definition
1	Very low confidence/ could not deliver against consideration
2	Low confidence in ability to deliver against consideration
3	Could deliver against consideration but with some constraints/ reservations
4	High likelihood of being able to deliver against consideration but with some constraints/ reservations
5	Full confidence in ability to deliver against consideration

Assessment considerations

The below criteria are detailed in Appendix H.2.

Assessment consideration	Considerations that apply similarly to both phases	Considerations that vary between implementation & steady-state phases
Adoption	Yes	
Flexibility and scalability	Yes	
Monopoly risk	Yes	
Social value	Yes	
Dependencies	Yes	
Governance		Yes
Skillset		Yes
Timelines		Yes
Costs		Yes
Supply chain		Yes

High-level assessment of the potential delivery options

Summary of the high-level assessment of the potential delivery options for the three functional components of a data sharing infrastructure

High-level assessment results

The adjacent table summarises the results of the high-level assessment, with the details of each assessment given in the subsequent Appendix subsections.

The evaluation scoring criteria are given on the previous page. The scoring is applied with equal weighting to each assessment consideration. The sum of each assessment consideration's score then provides the total score for that delivery option shown in the table.

In cases where the scores are nuanced, additional thought was given to considerations in **highlighted red**, as those are noted as priority considerations for the associated phase of execution. Further stakeholder engagement needs to be undertaken to validate the matrix assessment and future requirements. See Appendix O for more details.

The cells highlighted in the table are the delivery option with the highest score for each of the lifecycle phases and functional components. From this high-level assessment it was observed that there is not a single option that applies to all functional components within a lifecycle stage.

The proposed governance models for each lifecycle phase is given in Appendix I.2.

Lifecycle phase	Delivery option	Functional components		
		Data preparation node	Data sharing mechanism	Trust framework
Implementation	**Option 1A:** Independently-led industry consortium	**31**	**31**	29
	Option 1B: Publicly-led development	27	23	25
	Option 1C: Technology provider builds it	27	29	21
	Option 1D: Directly procure an existing solution and/or services from an organisation with relevant experience	28	28	**35**
Steady State operation	**Option 2A:** Solution given to an energy sector strategic entity	24	**32**	**31**
	Option 2B: Solution given to a national-level strategic entity	**28**	27	24
	Option 2C: Solution given to an energy sector operational entity	19	29	29
	Option 2D: Create a commercial agreement to support operation, maintenance, & further develop solution	23	25	28
	Option 2E: Solution owned & operated by private entity	19	18	19

The delivery options highlighted are the highest scoring from the high-level assessment have been developed further in Appendix H.3 to understand the operating model, delivery timelines, and potential costs. The assessment conducted are the view of the consortium, and further stakeholder engagement, considerations and needs review is recommended (see Appendix O).

H.2.1

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Evaluation of the delivery options for the data preparation node

Implementation phase of the data preparation node

Assessment to determine the entity that will manage the aspect during the operational lifecycle

	Option 1A: Independently-led industry consortium	**Option 1B:** Public-led development	**Option 1C:** Technology provider builds it	**Option 1D:** Directly procure an existing solution and/or services from an organisation with relevant experience
Adoption	4 – High chance industry views and needs are incorporated	3 – Able to lead the sector but questions over ability to drive adoption through provision of necessary training materials	4 – Ability to build something given the existing user centred design and technical requirements	4 – Similar product already exists because it was built for another need / sector.
Monopoly risks	5 – Can design and set up to mitigate this risk.	5 – Can design and set up to mitigate this risk.	3 – This option risks vendor lock-in. Some competition between orgs.	2 – This option risks vendor lock-in given single source, unless mandated fully open source.
Social value	4 – Distributed learnings for the consortium developing it; can incentivise further information exchange.	4 – Social benefits gained by publicly owned entity, can incentivise sharing learnings.	2 – Small benefits to UK, even if location of provider is based in UK.	3 – Benefits to UK business if located in UK.
Governance	3 – Consortium building, and agreement may be challenge.	3 – Extensive engagement challenging for one organisation.	2 – Likely to be less knowledgeable about sector	2 – Likely to be less knowledgeable about sector
Supply chain	4 – Depends on the make-up of industry consortium.	4 – Is stable (publicly owned)	4 – Large companies are typically stable	3 – Risk placed on single, smaller organisation
Skillset	4 – Make up of consortium critical path.	3 – Unclear if organisation has technical skills during delivery period.	4 – Will have the required technical skills. Fewer stakeholder skills in domain.	4 – Will have the required technical skills. Fewer stakeholder skills in domain.
Timelines	3 – Ability to deliver key to successful consortium but ramp-up time and alignment of organisations could impact timelines	2 – Will need to acquire relevant skills which will take time, less agile than other options. Reliance on public sector timescales and resource.	4 – Will require some time to get the right engagement from industry stakeholders given not in sector, but will be quick to build, may have already started	5 – Expertise and smaller companies more agile.
Costs	4 – Similar rate card to big tech	3 – Higher overhead costs to build relevant skills.	4 – Able to rationalise costs through using existing capabilities, likely would absorb some due to prestige.	5 – Likely a cheaper tender to complete work as adaptation rather than build required/ less overhead
Total	**31**	**27**	**27**	**28**

Steady-state operation phase of the data preparation node

Assessment to determine the entity that will manage the aspect during the operational lifecycle

	Option 2A: Solution given to a strategic entity	**Option 2B:** Solution given to a national-level strategic entity	**Option 2C:** Solution given to an energy sector operational entity	**Option 2D:** Create a commercial agreement to support operation, maintenance, and further development of the solution	**Option 2E:** Solution owned and operated by a private entity
Adoption	4 – Ability to engage and mobilise sector given strategic role	5 – Ability to engage and mobilise sector and other sectors to combine and align	3 – Less strategic importance, although still has sector credentials and understanding	3 – Ensure ability to deliver in contract award but may take some time to mobilise	2 – Without a compelling reason to engage, there is no guarantee the required organisations will engage
Monopoly risks	3 – Could prioritise needs of a specific sector over other sectors.	5 – No lock in, considers not only needs of sector but needs of nation allowing expansion rather than risking monopoly	1 – Single entity ownership could prioritise own needs or priorities over sector's, could drive development in a way that results in lock-in	2 – Dependent on government funding and could be a single contract award however could be managed by contract requirements and length; risk of vendor lock-in (too difficult to switch)	2 – A single source private entity delivering this service risks proprietary tech lock in.
Social value	4 – Can use strategic position to drive innovation in sector and create new jobs and skills that do not currently exist in organisation	5 – Drive cross sector innovation, knowledge transfer and inclusion at a National scale	1 – Could increase dependency on proprietary systems, may be focussed on internal objectives rather than the innovation ones of nation	2 – Contract likely to go to a large company, unlikely to drive UK social value needs, although could be contractually obligated to	1 – Private entity will likely do little to prioritise social value beyond direct (and indirect) job creation.
Governance	3 – Will have access to required stakeholder breadth but may struggle managing from a resource perspective	4 – Will have access to relevant industry and cross sector groups but may struggle managing from resource perspective	2 – May not have breadth of stakeholder relationships required or interest in owning and managing governance at required scale	3 – Will need to demonstrate ability to do so contractually although may not have the industry relationships to be successful	1 – Likely to be challenging to integrate with existing governance design.
Supply chain	4 – Stable, publicly owned	3 – Strategic body is publicly owned although dependent on political strategy	2 – Risk placed on single organisation	3 – Risk placed on single or consortium organisations, however ability to hand over contract if issue arises	3 – Likely to develop stable supply chain.
Skillset	2 – Would need to contract out in short/ medium term and develop skills	2 – Would need to contract out in short/ medium term and develop skills	4 – Gift to entity with required skills although less control over future needs and development	5 – Award contract to entity(s) with required skills	5 – Likely to have or more easily acquire skills required.
Timelines	2 – Not likely very agile	2 – Not very agile	3 – Single entity more agile	4 – Contractual obligations and incentives to deliver	4 – Revenue will depend on moving quickly
Costs	2 – Costs held by public sector and would need to contract out in short term	2 – Costs held by public sector and would need to contract out in short term	3 – Low cost to government but operating model may result in costs trickling to consumer	1 – Contracting will require payment and therefore costs at higher level	1 – Costs are broadly likely to be comparable to Option 2D, with costs to different participants attributed in unknown ways.
Total	**24**	**28**	**19**	**23**	**19**

H.2.2

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Evaluation of the delivery options for the data sharing mechanism

Implementation phase of the data sharing mechanism

Assessment to determine the entity that will manage the aspect during the operational lifecycle

	Option 1A: Independently-led industry consortium	**Option 1B:** Public-led development	**Option 1C:** Technology provider builds it	**Option 1D:** Directly procure an existing solution and/or services from an organisation with relevant experience
Adoption	4 – High chance user needs are incorporated, and delivery is focussed on the requirements	2 – Are able to lead the sector but questions over ability to deliver.	4 – Ability to build technical infrastructure and supporting processes that are robust	3 – Using a product that already exists that was built for another need / sector suggests potential for transfer but may see pushback from sector
Monopoly risks	5 – Can design & set up to mitigate this risk.	5 – Can design & set up to mitigate this risk.	3 – This option may lead to vendor lock in. Some competition between orgs could make it less likely.	2 – This option may lead to vendor lock in given single source, unless mandated fully open source.
Social value	4 – Distributed learnings for the consortium developing it, can incentivise further information exchange.	4 – Social benefits gained by publicly owned entity, can incentivise sharing learnings.	2 – Small benefits to UK, even if location of provider is based in UK unless mandated to deliver on this elsewhere	3 – Benefits to UK business if located in UK.
Governance	3 – Getting consortium together & in agreement may be challenge.	2 – Extensive engagement challenging for one organisation, with limited resource and little experience with technology delivery governance	4 – Significant experience in delivering similar governance requirements	4 – Significant experience in delivering similar governance requirements
Supply chain	4 – Depends on the make-up of industry consortium.	4 – Is stable (publicly owned)	4 – Large companies are typically stable	2 – Risk placed on single organisation
Skillset	4 – Make up of consortium critical path.	2 – Unclear if has technical skills during delivery period.	4 – Strong technical skills and experience in delivering against similar requirements, however energy domain expertise less certain.	4 – Strong technical skills and experience in delivering against similar requirements, however energy domain expertise less certain.
Timelines	3 – Ability to deliver key to successful consortium however ramp up time and alignment of organisations could impact timelines	2 – Will need to acquire relevant skills which will take time, less Agile than other options	4 – Engagement slowest moving part but will be quick to build, may have already started.	5 – Existing expertise. Smaller companies more agile.
Costs	4 – Similar card rate to big tech	2 – High overhead costs to hire or build relevant skills.	4 – Able to rationalise costs and potentially absorb	5 – Likely a cheaper tender to complete work/ less overhead
Total	**31**	**23**	**29**	**28**

Steady-state operation phase of the data sharing mechanism

Assessment to determine the entity that will manage the aspect during the operational lifecycle

	Option 2A: Solution given to a strategic entity	**Option 2B:** Solution given to a national-level strategic entity	**Option 2C:** Solution given to an energy sector operational entity	**Option 2D:** Create a commercial agreement to support operation, maintenance, and further development of the solution	**Option 2E:** Solution owned and operated by a private entity
Adoption	4 – Responsible for strategically managing with other market participants in mind.	3 – Buy in from a non-energy related entity may be challenging.	3 – This type of and infrastructure management is within the capability of these types of organisations.	4 – With correct incentives and contractual arrangements this can be managed by a third party on behalf of an organisation.	2 – Without a compelling reason to engage in the service, there is no guarantee the # of required organisations will engage,
Monopoly risks	5 – Limited risks if exists as a publicly owned organisation.	4 – Limited risks, however non-energy related domain knowledge may pose challenge.	3 – An operational entity is managed with different governance mechanisms than a single source strategic org, which may create risk.	4 – Risk wrapped up in the way a contractual arrangement is written, and roles/responsibilities are defined.	2 – A single source private entity delivering this service is the definition of a monopoly, though market may correct to an oligopoly over time.
Social value	4 – Strategic organisations likely to prioritise social value	4 – Strategic organisations likely to prioritise social value	3 – Less certain social value with operational organisations given less of a strategic focus.	2 – Unless explicit within contractual arrangements, social value unlikely to be prioritised.	1 – Private entity will likely do little to prioritise social value beyond direct (and indirect) job creation.
Governance	4 – Well understood knowledge of the sector but less knowledge on how to manage assets for sector than operational entity.	3 – Lack of knowledge of the sector may become a challenge.	4 – Well understood and established governance mechanisms for these organisations and change management of technical systems.	3 – Given contractual arrangements, may be challenging to determine and run governance that supports the sectors widest interest.	1 – Likely to be challenging to integrate with existing governance design.
Supply chain	5 – Long term stability and resource given strategic role in the sector.	4 – Likely stable but unclear resource allocation to energy sector given wider scope.	4 – Secure long-term position in codes or licences.	3 – Commercial agreements can change over time and provides less guarantee than other options.	3 – Likely to develop stable supply chain.
Skillset	3 – Expected this capability would grow over time.	3 – Expected this capability would grow over time.	4 – Expected this should already exist given existing responsibility	3 – Depends on the nature of the organisation.	4 – Likely to have or more easily acquire skills required.
Timelines	4 – Expect to be strong on stakeholder engagement and uptime/ response management given criticality to mission.	3 – Less certain on strength of incentive to maintain uptime and ability to engage in a timely way.	4 – Expect to be strong on stakeholder engagement and uptime/ response management given criticality to mission.	3 – the one step removed contractual arrangement from the responsible org may slow progress.	2 – Less confidence stakeholder engagement will be positive if a commercialised product
Costs	3 – May incur additional costs as role of organisation is less technical.	3 – Coming from a different sector will incur additional costs to ensure relevant skills & expertise	4 – Costs likely less given already have sufficient skills and technology to facilitate work.	3 – outsourcing this functionality may incur additional costs (management of contracts etc)	3 – Costs are broadly likely to be comparable to option 2D, with costs to different participants attributed in unknown ways.
Total	**32**	**27**	**29**	**25**	**18**

H.2.3

Evaluation of the delivery options for the trust framework

Implementation phase of the trust framework

Assessment to determine the entity that will manage the aspect during the operational lifecycle

	Option 1A: Independently-led industry consortium	**Option 1B:** Public-led development	**Option 1C:** Technology provider builds it	**Option 1D:** Directly procure an existing solution and/or services from an organisation with relevant experience
Adoption	3 – High chance the industry views and needs are incorporated	2 – Able to lead the sector, unclear if right governance for propagate adoption.	3 – Technical implementation likely good	4 – Similar product already exists that was built for another need / sector.
Monopoly risks	5 – Can design and set up to mitigate these risks.	5 – Can design and set up to mitigate these risks.	2 – Having big tech design the Trust framework may lead to use of proprietary tech, unless mandated otherwise.	3 – Provided entity has not developed proprietary technology to enable solution, monopoly risk is low.
Social value	4 – Distributed learnings for the consortium developing it, can incentivise further information exchange.	4 – Social benefits gained by publicly owned entity, can incentivise sharing learnings.	2 – Small benefits to UK, even if location of provider is based in UK.	3 – Benefits to UK business if located in UK.
Governance	3 – Consortium building and agreement may be challenge.	3 – Extensive engagement challenging for one organisation.	2 – Less knowledgeable about sector challenges.	5- Existing Trust frameworks have high-levels of governance in place already
Supply chain	3 – Depends on the make-up of industry consortium.	3 – Stable (publicly owned)	3 – Large companies are typically stable.	5- Supply chain already established.
Skillset	4 – Make up of consortium critical path.	2 – Unclear if organisation has technical skills during delivery period.	3 – Energy domain expertise less certain. Less stakeholder skills in domain.	5 – Existing Trust framework(s) have skill set established to deliver.
Timelines	3 – Consortium would need lead up time to set up appropriately.	3 – Would need lead up time to set up stakeholders appropriately.	2– Trust framework is governance heavy, challenge for big tech.	5 – Expertise and smaller companies more agile.
Costs	4 – Similar card rate to big tech	3 – Potentially higher overhead costs to build relevant skills.	4 – Able to more efficiently assign costs.	5 – Likely a cheaper tender to complete work as adaptation rather than build required/ less overhead
Total	**29**	**25**	**21**	**35**

Steady-state operation phase of the trust framework

Assessment to determine the entity that will manage the aspect during the operational lifecycle

	Option 2A: Solution given to a strategic entity	**Option 2B:** Solution given to a national-level strategic entity	**Option 2C:** Solution given to an energy sector operational entity	**Option 2D:** Create a commercial agreement to support operation, maintenance, and further development of the solution	**Option 2E:** Solution owned and operated by a private entity
Adoption	4 – Could lead the sector to reach, revise, and enforce agreements because of their remit in the sector.	3 – moderate confidence the mechanism will be adopted with on-going industry input due to complexity of stakeholder engagement in the energy industry	4 – high confidence the mechanism will be adopted with on-going industry input due to complexity of managing a consortium	3 – experience in management of a similar product, but stakeholder engagement / alignment can be a concern.	2 – If commercial incentives were right adoption may be widespread, but question marks over why not possible to date
Monopoly risks	4 – very high confidence the mechanism will be flexible to on-going industry input and support the whole industry.	4 – Limited risks, however non-energy related domain knowledge may pose challenge.	4 – very high confidence the mechanism will be flexible to on-going industry input and support the whole industry.	4 – entity can be bound under a commercial agreement; therefore, low monopoly risk	1 – Entity would be the definition of a monopoly service which could influence market development.
Social value	4 – high confidence knowledge in managing this mechanism will be used for greater good.	3 – high confidence knowledge in managing this mechanism will be used for greater good, but ability to knowledge share can be limited.	3 – in managing this mechanism will be used for greater good, but can be slow due to nature of the business	4 – entity can be bound under a commercial agreement; therefore, no incentive to create additional value.	1 – Private entity will likely do little to prioritise social value beyond direct (and indirect) job creation.
Governance	4– Can bring existing relationships that can support wider management and change in the mechanism.	2 – entity can face challenges because of non-existing relationships that will be required to improve and maintain the mechanism	4 – operational entity can bring existing relationships that can support wider management and change in the mechanism.	4 – Entity can be overseen by government through existing T&C.	2 – Likely to be challenging to integrate with existing governance design but could be appropriately incentivised.
Supply chain	4 – high confidence in the organisation to ensure a viable supply chain	4 – high confidence in the organisation to ensure a viable supply chain	4 – high confidence in the organisation to ensure a viable supply chain	4 – high confidence in the organisation to ensure a viable supply chain	3 – Likely to develop stable supply chain.
Skillset	4 – previous experience in managing data sharing agreements	3 – previous experience in managing data sharing agreements, but not necessarily in the energy sector	3 – previous experience in managing data sharing agreements, but specific to a niche area in the sector	3 – ability to deliver scope determined by set T&C; therefore, dependent on the procurement process	5 – Likely to have or more easily acquire skills required.
Timelines	3 – high confidence in the organisation to ensure a viable supply chain	2 – high confidence in the organisation to ensure a viable supply chain	3 – high confidence in the organisation to ensure a viable supply chain	4 – ability to deliver scope determined by set T&C; therefore, dependent on the procurement process	4 – Revenue will depend on moving quickly.
Costs	4 – cost could be shared across other parts of the business	3 – cost could be shared across other parts of the business, but higher due to the non-core aspect	4 – cost could be shared across other parts of the business	2 – high costs because of the singular nature of long-term delivery, therefore higher overhead	1 – Costs are broadly likely to be comparable to option 2D, with costs to different participants attributed in unknown ways.
Total	**31**	**24**	**29**	**28**	**19**

H.3

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Proposed delivery pathways for a data sharing infrastructure

Pathways to deliver a data sharing infrastructure

The various options that can support the procurement

Various combinations

As set out in Appendix H.2 there are many combinations of options that can be taken forward between implementation and steady state operation of each of the components of a data sharing infrastructure.

While the following page provides the overview of the proposed pathway for all three components; and the subsequent sections providing detail on that pathway; there are other options that can be considered.

For example, within the data preparation node options, an option is for government to directly procure a solution (*the second scoring option*). For the trust framework, the steady state governance could be given to a private entity (*the lowest scoring option*).

It is considered that the provided pathways described in the following pages provide the best optionality, and government can deviate one or two components from it without fundamentally creating additional challenges.

Commonality between all pathways

Not every combination has been tested. However, it is considered that the governance structure proposed for implementation in Appendix I can be used regardless of the implementation pathways described.

Therefore, any iteration of the pathway by government would still be enabled by the governance structure proposed.

For the purposes of this feasibility study, the following are considered common across all pathways:

- The operating model outlined for each of the three proposed aspects of the data sharing infrastructure
- The cost ranges
- The indicative timeline
- The breakdown in the roles and responsibilities

Proposed delivery pathway for each functional component

Highest scoring pathway, but not the only option

Data preparation node

The high-level assessment concluded the following:

- **Implementation:** Independently-led industry consortium (option 1A)
- **Steady-state operation:** Solution given to a national-level strategic entity (option 2B)

This assessment suggested that an organisation with strategic remit across multiple sectors would be the long-term solution. This could be a new organisation (such as an open-source foundation) or an existing organisation/programme given further responsibilities (such as the National Digital Twin Programme).

There are currently limited organisations with the technical skill and possible remit to support this. It is considered that primary legislation is required to create a new entity or modify the remit of an existing entity.

Within the context of existing digitalisation initiatives, this functional component is similar to the Integration Architecture of the National Digital Twin Programme

Appendix H.3.1 outlines the operating model, timelines, and potential costs for the data preparation node.

Data sharing mechanism

The high-level assessment concluded the following:

- **Implementation:** Independently-led industry consortium (option 1A)
- **Steady-state operation:** Solution given to a energy sector strategic entity (option 2A)

This assessment suggests that an organisation with a strategic remit for the energy sector would be responsible for the development and management of the data sharing mechanism.

Within the context of the current energy system and existing digitalisation initiatives, this functional component is similar to the Virtual Energy System.

The Electricity System Operator (ESO) is also the closest organisation that currently fits the description of the energy sector strategic entity, with the Future System Operator (FSO) being a possible potential candidate for the long-term responsibility.

Appendix H.3.2 outlines the operating model, timelines, and potential costs for the data sharing mechanism.

Trust framework

The high-level assessment concluded the following:

- **Implementation:** Directly procure an existing solution and/or services from an organisation with relevant experience (option 1D)
- **Steady-state operation:** Solution given to a energy sector strategic entity (option 2A)

The delivery option of the trust framework is closely linked to that of the data sharing mechanism, as functionally the organisation that is responsible for the data sharing mechanism will need to be closely aligned, and ideally have a direct relationship with, the organisation responsible for operating the trust framework.

Within the context of the current energy system and existing digitalisation initiatives, this functional component is similar to the Open Energy trust framework.

Appendix H.3.3 outlines the operating model, timelines, and potential costs for the trust framework.

H.3.1

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Proposed delivery pathway for the data preparation node

Proposed delivery pathway for the data preparation node

Overview of the delivery pathway and key assumptions and dependencies

Overview

The proposed delivery pathway for the data preparation node is an independently-led industry consortium bringing together the capabilities to deliver against the requirements, followed by a handover to a national-level strategic entity that would ensure the long-term management and development.

An independently-led industry consortium will ensure all user requirements are met, delivered against timescales due to contractual requirements, and that there are the right combination of skills required to deliver and govern the data preparation node.

Handover to a national-level strategic entity would also create connectivity between adjacent sectors. This will ensure long term efficiencies through early cross sector alignment.

Results of the high-level assessment

The high-level assessments are given in Appendix H.2.

Implementation	Score
Option 1A: Independently-led industry consortium	**30**
Option 1B: Publicly-led development	27
Option 1C: Technology provider builds it	27
Option 1D: Directly procure an existing solution and/or services from an organisation with relevant experience	28
Steady-state operation	**Score**
Option 2A: Solution given to an energy sector strategic entity	23
Option 2B: Solution given to a national-level strategic entity	**28**
Option 2C: Solution given to an energy sector operational entity	19
Option 2D: Create a commercial agreement to support operation, maintenance, and further development of the solution	23
Option 2E: Solution owned & operated by private entity	19

Key assumptions & dependencies

Key assumptions for the proposed delivery pathway are:

- Government would fund the delivery and manage the procurement of the delivery consortium.
- The delivery consortium selection would ensure the best combination of required skills and capabilities to deliver against the requirements and objectives.
- The national-level strategic entity would see the value of, and be incentivised to ensure, the long-term success of the data preparation node.
- The national-level strategic entity may need to contract out in the short- medium term management and development of the data preparation node whilst it matures and develops the required skills
- The national-level strategic entity would have the freedom to engage with stakeholders and develop and manage the steady-state operating model, ensuring it is not dependent on government funding in the long term, whilst minimising costs to the consumer.

Components of the data preparation node

Overview of the recommended components that will make up the data preparation node

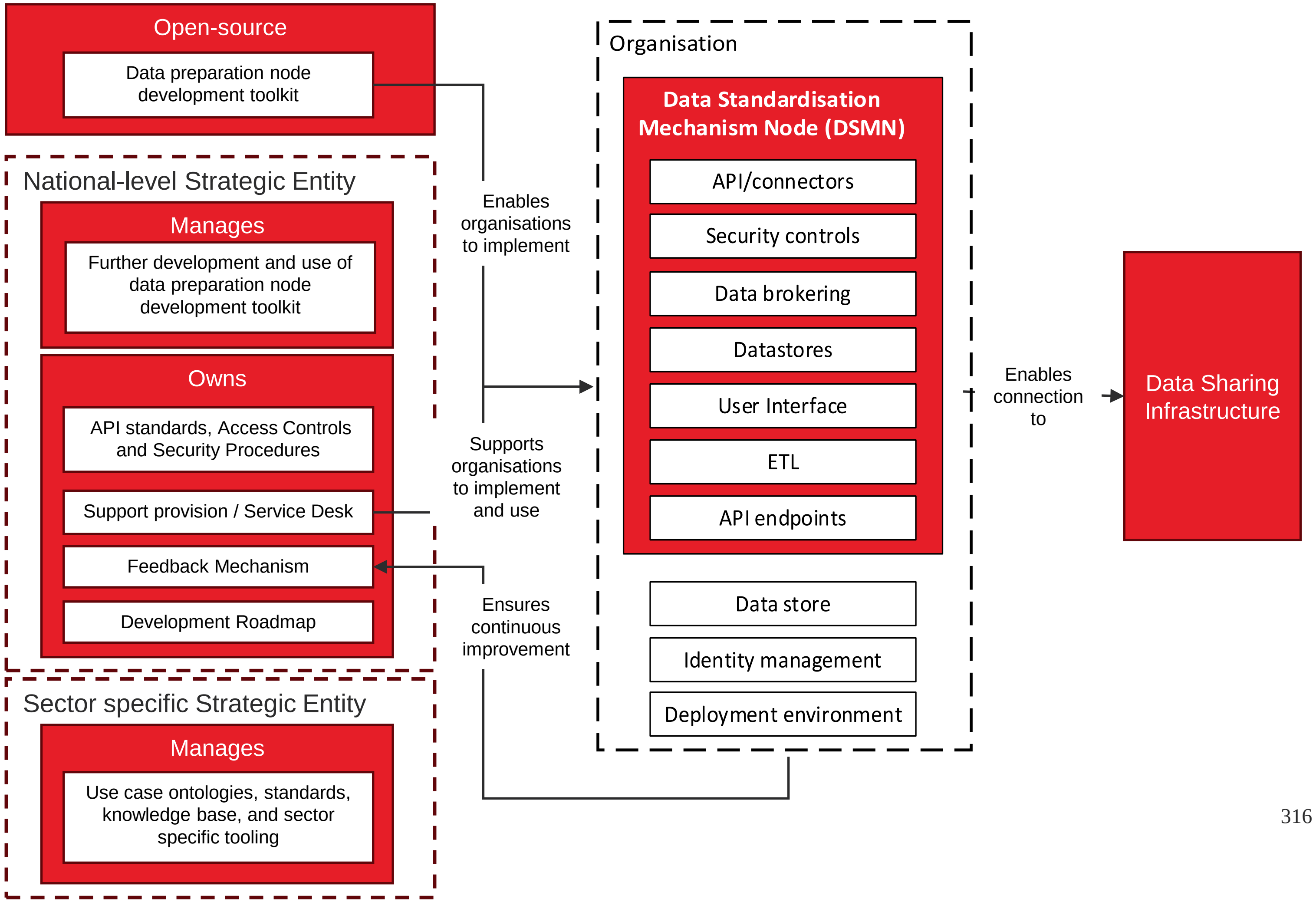
The diagram summarises the components of the data preparation node.

It highlights their respective ownerships and how they support organisations and users to engage with a data sharing infrastructure.

There is a recommended delineation between the open-source provision of the *data preparation node development toolkit* and the management of the data preparation node itself.

The provision of the toolkit as open-source will lower barriers to entry and drive innovation, whilst management and ultimate decision making is with the national-level strategic entity.

This minimises the risk of market failure, ensures the provision of sufficient support to users to drive adoption, and enables any future development aligns with the needs of the sector.



Operating model of the data preparation node

Steady-state operation of the data preparation node

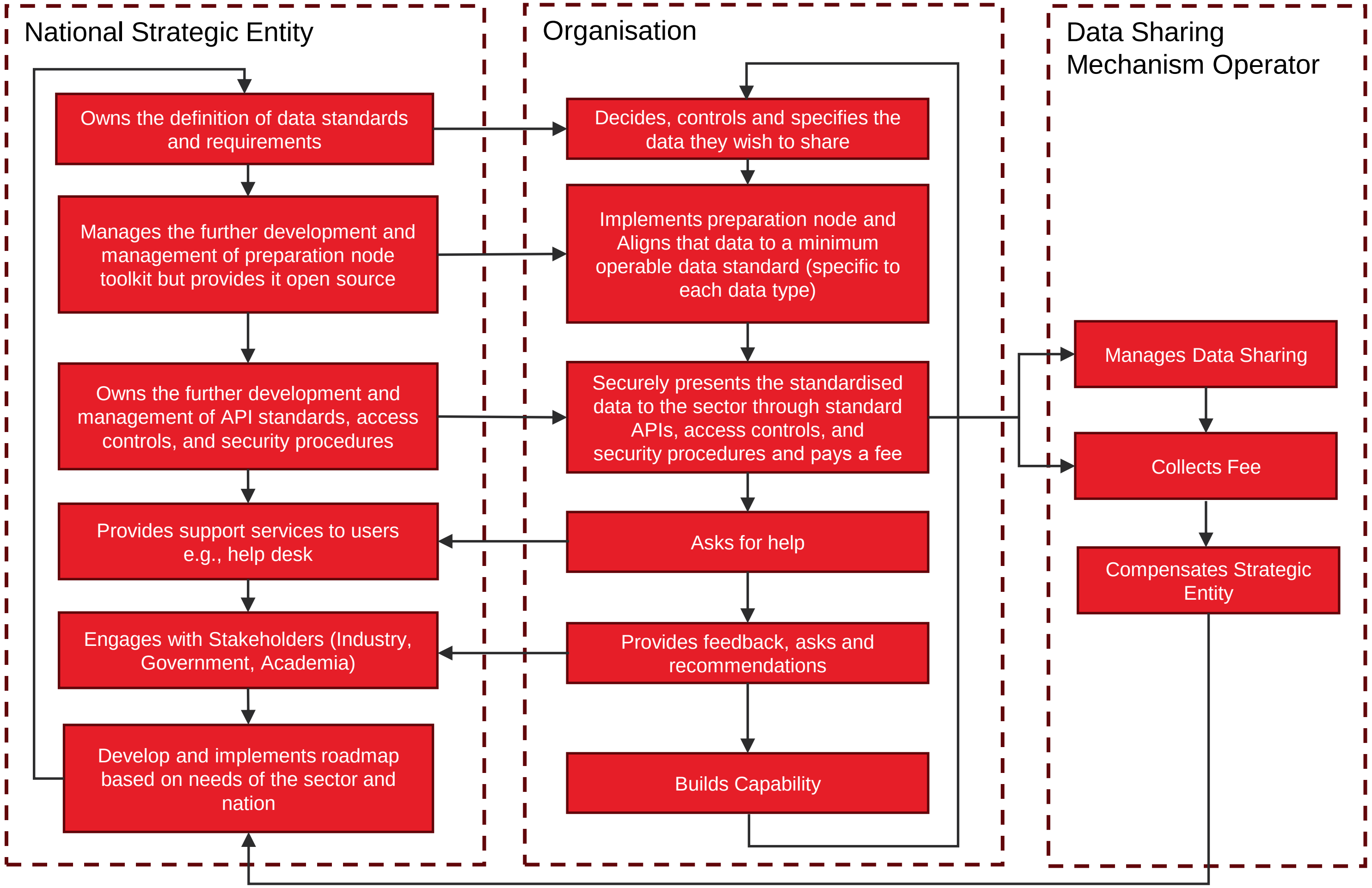
The diagram outlines the proposed steady-state operating model for the data preparation node. A key aspect of the operating model is a business model that minimises the national-level strategic entity's dependency on public funding.

One option is that the national-level strategic entity has this role considered as a statutory duty, and cost recovers for it through its existing mechanisms.

Another solution is that whilst the toolkit is provided open source and support free of charge, any organisation that connects a node to the data sharing infrastructure must pay a fee. This fee is used to both fund the management of the data sharing infrastructure and fund the national-level strategic entity to manage the data preparation node.

There are several potential options for the structure of this fee which should be considered and designed during the MVP development. These include, for example:

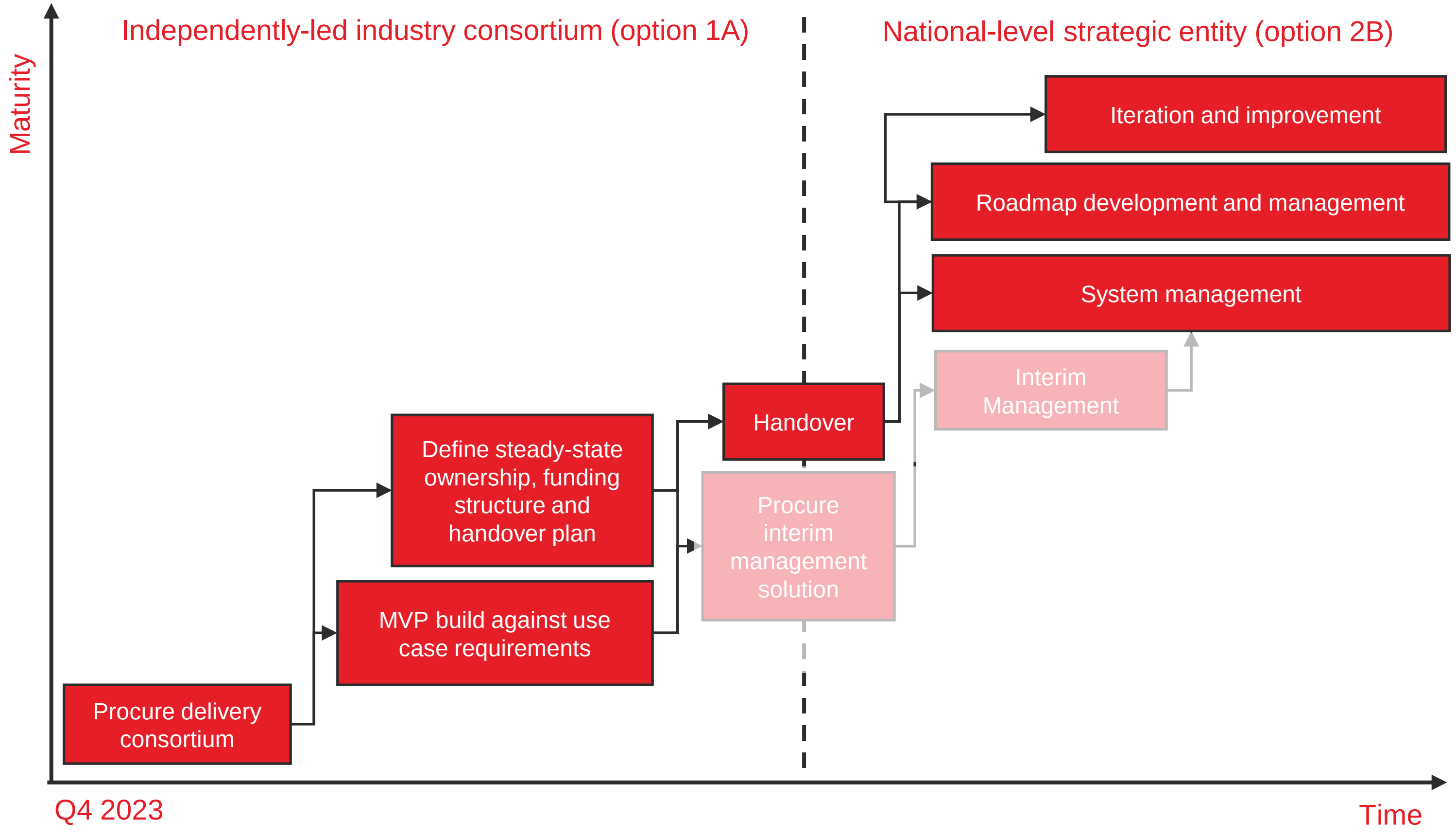
- Typical SaaS model where an organisation pays licence fee which scales with number of users
- One off connection fee and yearly flat fee structure per node connection
- A standard yearly fee for connection with costs that scale based on the volume of data shared.



Delivery timelines and indicative costs

Timelines and costs for the data preparation node

Timelines



Indicative costs

The cost to deliver the MVP would be funded by government and paid to the consortium on achieving delivery milestones as outlined in the contract. Based on the delivery of similar initiatives (e.g. Telicent and the Integration Architecture) it is expected that the MVP delivery costs would be £1m-£3m.

It is expected that the steady-state management costs would be £2m-£4m per year, which would need to be managed by the national-level strategic entity.

However, as management costs could be recouped by a node connection fee model, this would minimise the cost to government and ensure greater resilience through removing dependencies on public funding.

The cost to manage in the transition period and short-term steady-state should be considered, as these activities may need to be contracted out while the national-level strategic entity is established and develops the required skills. It is recommended the delivery entity works with government to define options and recommendations for this as part of the MVP delivery.

Ongoing costs of any background IP must also be considered and incorporated into the cost model.

Delivery option considerations

Summary of the delivery option considerations for the data preparation node

Overview

In addition to the proposed delivery pathway there are additional delivery reflections to be considered.

A decision on these will inform the requirements for procurement and underpin the implementation and steady-state operating model and future success of the data preparation node.

These reflections are:

- **Build or Buy:** The design and delivery of the data standardisation infrastructure from first principals or the use and customisation of existing solutions to act as the foundations.
- **Public or Private:** The provision of ownership of the data preparation node to a public or private organisation.
- **Open or Proprietary:** The data preparation node could either be open source and freely available in design or proprietary such that it is owned by one organisation only.

The benefits and challenges of each delivery option is summarised on this page.

Built vs Buy

Data standardisation is a common activity across multiple sectors, and there are existing solutions available that have proven success that could be leveraged to minimise time to delivery and costs.

However, the use of existing technology will require customisation and an understanding of the needs of the sector and users. This is why it is recommended that the delivery pathway considers a consortium of organisations that could support the solution provider and ensure successful delivery.

Any existing solution considered must be evaluated for its ability to be adapted to meet the requirements as set out in the technical requirements Appendix G.

Public vs Private

It is recommended that the data preparation node is publicly owned, but with a payback structure that supports resilience and reduces dependencies on public sector funding in the long term.

This will ensure the management and roadmap meets the needs of the sector, whilst ensuring economic efficiency in its steady-state management.

Private ownership could result in prioritisation of individual needs and the development of an operating model that result in costs to the consumer and may not support accessibility and social value objectives of a data sharing infrastructure.

Open vs Proprietary

Open source would support the innovation and inclusion objectives of the data preparation node, alongside the need for the continuous improvement of the data preparation node.

However, making the data preparation node fully open source introduces risks around development direction and control required to mitigate risks (e.g., market failure as a result of mis-shared data). It also poses challenges around costs for steady-state management and how these would be recouped, which could reduce the resilience of the system.

The proposed solution is that the data preparation node toolkit is provided open source to support innovation and reduce barriers to entry to a data sharing infrastructure. However, the interface of a node with the data sharing mechanism and the technology (e.g., API) and processes (e.g., security protocols) are governed by the national-level strategic entity.

H.3.2

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Proposed delivery pathway for the data sharing mechanism

Proposed delivery pathway for the data sharing mechanism

Overview of the delivery pathway and key assumptions and dependencies

Overview

The proposed delivery pathway for the data sharing mechanism is an independently-led industry consortium bringing together the capabilities to deliver against the requirements, followed by a handover to an energy sector strategic entity that would ensure the long-term management and development.

An independently-led industry consortium will ensure all user requirements are met, delivered against timescales due to contractual requirements, and that there are the right combination of skills required to deliver and govern the data sharing mechanism

Handover to an energy sector strategic entity would enable the development of future capabilities in line with a broader set of stakeholder engagement.

Results of the high-level assessment

Implementation	Score
Option 1A: Independently-led industry consortium	**31**
Option 1B: Publicly-led development	23
Option 1C: Technology provider builds it	29
Option 1D: Directly procure an existing solution and/or services from an organisation with relevant experience	28
Steady-state operation	**Score**
Option 2A: Solution given to an energy sector strategic entity	**32**
Option 2B: Solution given to a national-level strategic entity	27
Option 2C: Solution given to an energy sector operational entity	29
Option 2D: Create a commercial agreement to support operation, maintenance, and further development of the solution	25
Option 2E: Solution owned & operated by private entity	18

Key assumptions & dependencies

Key assumptions for the proposed delivery pathway are:

- The energy sector strategic entity would fund the delivery and manage the procurement of the delivery consortium
- The delivery consortium selection would ensure the best combination of required skills and capabilities to deliver against the requirements and objectives.
- The energy sector strategic entity has an obligation to manage and maintain the service on behalf of the sector.
- The energy sector strategic entity would be supported in that obligation by licence obligations or primary/secondary legislation.
- The energy sector strategic entity may need to contract out in the short/medium term management and development of capabilities whilst it matures and develops the required skills.

Components of the data sharing mechanism

Overview of the recommended components that will make up the data sharing mechanism

The diagram summarises the components of the data sharing mechanism.

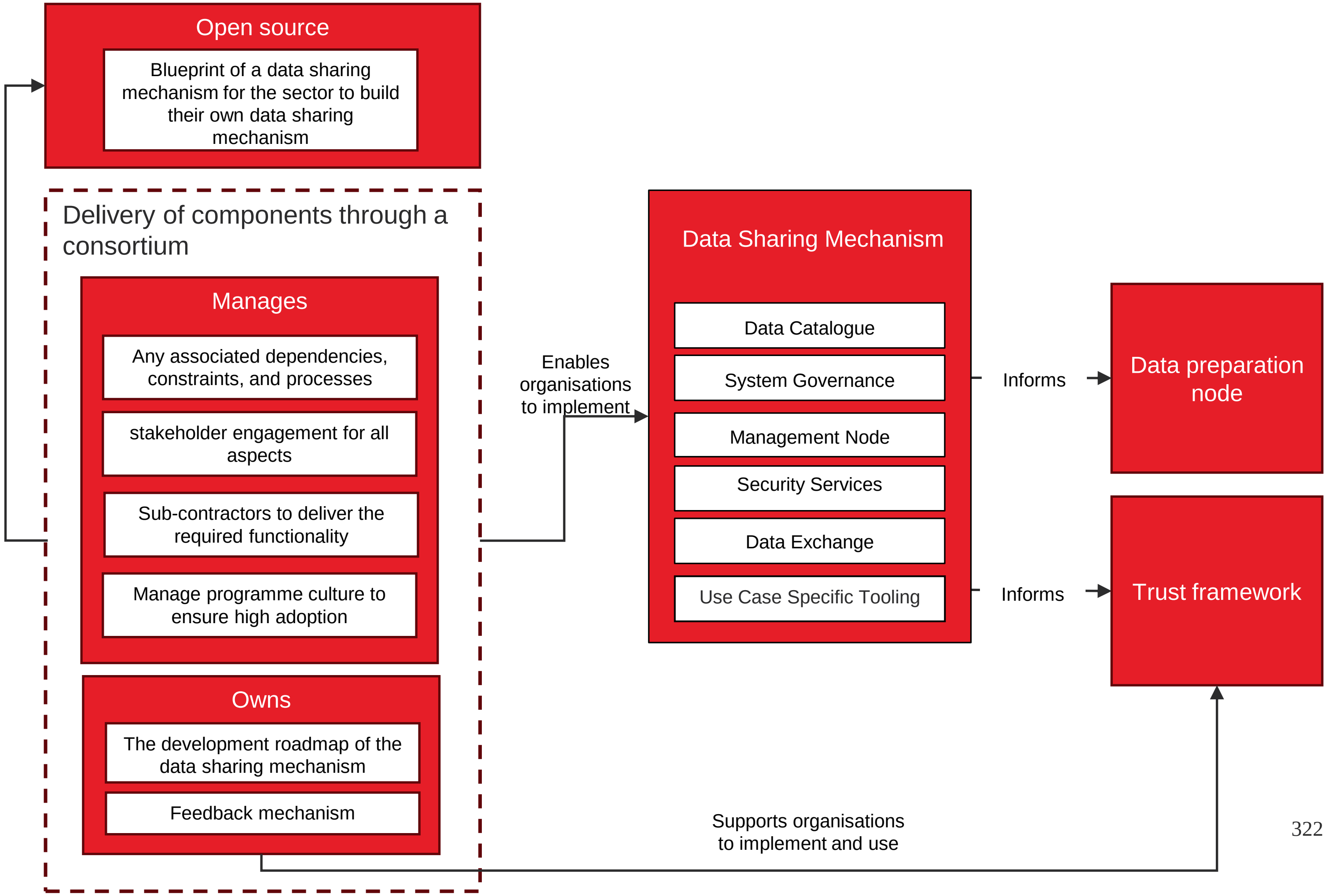
It highlights their respective ownerships and how they support organisations and users to engage with a data sharing infrastructure.

The independently-led industry consortium will engage stakeholders, define user requirements, and develop a sector accepted data sharing mechanism.

The collective nature of the delivery will ensure all aspects of the data sharing infrastructure will be incorporated to provide an optimal user experience.

As the central component that links the trust framework, and the data preparation node, the breadth and depth of the independently-led industry consortium will be a value-add in aligning varying opinions, and requirements.

The delivery of a blueprint that encompass and connects all aspects of the data sharing mechanism will mitigate market failure and encourage innovation by building on existing features.



Operating model of the data sharing mechanism

Steady-state operation of the data sharing mechanism

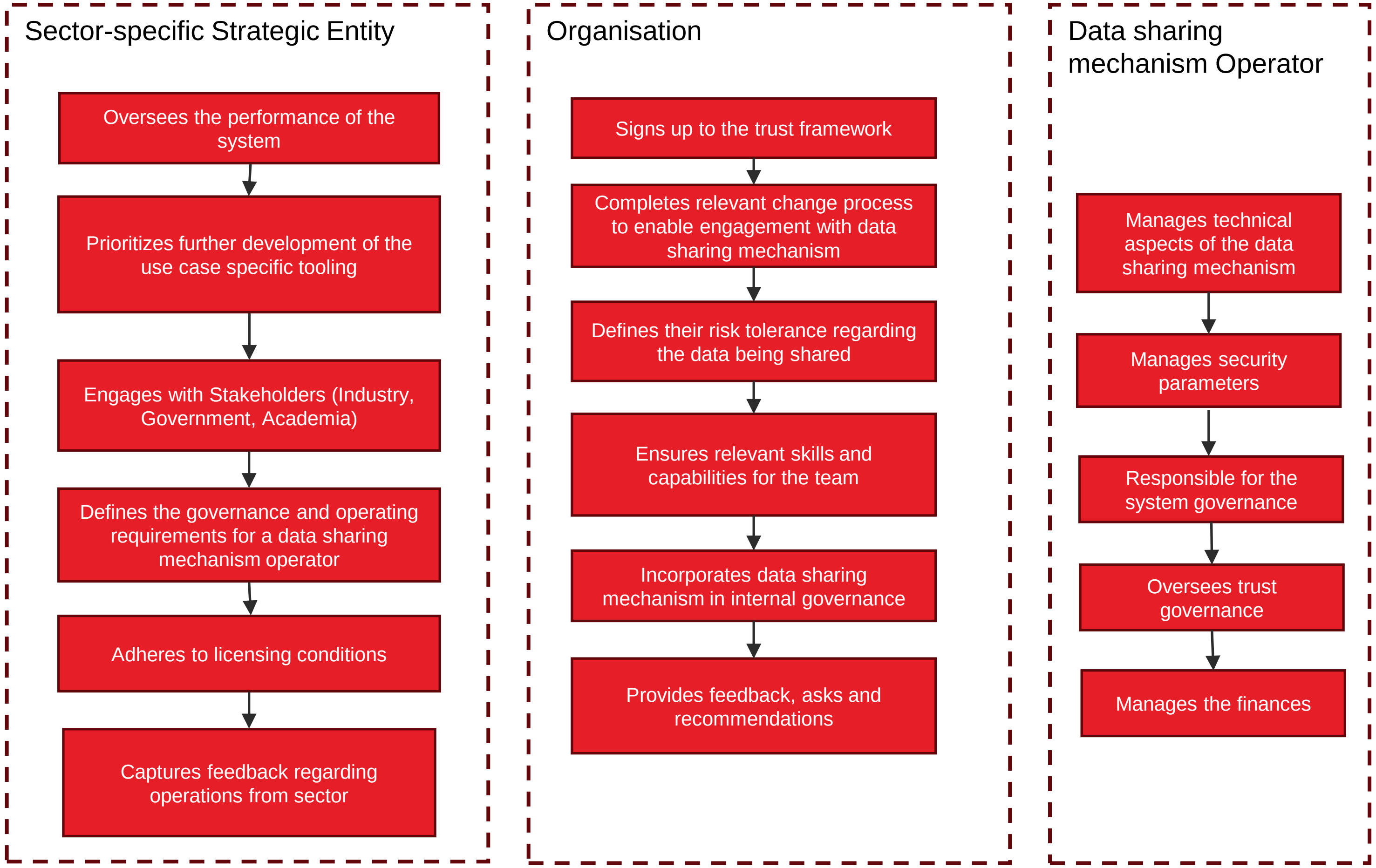
The diagram outlines the proposed steady-state operating model for the data sharing mechanism.

A key aspect of the operating model is the energy sector strategic entity's dependency on public funding via existing financed cost recovery routes for the organisation.

One option is that the energy sector strategic entity has this role considered as a statutory duty, and cost recovers for it through its existing mechanisms.

Given the transfer of data between market participants is a pre-requisite of a functioning market, it may be possible to include the costs into the energy sector strategic entity's overall portfolio and operate it as a strategic programme of work with a significantly streamlined governance process to manage the operation of the overall system.

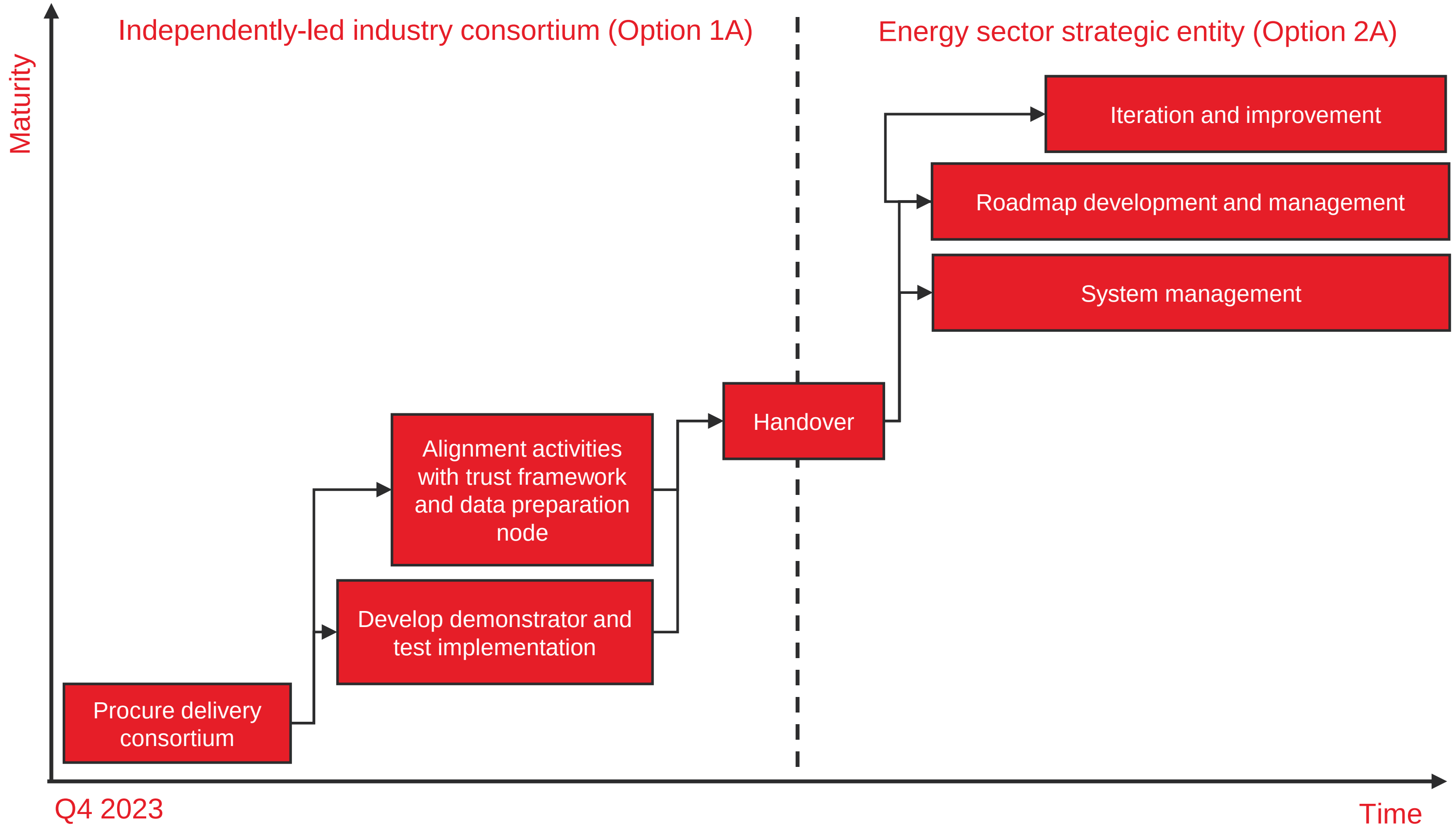
In addition to the mandate, the energy sector strategic entity could license aspects of the mechanism to recover costs to limit the dependency on public funds.



Delivery timelines and indicative costs

Timelines and costs for the data sharing mechanism

Timelines



Indicative costs

The cost to deliver the MVP would be funded by government and distributed to the delivery consortium. It is expected that the MVP delivery costs would be in the region of £10m-£20m over the course of its delivery lifecycle. This cost will increase as other extended functionality is implemented.

It is expected that the steady-state management costs would as a minimum exceed £18m per year, which would need to be managed by the strategic entity. However, costs to do so could be recouped by the data sharing mechanism operator through licenses or contracting services. This would minimise dependencies to the government and the orchestrating entity and ensure greater resilience.

The cost to manage in the transition period and short-term steady-state should be considered as these activities may need to be contracted out whilst the strategic entity develops the required skills.

It is recommended the delivery entity works with the sector specific strategic entity to define options and recommendations for this as part of the MVP delivery.

Ongoing costs of any background IP must also be considered and incorporated into the cost model.

Delivery option considerations

Summary of the delivery option considerations for the data sharing mechanism

Overview

In addition to the proposed delivery pathway there are additional delivery reflections to be considered.

A decision on these will inform the requirements for procurement and underpin the implementation and steady-state operating model and future success of the data sharing mechanism.

These delivery reflections are:

- **Build or Buy:** The design and delivery of the data sharing mechanism from first principles or the use and customisation of existing infrastructure to act as the foundations.
- **Public or Private:** The provision of ownership of the data sharing mechanism to a public or private organisation.
- **Open or Proprietary:** The data sharing mechanism could either be open source and freely available in design or proprietary such that it is owned by one organisation only.

The benefits and challenges of each delivery option is summarised on this page.

Built vs Buy

The development of a data sharing mechanism is a significant undertaking.

As summarised in the technical requirements Appendix G, within the context of the current energy system and existing digitalisation initiatives, this functional component is similar to the Virtual Energy System.

The option presented in this pathway could be a blend of build and buy, as the Virtual Energy System has scoped out the boundaries and capabilities of the data sharing mechanism but has not built it yet.

Alternatively, using the learnings from both the Virtual Energy System and this feasibility study, a procurement exercise could be undertaken to identify if an existing platform has all the relevant capabilities.

Public vs Private

The data sharing mechanism is the core infrastructure that enables data to transmit between market participants.

Through stakeholder engagement and testing it was concluded that there is a need for one instance of the data sharing mechanism to initially to exist for the sector, and that this should be within public ownership. However, it was noted that in the future there could be the need for other instances of the data sharing mechanism that are privately owned.

There are risks associated with private ownership of what would likely become critical national infrastructure. Similarly, public ownership in the first instance enables decisions on scope and will facilitate other marketplaces to emerge.

Open vs Proprietary

The core infrastructure for data sharing is expected to be a blend of open and proprietary (closed) software and governance. This would follow a presumed open approach which is aligned with Ofgem's approach to Data Best Practice.

Proprietary, or closed, systems would be developed where there are compelling reasons to do so, for example security considerations.

The described delivery route can facilitate these outcomes by closely working with stakeholders to identify the appropriate scope for the data sharing mechanism.

H.3.3

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Proposed delivery pathway for the trust framework

Proposed delivery pathway for the trust framework

Overview of the delivery pathway and key assumptions and dependencies

Overview

The proposed delivery pathway for the trust framework is to directly procure an existing solution and/or services from an organisation with relevant experience.

Once the trust framework is developed, the operations and management could be handed to an energy sector specific strategic entity. The management of the trust framework could be delivered by a third party on behalf of the energy sector strategic entity

This delivery route can ensure quick decision making, faster collaboration. Handover to an energy sector strategic entity would increase legitimacy and fair competition.

Results of the high-level assessment

Implementation	Score
Option 1A: Independently-led industry consortium	29
Option 1B: Publicly-led development	25
Option 1C: Technology provider builds it	21
Option 1D: Directly procure an existing solution and/or services from an organisation with relevant experience	**35**
Steady-state operation	**Score**
Option 2A: Solution given to an energy sector strategic entity	**31**
Option 2B: Solution given to a national-level strategic entity	24
Option 2C: Solution given to an energy sector operational entity	29
Option 2D: Create a commercial agreement to support operation, maintenance, and further development of the solution	28
Option 2E: Solution owned & operated by private entity	19

Key assumptions & dependencies

Key assumptions for the proposed delivery pathway are:

- The energy sector strategic entity would directly procure an existing solution and/or services from an organisation with relevant experience.
- The energy sector strategic entity may choose to subcontract certain aspect of the trust framework
- Signing up to the trust framework becomes a pre-requisite for using the data sharing infrastructure.
- The trust framework and the data sharing mechanism are aligned in their technical architecture and governance
- The governance of the organisation responsible for the trust framework is the responsibility of the energy sector strategic entity.
- The governance of the implementation of the trust framework is the responsibility of the organisation responsible for the trust framework.

Components of the trust framework

Overview of the recommended components that will make up the trust framework

The diagram summarises the components of the trust framework.

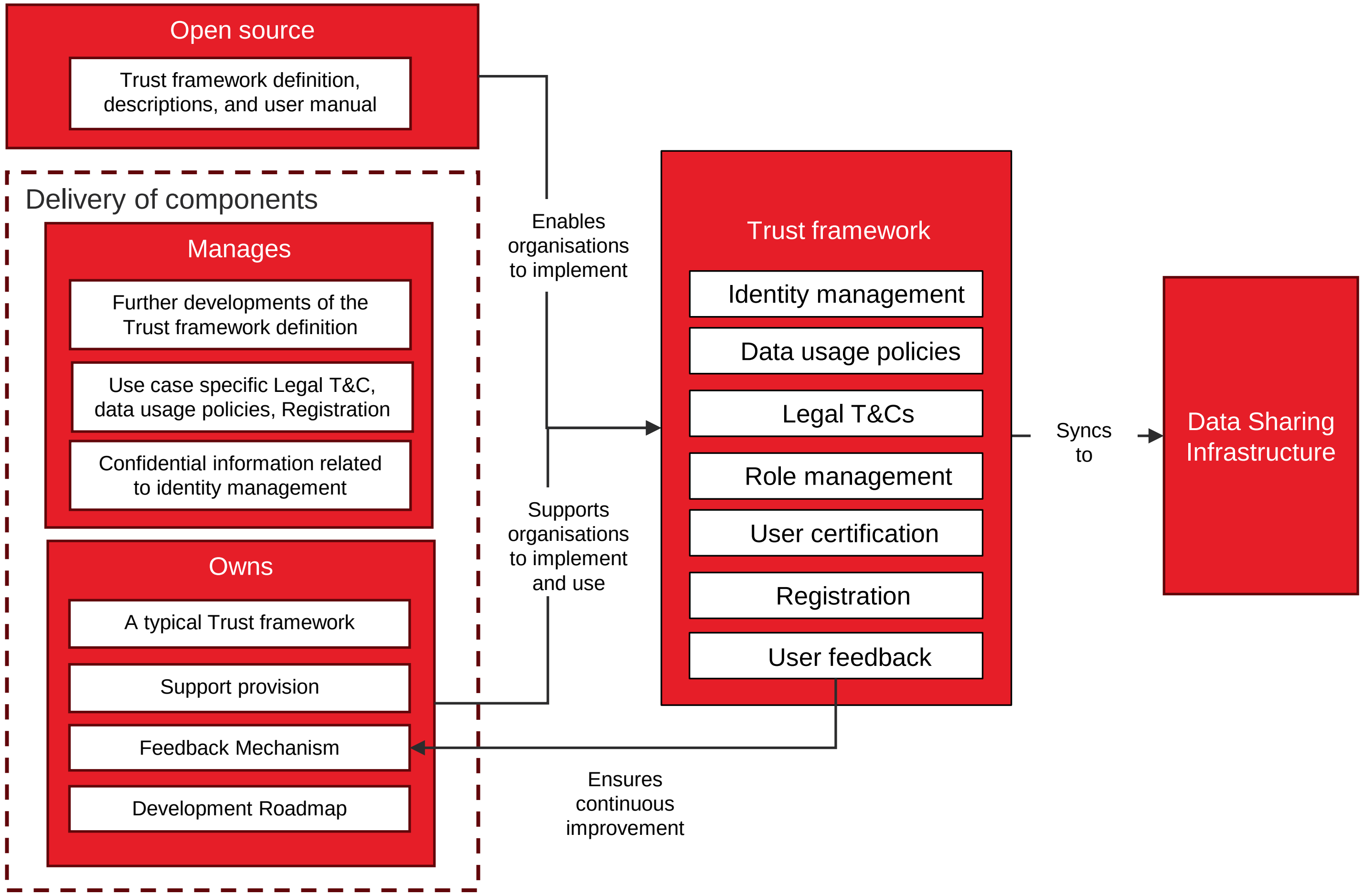
It highlights their respective ownerships and how they support organisations and users to engage with a data sharing infrastructure.

The delivery entity can leverage their previous experience to establish a framework that facilitates stakeholder alignment on common terms and conditions based on data types and sensitivities.

This framework will reduce the defensive stance currently adopted by most stakeholders in the sector.

By empowering the energy sector strategic entity to make final decisions, the risk of market failure due to lack of collaboration among stakeholders is minimised.

The framework ensures adequate user support to drive adoption. It can enable the future development that is aligned with sector needs and user requirements. This would be achieved through a well-defined scope and a requirement for continuous improvement and evolution of the trust framework.



Operating model of the trust framework

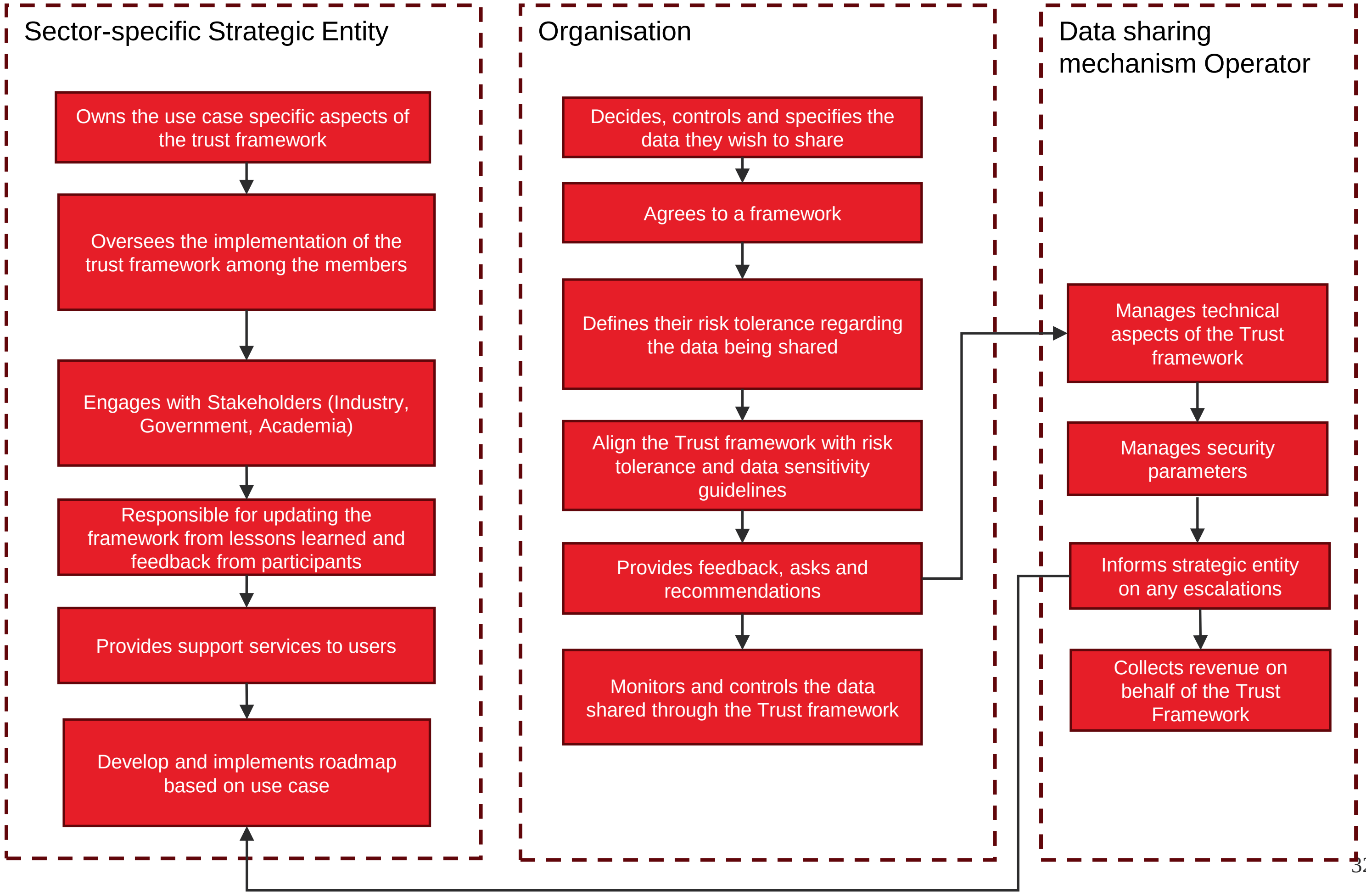
Steady-state operation of the trust framework

The diagram outlines the proposed steady-state operating model for the trust framework.

The operating model design provides the ability for the trust framework to engage with stakeholders to continually improve and iterate upon the service it is providing and have sufficient oversight and alignment with the data sharing mechanism and the data preparation node.

Cost recovery for the service is described on the next page. At a high-level the options are:

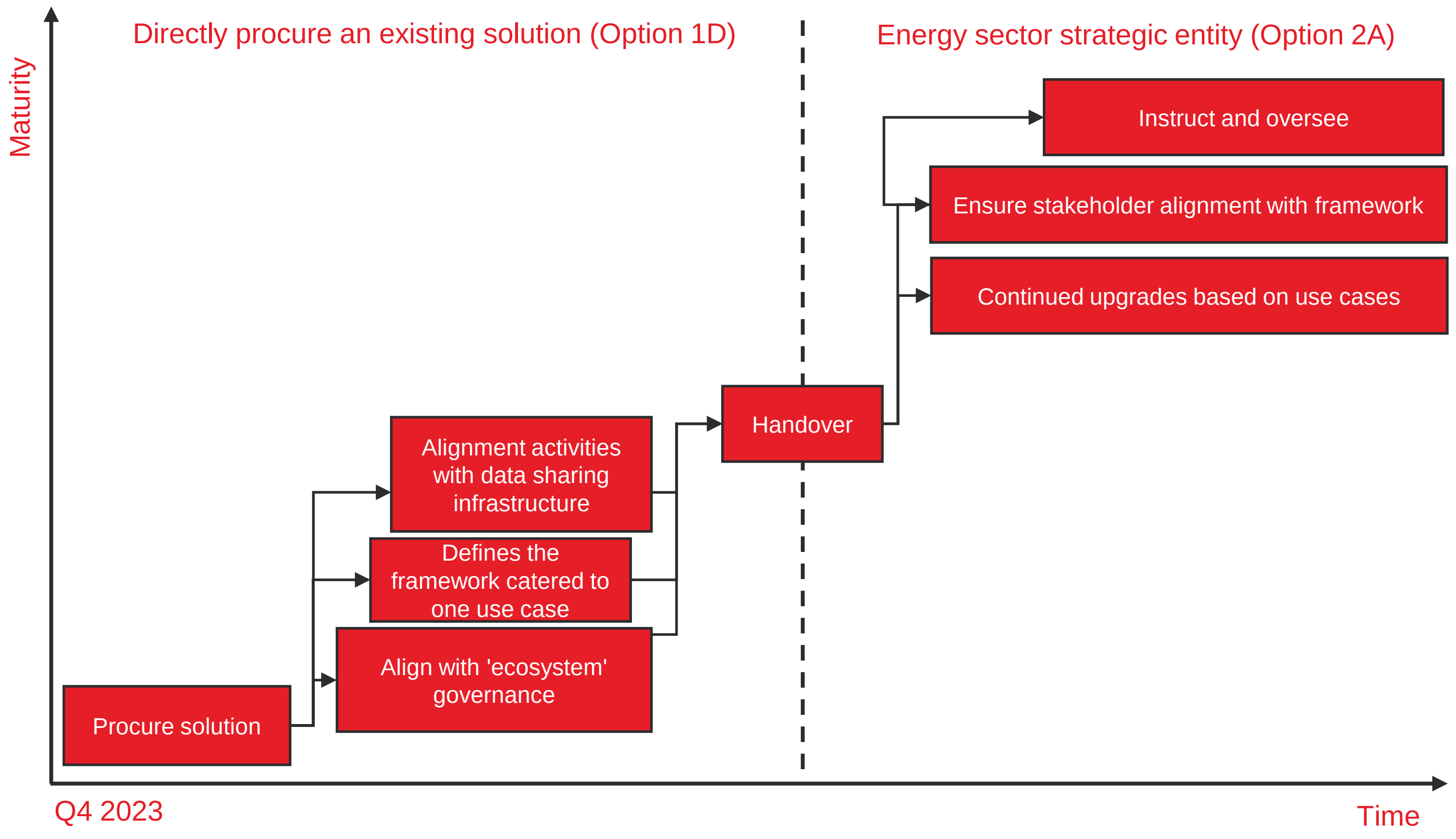
- The energy sector strategic entity to directly fund the management of the solution;
- The trust framework to directly cost-recover from market participants; or,
- The trust framework combines its management costs with the management costs for the data sharing mechanism.



Delivery timelines and indicative costs

Timelines and costs for the trust framework

Timelines



Indicative costs

The cost to deliver the MVP could be funded by government or the industry consortium procuring the data sharing mechanism and paid to the relevant organisation on achieving delivery milestones as outlined in the contract. Based on the delivery of similar initiatives (e.g., Open Energy) it is expected that the MVP delivery costs would be £2m-£6m over the course of its delivery lifecycle

It is expected that the steady-state management costs would be a minimum of £2m per year. However, costs to do so could be recouped by a service contract with the data sharing mechanism. This would minimise dependencies to the government and orchestrating entity and ensure greater resilience.

The cost to manage in the transition period and short-term steady-state should be considered as these activities may need to be contracted out whilst the energy sector strategic entity develops the required skills.

It is recommended the delivery entity works with the sector specific strategic entity to define options and recommendations for this as part of the MVP delivery.

Ongoing costs of any background IP must also be considered and incorporated into the cost model.

Delivery option considerations

Summary of the delivery option considerations for the trust framework

Overview

In addition to the proposed delivery route there are additional delivery reflections to be considered.

A decision on these will inform the requirements for procurement and underpin the implementation and steady-state operating model and future success of the trust framework.

These delivery reflections are:

- **Build or Buy:** The design and delivery of the trust framework from first principals or the use and customisation of existing infrastructure to act as the foundations.
- **Public or Private:** The provision of ownership of the trust framework to a public or private organisation.
- **Open or Proprietary:** The trust framework could either be open-source and freely available in design or proprietary such that it is owned by one organisation only.

The benefits and challenges of each delivery option is summarised on this page.

Built vs Buy

The trust framework is a process for agreeing the rules of data sharing. A solution for this is not a readily available commercial product that industry actors have high degrees of confidence in.

As summarised in the technical requirements Appendix G within the context of the current energy system and existing digitalisation initiatives, this functional component is like the Open Energy trust framework.

The Open Energy trust framework has already been partly funded by government through the modernising energy data access (MEDA) competition. The Virtual Energy System has also identified the Open Energy trust framework as a potential preferred solution for their programme.

Public vs Private

The trust framework provides the governance and legal framework that gives the users the confidence, right, and legality to share data between parties.

This functionality of a data sharing infrastructure is critical to its uptake and the trust of the system itself.

Therefore, it is considered that the management of the trust framework receives sufficient oversight and governance from a public body.

Open vs Proprietary

The mechanics of delivering a trust framework as either open-source or proprietary is currently less apparent than for the other functional components of the data sharing infrastructure.

The implementation of different methods of permissions-based access e.g., Attribute Based Access Control (ABAC), Role Based Access Control (RBAC) or Policy Based Access Control (PBAC) will be an automated process checking the permissions of the user accessing the data against the permission required for the data being requested. Where possible, this should be an open-source implementation.

H.4

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Procurement of a data sharing infrastructure

Potential procurement methods of a data sharing infrastructure

Three methods to procure a data sharing infrastructure

Overview

There are multiple methods for procuring the delivery of a data sharing infrastructure in line with the recommended delivery pathways.

These methods have the following considerations:

- **Ownership of responsibility for delivery** – the extent to which government or industry is responsible for programme oversight and governance
- **Funding routes** - the extent to which government or industry is responsible for funding the programme and its ongoing operations
- **Collaboration** – the extent to which procurement route ensures the required cross government, industry and academic collaboration
- **Time to deliver** – the extent to which the procurement route ensures delivery within the necessary timescales to support the future energy system

Three potential methods have been identified for consideration. All of which provide opportunities and constraints for the successful delivery of a data sharing infrastructure.

1. Align existing programmes

Government incentivises, or funds secondments, or enables a task force. They have the responsibility of aligning existing programmes to ensure work to date is leveraged, aligned, gaps identified, and relevant delivery mechanisms put in place to close them.

2. Direct procurement

Government directly procures the relevant consortiums required to deliver a data sharing infrastructure, as outlined in the delivery routes, and holds responsibility for its successful delivery.

3. Combined approach

Government procures a task force and procures an initial phase of work that demonstrates value of a data sharing infrastructure to incentivise required collaboration.

More details on how these methods, combined with delivery pathways and options, form potential routes can be found in Appendix K.

Next steps

The next steps, further detailed in Appendix O, involve a detailed analysis of delivery and governance, alongside the expected costs to make an informed decision on the most beneficial route forwards for the government, energy sector and UK as a whole.

This assessment should consider:

- Benefits delivered by each potential option
- Funding options available
- Risks afforded by each potential option
- How this relates to the options put forwards for governance and costs

Overall costs for the data sharing infrastructure

Scope of the government intervention to enable a data sharing infrastructure

Overview

The cost ranges for the various components are considered a class 5 estimate, with uncertainty range of +100% or -50%.

The costs are sourced from, and correlate with, previous government-funded projects.

Such historical prices provide an initial estimate, but further detailed cost estimate are dependent on the following requirements:

- Delivery pathways
- Detailed outline of the MVP technology
- Scale of implementation
- Use cases

Summary of MVP costs

The MVP implementation of the **data preparation node**, encompassing the, sharing, or transformation of data, is expected to be **£1m-£3m**, depending on the complexity of design, procurement pathway, and future improvements. While the potential steady state costs can cost **£2m-£4m per year**.

The MVP implementation of the **trust framework**, to ensure security, and compliance, is anticipated to cost **£2m-£6m**, reflecting the complexity of enabling scalable, and codifying the various legal terms and conditions, identity management, and security controls. While the **steady-state costs** would be **minimum £2m per year.**

The MVP implementation of **data sharing mechanism**, the engine that facilitates seamless data sharing, is estimated to be **£10m-£20m**. While the **steady-state costs** would be **minimum £18m per year.**

Therefore, the overall investment for implementing an MVP of an energy sector data sharing infrastructure is projected to be **£13m-£29m.** While the **steady-state costs** would be **minimum £22m per year.**

These costs do not account the income generated from licensing, exporting technology, and other enabling innovation.

Next steps

The next steps involve the development of a cost framework that is based on a comprehensive assessment of the specific requirements and constraints within each of the three components of a data sharing infrastructure (data preparation node, trust framework, and data sharing mechanism).

The cost framework can be developed by soliciting quotes from vendors for all aspects and roles required to implement and run a data sharing infrastructure, calculating service, and material costs based on the needed expertise, and licensing and compliance requirements.

Additionally, a thorough risk analysis is required to anticipate potential challenges and define contingency plans to identify appropriate contingences in the cost estimates.

Appendix I

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Governance of a data sharing infrastructure

Governance of a data sharing infrastructure

Summary of the governance models for a data sharing infrastructure

Overview

This appendix conducts a review of the options for governance of a data sharing infrastructure and proposes an integrated governance solution.

It considers:

- Governance models
- Data sharing infrastructure governance
- Developing governance over time

Key findings

The data sharing infrastructure blueprints, as well as any initial implementation, will need to be governed effectively and will require an incremental approach in order to facilitate early action.

The proposals within this Appendix outline three-time horizons of governance arrangements:

- **Implementation (2024-2026)**
- **Steady-state (2026-2030)**
- **Future-state (2030+)**

Diagrams showing these phases are given in the following pages and denote the creation of a "***Data Sharing Infrastructure Task Group***", then transitional arrangements for that task group to pass responsibilities to an "***Energy Data Sharing Infrastructure Operator***" and the "***Energy Digitalisation Orchestrator***"

A core recommendation of this appendix is the initial set up of the ***Data Sharing Infrastructure Task Group***.

I.1

Governance models

Context

A summary of the remit and function of governance structure to enable a data sharing infrastructure

Overview

Governance provides a framework for managing systems, organisations, and initiatives. It identifies who can make decisions, who has the authority to act, and who is accountable to ensure things run legally, ethically, sustainably, and successfully.

From the engagement with stakeholders, it was apparent that to be successful in meeting government priorities a data sharing infrastructure should be conceived as more of an ‘ecosystem that facilitates data sharing’. Governance emerged as a key enabler to a data sharing infrastructure as it would allow the creation of a common and trustworthy data sharing ecosystem made of consistent digital infrastructure, guidelines, protocols, and minimum standards.

Without a clear governance framework, it would not be possible for the technology component of a data sharing infrastructure to facilitate the exchange and access to data needed by users.

Specifically, governance is an essential enabler for actors to share their data primarily by helping address data classification, access condition, and licencing.

The lack of clear digital governance across the energy sector was also identified as a critical gap across use cases, with no clear actors with the mandate and capability to provide the necessary steer or give validation to some of the industry-led initiative taking.

Remit and functions of governance

A data sharing infrastructure will require a management framework that encompasses all its key aspects.

Primarily, it would consider these functions :

- **Technology oversight:** Oversight of the technology component that enable the data sharing infrastructure. Particularly around:
  - Building, adoption and maintenance of open protocols and applications (e.g. standardisation node).
  - User permissions, identity management, and authentication.
- **Security:** Clear consistent direction setting and assurance around security policies, requirements and controls (cyber, security, resilience, NIS CNI, disaster response, use of PET).
- **Interoperability:** Enablement of interoperability through supporting agreements around minimum operable data standards, their enforcement, and validation.
- **Data governance:** Implementation of a clear and consistent governance approach to the data sharing. This should clarify data sensitivity classes, access and licencing parameters.
- **Audit:** Independent scrutiny and evaluation to ensure data sharing is legitimate, performant, resilient and brings value to industry.
- **Coordination:** Coordination between different governance functions, data and digitalisation legislation, regulation and other initiatives across the energy sector and beyond.
- **Adoption & engagement:** Oversight of a data sharing infrastructure adoption and up-take across energy sector actor, facilitating input and consensus reaching across industry.
- **Future needs:** Review of future development based on the sector emerging needs and feedback.
- **Funding:** Evaluation and recommendations of funding structures, and incentives.

Current governance landscape

Establishment of Electricity Act in 1989

Overview of current landscape

The current GB energy governance system was established in 1989 under the Electricity Act by privatising both electricity and gas sectors. Since then, multiple amended acts have passed, such as Utilities Act 2000 to establish the Office of Gas and Electricity Markets (Ofgem), the Energy Act 2004, establishing the Nuclear Decommissioning Authority, and Energy Act 2008 established a renewables obligation for generating electricity from renewable sources.

The current system is designed by legislation that allows firms to compete in markets designed by regulations, with different arrangements in place for networks, generation, and supply defining what is bought and sold; where the value lies; and who profits.

GB energy governance institutions include Government departments such as DESNZ and Ofgem. Ofgem is a key governance link to the private sector which owns the vast majority of the physical assets associated with the GB energy system.

There are currently several initiatives and reforms being evaluated and consulted upon across the industry that might lead to some of the governance landscape evolving significantly in the future.

Current dependencies and constraints

The main dependencies and constraints identified are:

- There is currently no process for direction-setting or managing of digitalisation, across government departments and agencies, and across different sectors.
- There is no overarching entity in the energy sector that can coordinate data and digitalisation across sectors, with various digital and data initiatives being undertaken by both government and industry. Wider coordination and prioritisation of these initiatives would be needed to ensure that they are run cohesively.
- There is a lack of coordination across the energy system, both within electricity (linking generation, supply, demand, flexibility services and storage) and between electricity, heat and transport, making it more difficult to identify data exchanges needed to support the sector's drive towards decarbonisation.
- Currently institutions and organisations across the energy sector do not have the necessary skills and competencies to deliver coordinated data and digitalisation initiatives across the sector effectively.
- Lack of clarity around upcoming governance landscape changes (FSO, REMA, Future of Local Energy Institutions and Governance, The Future of Distributed Flexibility). Clarity of upcoming governance changes is essential to identify a governance structure for the future critical data exchange such as that provided by a data sharing infrastructure.
- Lack of clarity from legislation and regulation in certain areas. The current governance frameworks have gaps in coverage, for example licencing regime for aggregators and trade are not yet present. This leads to a variety of inconsistent data practices.
- The current standards landscape is very complex with a multitude of owners making it difficult for actors (e.g., system and network operators, innovators, end users) to navigate, identify and apply relevant standards. This make the coordination and promotion of wider interoperability more challenging.

Review of the governance of existing energy sector initiatives

High-level review of the governance of selected existing energy sector initiatives providing sector-side services

Smart Metering Governance

The DCC is governed by the Smart Energy Code (SEC) and through their price-controlled licence.

This framework, and its implementation in the DCC's, context is slow to change and has a large amount of uncertainty surrounding it due to the licence being reviewed and possibly renewed in the coming 18 months.

The DCC have developed security processes and systems which are deployed by hundreds of organisations, underpin thousands of device combinations and billions of message transactions.

Similarly, their finance operations and processes facilitate complex cost recovery across multiple industry programmes and customers (energy retailers, other DCC users).

Re-using mature technology and governance capabilities that have already been paid for could deliver further financial savings for the industry and consumers.

Automated Asset Registry Proposal

The automatic asset registration programme (AAR), another NZIP funded feasibility study, aims to support the development of an automated secure data exchange process for registering small-scale energy assets and collecting and accessing small-scale energy asset data.

The programme looked at options for future governance of a technological solution which will require a larger technological interface with industry partners as well as maintenance, fuller cost recovery and change management.

While the AAR may not end up being a regulated route, the exploration suggested that common digital infrastructure assets, such as AAR, have broad support to be a regulated service with associated cost recovery and governance.

Within the energy sector context, the most likely route therefore sits within an existing industry code, given Ofgem's move to consolidate the codes and appoint code managers to oversee them.

Over the course of the next 18 months or so, greater certainty will emerge on how this digital infrastructure will be prioritised, governed and incorporated into the energy system.

Open Energy

Open Energy is a non-profit project working with the energy sector to facilitate access to energy data and break down barriers to data sharing. It is a non-regulated entity and as such has no licence or code that compels organisations to engage with the service. Open Energy has been looking to develop a Trust framework and a governance model for data sharing to ensure data is used appropriately for the purposes intended - addressing questions of security, liability and redress.

The trust framework intends to include verification and assurance services at both organisational and dataset level. This will assure that (a) organisations are genuine; (b) consent is given to share data with the pre-agreed rules; and (c) enables that consent to be linked to rules for licensing, liability transfer, legal, and operational processes.

Currently, Open Energy Governance Service (OEGS) is set to support members to provide, share and access different classes of shared data (based on set Data Sensitivity Classes) based on pre-emptive licensing. For actors wishing to access Shared data, the Governance Service provides a mechanism to reduce friction and bilateral contract negotiation.

Potential governance structures

Centralised vs decentralised approaches

Governance structures outcomes

A governance structure for a data sharing infrastructure needs to clearly define the overarching outcomes it wants to achieve by setting itself a specific remit and set of functions.

For a data sharing infrastructure to enable the exchange of energy data in a secure and interoperable manner through the provision of a minimum layer of digital infrastructure, it is considered that the best suited structure is one that brings:

- **Transparency and openness** – brings visibility to its operation to enable trust and adoption across different market's participants.
- **Accountability** – provides clear definition of responsibilities and party responsible for each governance function and avoid conflicts of interest.
- **Legitimacy** – assures the endorsement of a data sharing infrastructure as a sector wide common digital infrastructure.
- **Responsiveness** – enables adaptation to future challenges, opportunities and stakeholder needs.

In future governance model recommendations, these set of outcomes should be used to evaluate and define in more detail a governance structure.

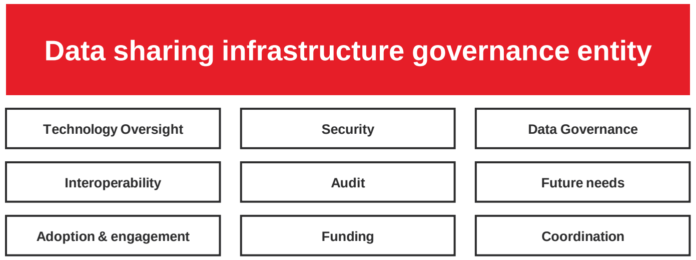
Centralised

A centralised approach would see all the governance functions identified being delivered by a central entity.

Such a structure poses serious challenges around management of conflict of interest with the same entity setting directions, auditing, and keeping themselves accountable. Therefore, this model does not meet one of core outcome of transparency and openness.

Furthermore, the breath of remit that a centralised structure will have to oversee it is unlikely to be easily found or possible to develop in a sensible time in one place. For these reasons, this structure is likely to be unsuitable for the governance needs of a data sharing infrastructure.

Centralised structure model



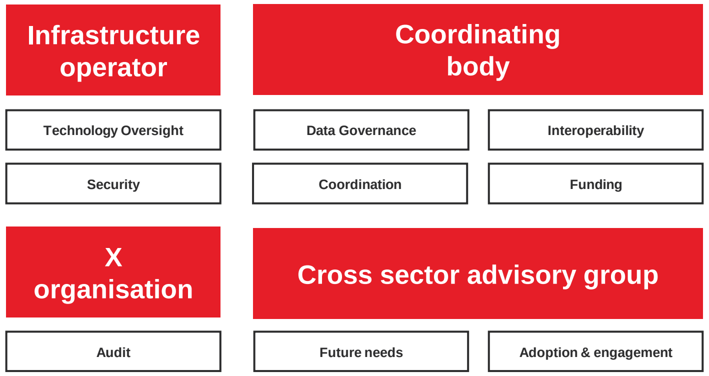
Decentralised

A decentralised approach will allow for governance functions to be split across purposely selected or designed organisations, with the right separation of power needed to assure accountability of the system.

A decentralised structure could take on different shapes, the exact definition of which, is set out elsewhere.

However, these could see core oversight and steer being provided by different segment of the sector, i.e., industry or government, or by an independent operator. In the next slide, we explore these three models in more details.

Example of potential De-centralised structure model



Three models of a decentralised governance structure

An overview of three different decentralised governance structures to support a data sharing infrastructure

Model 1 - Industry led

A decentralised structure could see industry involvement to varying degrees. An option could be for industry led design of the best suited structure and self-organise to meet the needs identified. In this instance, industry could likely drive some of primary governance functions (e.g., technology, interoperability coordination, stakeholder engagement) while still working with other parties to support the delivery of other governance function (e.g., audit, fundings, security etc..).

Pro

- Potential for high responsiveness – this model could lead to high industry participation and surfacing of needs

Cons

- The industry may struggle to agree on roles and responsibilities, hindering the recognition of a data sharing infrastructure as a sector-wide initiative.
- Influential actors, or those further developed with their data practices, may steer participation towards certain value or benefits, potentially neglecting efforts valuable to underrepresented parties like consumers. Volume of stakeholders will also be challenging to manage.

Model 2 - Government led

A structure distributed across government could see most governance functions being delivered by existing government and regulatory bodies. i.e., Ofgem or DESNZ take on core functions while other government department support delivery of other aspects, specific to individual areas of expertise (security, or audit), or be commissioned to industry (e.g., technology development or operation).

Pro

- Potential for high legitimacy – clear endorsement of a data sharing infrastructure.
- Potential for clear set of accountability – top-down design of accountability starting with government.

Cons

- Expanding the existing energy government body to provide necessary governance function would require a strong justification, making it potentially unfeasible to implement without wider industry support.
- The industry may have a low response due to concerns about the government-led governance prioritising specific outcomes, which may not be supported by all actors, leading to a perceived lack of transparency.

Model 3 - Independently led

Most governance structures could be provided by an independent entity/entities, given the right powers to be effective. These entities can provide direction and oversight separate from any specific segment of actors.

A specific aspect of the governance function could still be delivered by specific actors across the sector who are best suited to do so (e.g., funding from a government actor, future needs from industry panels, audits from both government and industry).

Pro

- Potential for high transparency and openness – impartial party involvement could lead to better perceived moderation of interests
- Potential for higher and more responsive industry engagement, and clear focus to encourage delivery
- Ease of design and implementation of effective accountability structures.
- High legitimacy of the structure with the right endorsement.

Cons

- A new entity or set of entities needs to be created.

Potential roles in the decentralised governance model

An overview of the roles within a decentralised governance model

Overview

The roles described are exemplars of potential governance roles that could be set up to deliver the several functions identified on the previous page.

Drawing from our findings, it is important to highlight that some of the proposed governance roles should be conceived as sector wide roles for them to be able to address key data sharing challenges (e.g., silos, lack of coordination and link across part of the sector etc..), such the Digitalisation orchestrator.

Roles	Description
Digitalisation orchestrator	A new independent entity for orchestration and coordination of data and digitalisation initiatives with clear government backing. Responsibilities include: • Drives effort across energy sector actors to improve data interoperability and provides guidance in relation to data sharing (data sensitivity classes, access and licencing parameters) to facilitate exchange of data. • Oversees the Digital infrastructure operator and other data and digitalisation initiatives across the sector to ensure coordination. Works with the advisory group input to define data digitalisation, principles and best practices, ensuring initiatives enable cross sector data sharing. • Identifies the needs for specific initiatives or funding routes required to enable specific outcomes to meet certain policy goals.
Digital infrastructure operator	A body that oversees, maintains, and operates the shared digital infrastructure that forms the Data Sharing Infrastructure. It would oversee build and maintenance of core components, set and coordinate user permission, oversee identity management and authentication function for a data sharing infrastructure, set security policies, and identify and manage security risks. It will set the principles, standards and rules for third party service development and integration.
Stakeholder groups	A series of appointed and industry led-panels to engage the industry to provide advice, feedback and bring forward industry consensus on thematic topics (such as security technology, data, future needs, adoption challenges, future needs and use cases). Additionally, it could also provide scrutiny functions to the above entities.
Government	Provides audit and scrutiny. It provides legitimacy to the governance model. It responds to the Digitalisation orchestrator entity recommendations around how legislation and regulation can be used to facilitate coordination around new initiatives, and how to best distribute fundings, among other functions. Potential to set delivery targets.

I.2

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Governance of a data sharing infrastructure

Governance of a data sharing infrastructure

Characteristics of the overall approach for data sharing infrastructure governance routes

Overview

The following pages outlines the potential governance models for the implementation and steady-state operation phases of a data sharing infrastructure. It is considered that separate governance approaches will be required for the two lifecycle phases because of their distinct requirements.

These lifecycle phase are outlined over three-time horizons:

- **Implementation (2024-2026)**
- **Interim-state (2026-2030)**
- **Steady-state (2030+)**

These governance models consider the proposed delivery routes in their construction; however, their design principles are applicable to any delivery route.

They are also intentionally designed from a perspective of ultimately facilitating cross-sector data sharing and interoperability.

Role of sector governance

Sector governance plays a vital role in shaping the operations and policies within the UK energy sector.

It encompasses various regulatory bodies, government departments, and industry stakeholders that work collectively to ensure the efficient, coordinated and sustainable management of energy resources.

Through a combination of legislation, monitoring, and enforcement, sector governance in the UK energy sector aims to foster innovation, decarbonization, and security of supply, while maintaining affordable and reliable energy for consumers and businesses alike.

The overarching governance described in the following pages reflect the ways in which the existing governance of the sector can, or cannot, be leveraged to deliver this work.

There is limited governance for digital assets and the development of data sharing infrastructure is an opportunity to introduce innovation for agile and responsive governance to support the pace and scale of the UK's digitalisation ambition.

Role of delivery governance

Delivery governance of an innovative and ambitious programme of work within the energy domain has been delivered in a few ways in the past, for example:

- The half hourly settlement implementation facilitated by Elexon.
- The smart meter rollout contracted and licenced to the Data Communications Company (DCC).

Learnings from these examples, and others, were considered when developing the proposed governance model for the implementation and steady-state operation phases of a data sharing infrastructure.

National level governance

The governance models show in this appendix includes an indicative national level governance structure.

This indicative structure is for explanation purposes only. The scope of this feasibility study did not include or consider the design of a national level governance.

Implementation phase governance (time horizon: 2024-2026)

Governance of a data sharing infrastructure during implementation

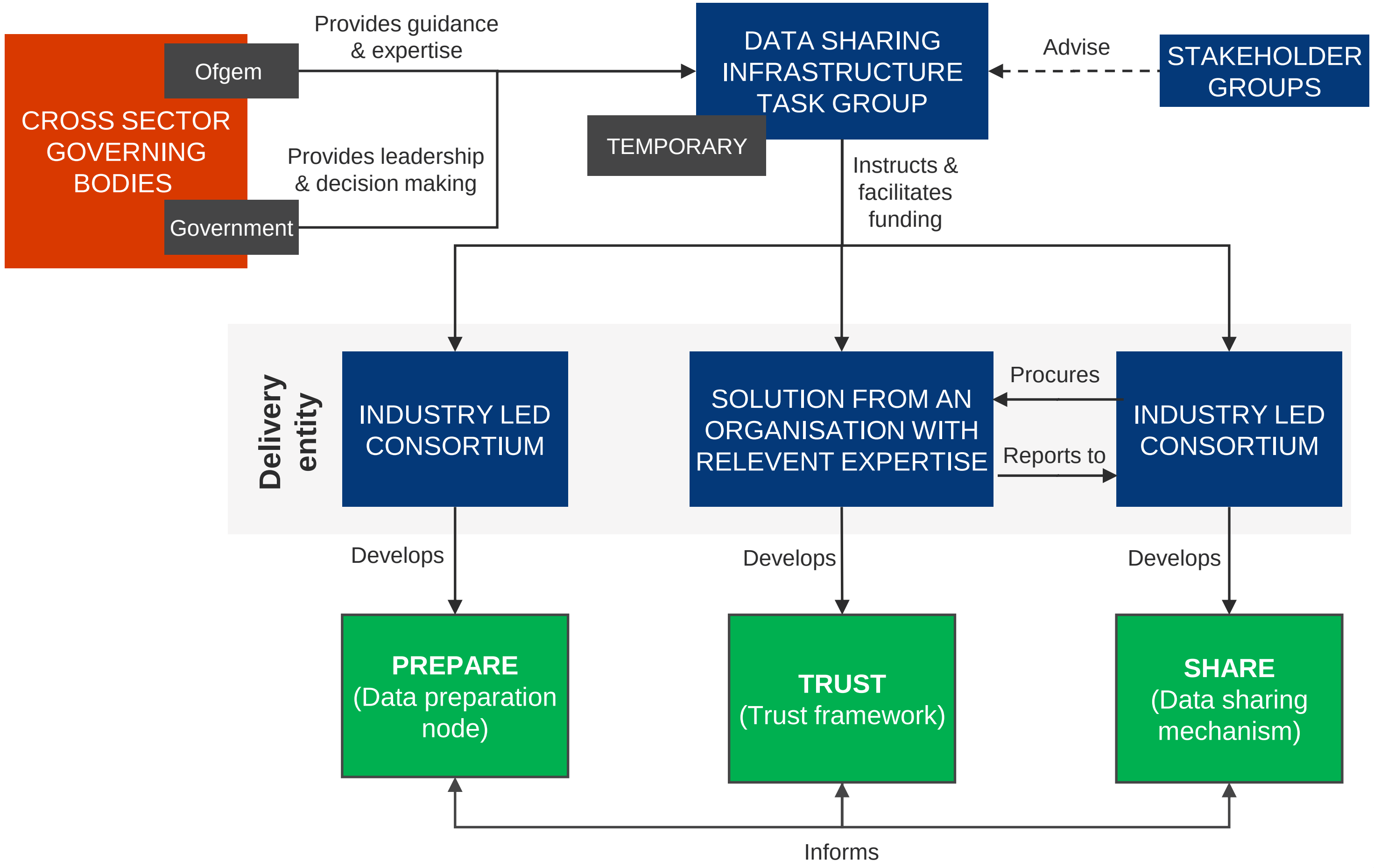
The diagram outlines the proposed governance of a data sharing infrastructure during the implementation phase.

The proposed approach is for a co-development of both the data preparation and data sharing mechanism, and the direct procurement of a trust framework solution from an organisation with relevant experience.

This approach enables government and industry to select and deliver a high priority use case, either taken from those detailed in the use cases, or elsewhere. See Appendix C for more information.

The governance shows two possible consortiums, one focussing on the development of a data preparation node, and the other on the development of the data sharing mechanism.

During implementation it is recommended that there is a ***Data Sharing Infrastructure Task Group*** established with the specific remit to fund and accelerate the development of the data sharing infrastructure on behalf of the energy sector. The Task Group should also be tasked with scoping the long-term governance of the data sharing infrastructure.



Steady-state operation phase governance

Governance of a data sharing infrastructure during steady-state operation

Overview

The diagram on the next page outlines the long-term options for the governance of data sharing across sectors.

The component parts of the data sharing infrastructure can be federated, both in terms of governance and in their deployment, across multiple sectors. Responsibility for sector-specific implementations would reside with that sector.

Common interoperable coordination is provided from a technology perspective by the data preparation node delivered by a ***National Data Sharing Infrastructure Operator***, and from a governance perspective by the ***Digitalisation Orchestrator***.

National level governance

The governance models show in this appendix includes an indicative national level governance structure.

This indicative structure is for explanation purposes only. The scope of this feasibility study did not include or consider the design of a national level governance.

Functions of the governance roles

Through workshops and testing with cross-sector stakeholders, several governance roles were determined.

- **Stakeholder Groups**: Provide advice, direction and challenge to the activities of the ***Digitalisation Orchestration*** within confines of a ToR.
- **Energy Digitalisation Orchestrator**: A temporary entity driven by industry, regulatory, or policy need for accelerated digitalisation within a specific sector. Responsible for rapid coordination of new digital infrastructure.
- **Energy Data Sharing Infrastructure Operator**: Responsible for the ongoing maintenance and operation of the data sharing mechanism and trust framework.
- **National Digitalisation Orchestrator**: This entity takes mandate from government, either directly from department powers or with new primary legislation, to focus on cross-sector digitalisation efforts. Provides funding and prioritising of activities.
- **National Data Sharing Infrastructure Operator**: Responsible for development and maintenance of the data preparation node and takes direction from the ***Digitalisation Orchestrator***.

Developing an ecosystem of cross-sector governance

The diagram on the next page outlines the potential target operating model for the governance of a cross-sector approach to developing cross-sector data sharing infrastructure.

The intent is to provide clarity and responsibility for the data preparation node to an organisation which a cross sectoral remit (the ***National Data Sharing Infrastructure Operator***), and then federate responsibility and ownership of the other components into their relevant industrial sectors.

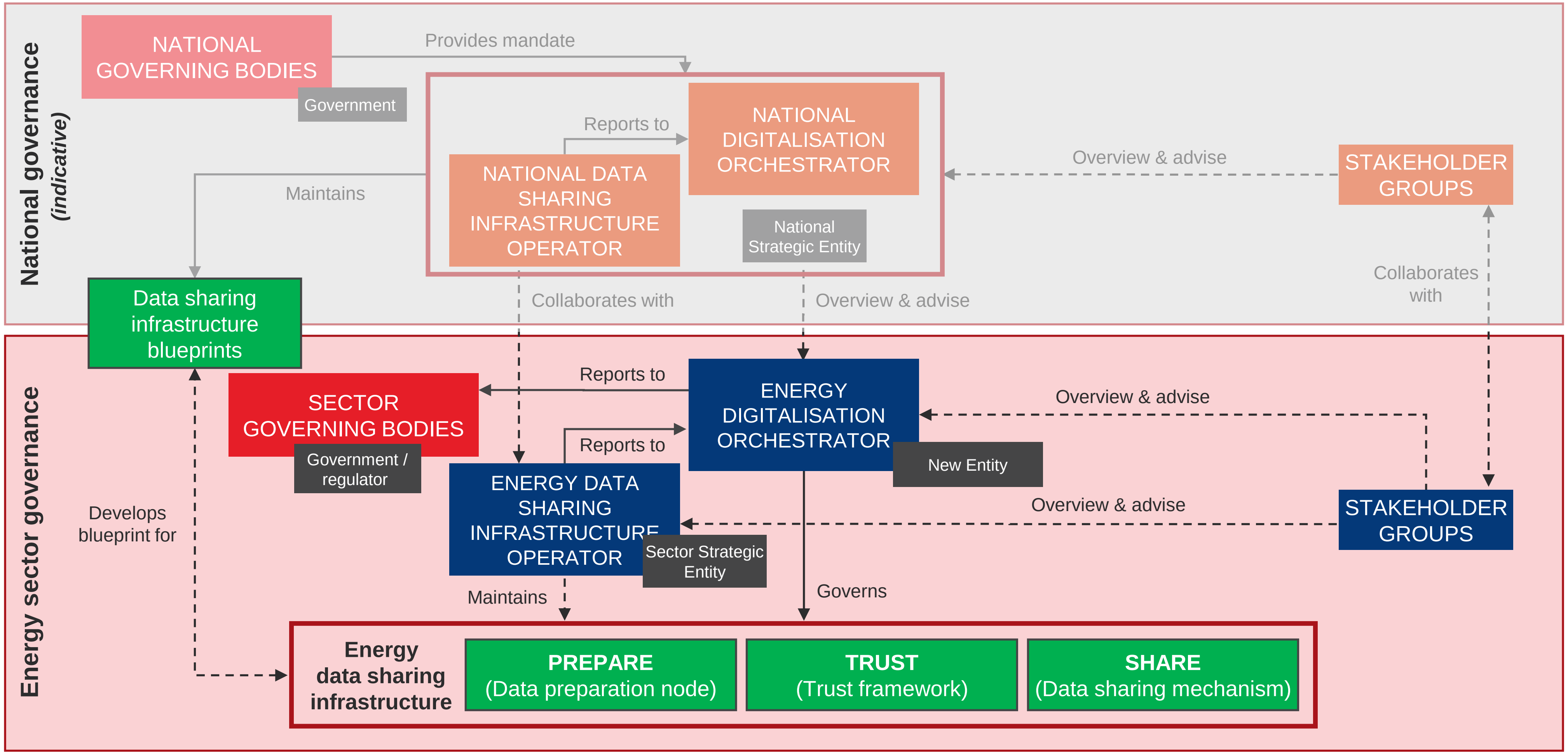
This approach allows sectors to own and operate the trust frameworks and data sharing mechanisms to their specifications through, for example, the ***Energy Data Sharing Infrastructure Operator***. This does not preclude private enterprises building additional instances of these elements too, where commercial opportunities arise.

The creation of this ecosystem would be incremental, with the first priorities being the ***Energy Data Sharing Infrastructure Operator*** and the ***National Data Sharing Infrastructure Operator*** to develop the capabilities.

Interim-state operation phase governance (time horizon: 2026-2030)

Ongoing governance of cross-sector data sharing infrastructure

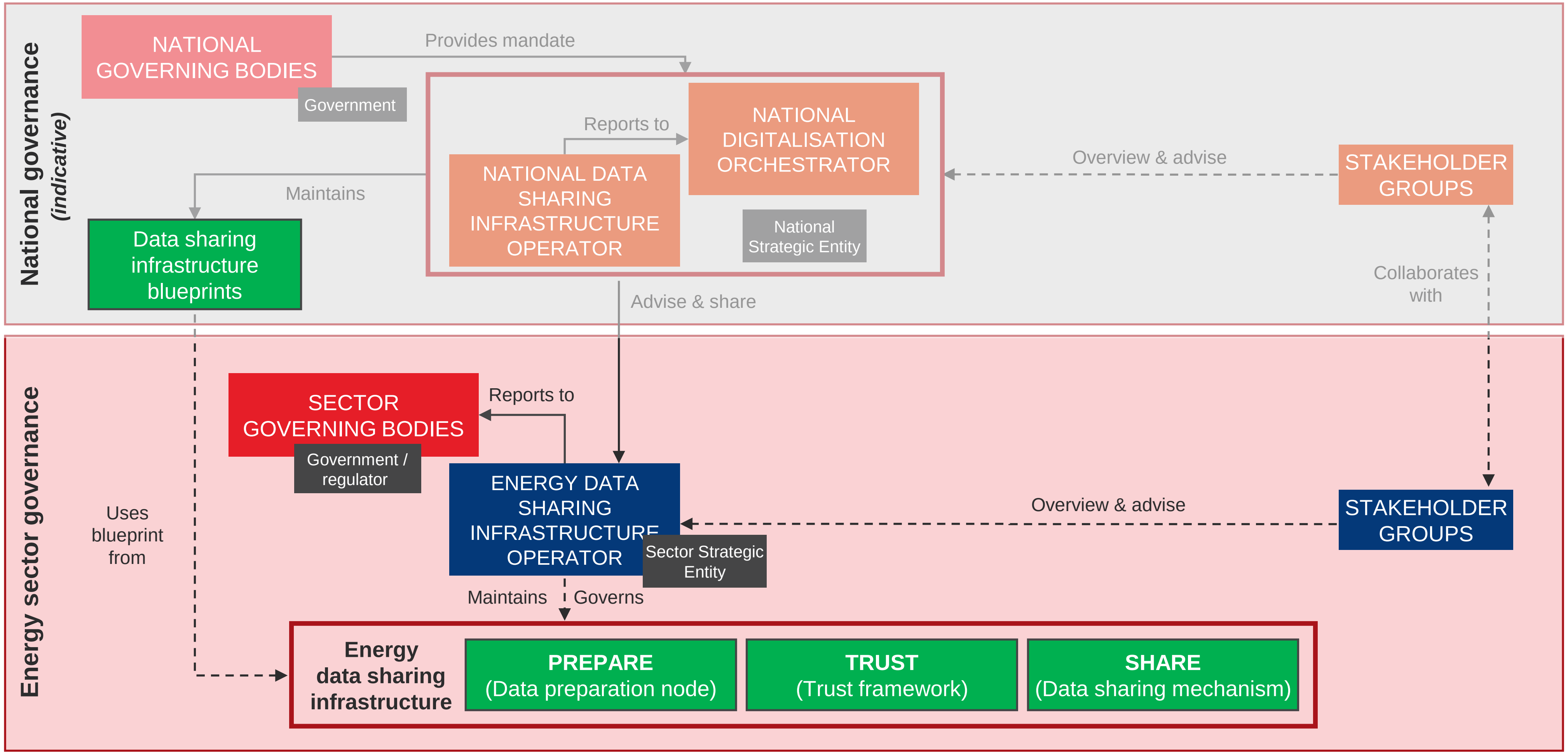
Indicative national level governance is included for explanation purposes only. Design of this level is outside of scope



Steady-state operation phase governance (time horizon: 2030+)

Ongoing governance of cross-sector data sharing infrastructure

Indicative national level governance is included for explanation purposes only. Design of this level is outside of scope



I.3

Developing governance over time

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Governance development from implementation to steady-state operation phase

Expected pathway for governance development through the lifecycle of a data sharing infrastructure

Near term (time horizon: 2024-2026)

Through the delivery of an implementation phase described in Appendix I.2, the ***Data Sharing Infrastructure Task Group*** would set up, with appropriate secretariat, terms of reference and funding mechanisms to develop the data sharing infrastructure blueprints, and technical demonstrator.

During this period, which considers the time horizon 2024-2026, the relevant roles and responsibilities of the ***Data Sharing Infrastructure Task Group*** can be handed over to the ***Energy Data Sharing Infrastructure Operator*** as and when that entity becomes technically capable to take on the responsibility.

Concurrently Ofgem could, through the RIIO3 process, update the digitalisation licence condition (9.5) to compel licensees to engage with the data sharing infrastructure and create guidance around the use of the blueprints to develop capability (as done with Data Best Practice).

This new amendment to the licence condition could have a date from when it applies align with ED3 licence conditions, so all networks have the same amount of time to be 'ready' for the requirements.

Medium term (time horizon: 2026-2030)

Within this timeframe (around 2026) it would be expected that government set up the ***Energy Digitalisation Orchestrator***, through established processes such as primary legislation or code/licence change for an existing organisation to take on the functional role.

This new legal entity takes on the relevant roles and responsibilities remaining with the ***Data Sharing Infrastructure Task Group***, with the task group then dissolving. Its ongoing role is to continue strategic development of the data sharing infrastructure.

Around this time data sharing infrastructure in the energy sector may have one or more instances or deployments of the data sharing mechanism and trust framework. For example, a 'network' instance and a 'regulation' instance. These would be designed from the same blueprints, so would be architecturally identical.

The ***Data Sharing Infrastructure Operator*** would be responsible for one of those instances; likely the on developed as part of the demonstrator, with other relevant organisations responsible for other instances. This could include privately owned and operated instances of the data sharing mechanism and trust framework.

Long term (time horizon: 2030+)

At this point, and once the strategic work of developing a data sharing infrastructure is sufficiently embedded and used across the sector, the ***Energy Digitalisation Orchestrator*** may be stood down, with any remaining function separated into its component parts and granted to either the ***Energy Data Sharing Infrastructure Operator***, or the newly created ***National Digitalisation Orchestrator***.

This new national body may have a 'division' that strategically coordinates the energy sector, in so far as ensuring coordination between and across different industrial sectors, such as water and telecoms. The ***National Digitalisation Orchestrator*** would likely derive power from primary legislation.

National level governance

The governance models show in this appendix includes an indicative national level governance structure.

This indicative structure is for explanation purposes only. The scope of this feasibility study did not include or consider the design of a national level governance.

I.4

Delivering a task group

Data sharing infrastructure task group

The needs case for a Data Sharing Infrastructure Task Group

Overview

Using a Task Group to accelerate development of the data sharing infrastructure can be realised through allocation of specific funding to release industry experts from existing roles via secondments. It is considered that this Task Group is derived from some combination of Ofgem, government, academia, and energy industry market participants (DNO's, Suppliers etc).

The specific skills required to would relate to the role and remit of the Task Group. The baseline expectation is that the requirements for expertise in at least the following capabilities, technical, project management and delivery, product development, governance, & legal.

The Task Group could be funded by DESNZ, through the NZIP innovation pots, or requesting HMT for a new funding pot. In addition to the Task Group, government should be provided a budget to procure solutions that will provide the MVP functionality of the data sharing infrastructure and build on said functionality to enable other use cases.

It is considered that another option could be to repurpose existing initiatives, such as the DDSG, to undertake the remit of a Task Group. This option is not recommended, as it is preferred that the winder sector are able to input.

This funding should incorporate both the ongoing governance of the Task Group but realising staged funding to develop both the blueprints and MVP development of solutions utilising those blueprints.

To ensure continuous implementation of the data sharing infrastructure, the funding for the deliver needs to be available on as needed basis, and not pieced together by different innovation funding schemes. It is expected that using the Strategic Innovation Fund (SIF) may be valuable, but risks associated to lack of coordination and loss of momentum can hamper the implementation if solely relied upon.

Responsibilities & objectives

- Oversees development of the data sharing infrastructure blueprint
- Enable a build and test of one instance of the data sharing infrastructure
- Recommend or propose licenses and code changes to enable use of the data sharing infrastructure
- Funds development, if required
- Ensure robust cybersecurity of the data sharing infrastructure

Needs case

- Lack of authority, no current one actor has capability or authority
- Cross cutting nature of proposal needs cross cutting governance
- Has not been achieved by the 'market'

Benefits

- Reduces the quantity of 1-2-1 engagement points between stakeholders and consortium.
- Provides a central body, representing the customers, which helps to bring government, regulators, and consortium together.
- Faster decision making, ensuring sector buy-in from the beginning.
- Develops new skills and capabilities across the sector.

Delivering a task group

Expected pathway for governance development through the lifecycle of a data sharing infrastructure

Overview

Data sharing infrastructure should be developed according to the needs of stakeholders and the energy system, independent of vested interests. This will require effective ongoing governance arrangements in addition to the technical implementation.

A task group should be commissioned by government with a clear mandate to support the implementation of data sharing infrastructure within the energy sector. Its mandate should be time limited and work in support of existing government initiatives.

Broadly, there are three approaches to achieve this, set out in the following slides.

1. **Within an existing government department**
2. **Arm's length body**
3. **Combined approach**

Characteristics

Below are key characteristics to use to select a delivery option.

- **Independent** – The task group should be free of commercial interest.
- **Mandate** – The task group can be given a clear and effective mandate to enable a data sharing infrastructure within the energy system.
- **Expertise** – The task group should have the ability to evaluate potential solutions and support implementation of those solutions.
- **Collaborative** – The task group should work with stakeholders across the energy sector and beyond to draw on existing solutions and best practice with broad support.
- **Vision** – Strong understanding of the energy sector needs and able to communicate this with the sector.

Governance

The task group should have government and regulator providing oversight to ensure that it delivers the right solutions in the best way.

- **Government** – Ensuring the task group operates in line with the mandate and then implements its approach.
- **Regulator** – Ensuring the task group is managed effectively and supports implementation of its approach..

Included in the remit should be that the task group identifies future use cases of a data sharing infrastructure and scopes options for the delivery of those implementations.

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Approach 1: Within an existing government department

Lower effort approach

Overview

The function could be carried out by a team within an existing government department. The task group can have an independent chair and governance structure but is ultimately overseen and accountable to the ‘parent’ government department and/or ministers.

A ‘within government’ body can be established by a government department providing there is support from a relevant minister and adequate funding.

In this approach, the focus of the task group is primarily to provide the technical oversight of a data sharing infrastructure of the organisations doing the development work. It can provide support to define a governance structure but will not be responsible for sector-wide governance.

For example, this can be done by energy sector specific personnel working through the NDTP framework.

How

DESNZ could come to a collaboration agreement, or direct resourcing of staff to the NDTP to support the development of data sharing infrastructure in energy.

The team could draw on existing DESNZ and Government staff (such as from GDS or CDDO) supplemented with secondments, as required.

It will be critical to build a team with technical delivery management experience and a deep understanding of the needs of the future energy system. This is expected to consist of no more than 3 individuals.

Precedent

- The Office for Artificial Intelligence was part of the Department for Digital, Culture, Media & Sport and the Department for Business, Energy & Industrial Strategy.

Advantages

- Low setup time for technical oversight function
- Can draw on existing government functions for organisation administration
- Opportunity to leverage existing government skills and expertise
- Direct ministerial oversight

Disadvantages

- Low level of independence
- Dependent on departmental funding
- Potentially challenging to attract external talent due to wage ceilings
- Industry may struggle to fully collaborate due to close government links

Approach 2: Arm’s length

Medium effort approach

Overview

The function could be carried out by an Arm’s length task group that is established by government but operates entirely independently. These organisations are established by government but operate with a degree of independence from the parent department.

Our assessment suggests the most appropriate type of arm's length approach is a Non-Departmental Public Body.

Non-Departmental Public Bodies operate independently from the parent department with a separate budget and legal structure.

In order to establish a Non-Departmental Public Body, it will be necessary to establish a formal governance and oversight structure with the parent department(s) and establish the core support functions of the independent organisation such as HR, Finance and IT.

Using this mechanism, a task group of larger size can be set up, with a focus on both providing the technical oversight of delivery as well as establishing the governance structures of a data sharing infrastructure.

How

A Non-Departmental Public Body can be established by a government department providing there is sufficient funding available and ministerial approval. It is also common for a consultation to take place ahead of an arm's length body being created. Legislation can be required if special powers are needed but we do not believe this is necessary in this case.

Precedent

- The Committee on Fuel Poverty is an Advisory, Non-Departmental Public Body and is sponsored by DESNZ.
- The Committee on Climate Change is a Non-Departmental Public Body with special powers, this required legislation to establish.

Advantages

- Higher level of independence from government
- Ring fenced budget
- Perceived status

Disadvantages

- Long setup time including a consultation and possibly legislation.
- For a time-limited body, this could be a major challenge and risk the body being seen as ‘self-serving’ if setup delays result in needing to extend the life of the task group
- High setup and organisation administration costs
- No existing team to leverage – need to recruit
- Governance and financial oversight can be complex

Approach 3: Combined approach

Blended approach

Overview

Using the two approaches described in previous pages a coordinated approach is taken.

Secondees are provided into a relevant government department to manage the technical oversight and development of data sharing infrastructure while an independent task group is separately established by government.

The task group, once set up, is responsible for development of the governance propositions for the energy sector, as well as being the interface for industry and the programme of work (including the technical oversight established by the secondees).

How

Secondees are provided to the NDTP and government could establish the task group within an existing independent and competent organisation to deliver. This would require the government to secure sufficient funding to cover the activities, identify a suitable host organisation and establish the correct governance to ensure it delivers effectively.

To deliver the funding to the task group it will be necessary to establish a viable funding mechanism. Given the specific requirements of the body it is likely a single source funding route will be required.

Precedent

Secondees into other government departments are common occurrences. The Committee on Fuel Poverty is an Advisory, Non-Departmental Public Body is sponsored by DESNZ.

Advantages

- Low setup time for technical oversight function
- Can draw on the organisation's existing functions for organisation administration
- High level of coordination between initiatives
- Ring fenced budget
- Leverage the status of the existing organisations
- Access to existing experts, capabilities, and network

Disadvantages

- Need for robust lines of communication
- Identifying suitable candidates for secondment to NDTP.

Appendix J

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Integration with the future energy system

Integration with the future energy system

Summary of how a data sharing infrastructure will integrate with the future energy system

Overview

This Appendix conducts a review on the existing constraints and dependence that could impact the development of a data sharing infrastructure for the energy system.

It considers:

- Adoption of a data sharing infrastructure
- Impact to stakeholders by having a data sharing infrastructure
- Interactions between the data sharing infrastructure and other energy sector digitalisation initiatives

Key findings

This appendix summarises the extent to which the data sharing infrastructure can have an impact on the future of the energy system.

It has identified that the National Digital Twin Programme (NDTP), Virtual Energy System, and Open Energy represent the three functional components of the data sharing infrastructure. Namely the Data preparation node, data sharing mechanism, and trust framework respectively.

The joining of those initiatives offers an opportunity to develop a cohesive blueprint for the data sharing infrastructure, and a way to test an implementation via a use case to demonstrate its usefulness.

Other industry change programmes are noted in this appendix, and insight into how they could interact with the data sharing infrastructure are articulated.

J.1

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Adoption of a data sharing infrastructure

Driving adoption

Accelerating adoption of a data sharing infrastructure

National

The National Digital Twin Programme (NDTP) is developing the initial blueprint of the Integration Architecture for data sharing, where a cross sector focus on facilitating development of digital twins is receiving support.

The alignment of objectives, as well as technical specificity between the integration architecture and this feasibility study suggest strong opportunity to drive the objectives of the NDTP through adoption of capabilities within the energy space and use the learnings from an energy implementation to accelerate and facilitate further cross sector work.

This collaborative approach can ensure low barriers to deployment by aligning with the Virtual Energy System and Open Energy initiatives, which provide many functional elements similar to the data sharing mechanism and trust framework respectively. A data sharing culture can also be embedded by working with these initiatives.

Given the strategic placement of the NDTP, this capability can be used to drive the wider adoption of the data sharing infrastructure through the Integration Architecture.

Sector-specific

Within any given industrial vertical, in this instance energy, there is a role for organisations to manage and iterate upon the integration architecture for the challenges a sector has, in addition to governing any regulated or public good instance of the data sharing infrastructure.

Those organisations, described in Appendix I as the ***Energy Digitalisation Orchestrator*** and the ***Energy Digitalisation Infrastructure Operator***, denote the focal point of driving adoption across the sectors.

Proper consideration of the terms of reference, or licenced/statutory responsibilities of those bodies should reflect their role in driving the adoption of the NDTP Integration Architecture as the basis for data sharing infrastructure within their sectors. Primarily, this focus is to ensure a multiplicity of organisations are tasked with driving the interoperability of these services.

The role of Ofgem and DESNZ will take on multiple strands. The overall governance of the system will be in part created, and then supported by both organisations – continued engagement in those processes will be required over time. This commitment will be key in providing the sector certainty that this is the right direction.

Adoption must be driven from a multi-pronged approach. Licences and codes are one opportunity to embed the requirements for obligated entities with the energy sector, but that must also be supported by training and upskilling.

We expect a core part of the work to be delivered by the ***Data Sharing Infrastructure Task Group*** detailed in Appendix I.

In addition, there will be a wider recognition of roles of these two organisations, Ofgem and DESNZ, in respect to creating the right environment for adoption, including horizon scanning and prioritising other policy or regulatory mechanisms to either remove blockers or facilitate new capability or skills being prioritised by the energy sector.

The proposed ***Energy Digitalisation Orchestrator*** and ***Energy Data Sharing Infrastructure Operator*** will also have responsibilities to drive adoption through their specified roles and remit when they are created.

J.2

Impact to stakeholder by having a data sharing infrastructure

Impact on different stakeholders

Where the impact sits between stakeholders

Government and regulator

The data sharing infrastructure will have differing degrees of impact across distinct stakeholder groups. For the government and the regulator, the setup of tenable governance structures has been identified as a key enabler for a successful data sharing infrastructure.

This will be achieved if significant and deliberate resource is given to the establishment of the management and governance framework. It needs to be ensured that it adheres to and fulfils the remits and functions identified through the stakeholder engagement work.

From the creation and appointment of positions, there may be new codes and licenses which will materialise to create this framework.

The longevity of the impact will be felt across governance and regulators, as the sustainability of the governance relies on not only continuous resource but agility.

Licensees

Regulatory practice of the energy sector is exercised through the codes and licenses which govern the industry.

With the introduction of data sharing infrastructure, these codes and licenses are subject to change - these have been noted in Appendix E.

This will pose a significant impact to those who are required to follow them. Entire practices and operations may need to be reviewed and updated to ensure compliance.

The overall benefit of the data sharing infrastructure must therefore justify the monetary, time and resource impact its participants may endure.

These participants include:

- Network Operators
- ESO
- Suppliers
- Gas Transmission and Distribution
- Energy Generators

Users

The successful participation for the users of a data sharing infrastructure will potentially introduce substantial impact to them.

Any required additional and bespoke skills and capabilities will need to be firstly identified and then acquired. This will be through both new and trained capacity - all within a landscape which already is already suffering from deficient data capabilities.

Users will therefore likely be required to obtain mandate funding, either within or out with their commercial structure, to finance the initial and continuing resource required for the participation of a data sharing infrastructure. The technical design, and hence level of impact, will inform the viability of this for the infrastructure users.

These participants include:

- Local Authorities
- Flexibility Service Providers and aggregators
- Investors and Asset Operators
- Consumers
- Other Sector participants

J.3

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Interactions between the data sharing infrastructure and other energy sector digitalisation initiatives

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Complimentary data sharing infrastructure initiatives (1 of 2)

High-level review of existing digital initiatives and their interaction with a data sharing infrastructure

Open Energy

Open Energy is a data portal that signposts to the largest curation of energy data across the sector.

It offers a data catalogue and a trust framework, which is modelled on Open Banking to enable secure data sharing. It contains a mixture of open and closed data and whilst data is not stored directly on the platform, users are instead directed to the organisations/owners for where that data is stored.

Icebreaker One, the parent company of Open Energy, have developed the Open Energy Trust Framework, which provides a thin/minimal layer of policy and technology to implement a trust framework within energy.

Icebreaker One are developing implementation in water (via STREAM) and finance (via Perseus). They are providing an approach to develop a trust framework and are using a 3rd party to provide the technology that enables the trust framework.

National Digital Twin Programme Demonstrator

The National Digital Twin Programme (NDTP) is directly run by the UK Government, in collaboration with industry and academia.

Their demonstrator project looks at infrastructure resilience, emergency planning and responsiveness; and energy demand, use and supply for the Isle of Wight.

Telicent were commissioned to deliver the technology aspects of the demonstrator using their 'CORE' platform. Users can initiate an instance of the open-source CORE tool in their own IT infrastructure to ingest raw data, cleanse and transform it into a specific standard – the Information Exchange Standard (IES4).

The data can then be visually represented through nodes and relationships to make the data easier to consume. Furthermore, the tool enables users to add security labels to their data, which provides the access control permissions using an Attribute Based Access Control (ABAC) model.

Telicent CORE shares many similarities with a data sharing infrastructure. There may be opportunities where CORE could be configured to perform data sharing infrastructure functionalities for future NDTP phases.

Virtual Energy System

ESO's Virtual Energy System programme aims to enable the creation of an ecosystem of connected digital twins of the entire energy system of Great Britain, which will operate in synchronisation to the physical system.

The initiative is currently in the Alpha phase through the GDS process, which specifically focusses on a demonstrator use case pertaining to electricity flexibility for grid supply points.

Building upon the data sharing architecture industry collaboration group, the Virtual Energy System's conceptual architecture looks to achieve a fully distributed architecture whereby users can retain ownership of their data whilst sharing it securely through the Virtual Energy System data infrastructure.

The functionality is similar to the data sharing mechanism, where the data licensing, security & governance, data search, and data streaming functionalities will be provided. A data preparation node would provide the sector with the correct tooling to enable preparation and standardisation of data, which could then be shared through the Virtual Energy System.

Complimentary data sharing infrastructure initiatives (2 of 2)

High-level review of existing digital initiatives and their interaction with a data sharing infrastructure

CReDO

The Climate resilience demonstrator is developing a connected digital twin across key services networks to provide a practical example of how connected-data and greater access to the right information can improve climate adaptation and resilience.

Their technical implementation approach works on connecting data using standardised approaches to managing access to data.

This approach, as relevant to this feasibility, would represent another 'data sharing mechanism' that those using data preparation nodes could connect to and exchange data with.

Stream

Stream has an ambition to design and deliver the ‘network of data pipes’ needed to share useful industry datasets in a secure, standardised and easy to access way.

This will allow water data to flow into larger datasets, enabling us to collaboratively solve tough sector challenges.

The ambition of the programme is to be cross sector, and given that, the linkages between stream and a data sharing infrastructure in energy could be an important collaboration point for the two sectors.

Alignment through the development of a ***Data Sharing Infrastructure Task Group*** could be an important strategic consideration, depending on the remit and approach of that task group.

Energy Data Visibility Project

Over 12 weeks, the Energy Data Visibility Project (EDVP) took an industry-led, consultative, and collaborative approach to test and validate metadata standards, glossaries and test a prototype solution with the energy community.

The process explored user needs, incorporated feedback from user engagement into development work and delivered user-facing services based on those needs analyses.

The outcome of the project was the development of Open Energy’s data search, which functionally is a data catalogue for indexing energy data.

This capability is aligned with the functional components of the data sharing infrastructure, within what is understood to be the data sharing mechanism.

Utilisation of this project can accelerate the development of a data catalogue blueprint for a data sharing infrastructure.

Integration with other energy sector digitalisation initiatives (1 of 2)

Interactions between the data sharing infrastructure and other energy sector digitalisation initiatives

Enabling future projects

In summary the data sharing infrastructure that is being proposed through this feasibility study may re-use some of the elements described in the previous pages of this report, such as Open Energy, National Digital Twin Programme, or the Virtual Energy System depending on the implementation and governance routes described in the next delivery routes (Appendix H).

Other projects, such as MHHS or AAR are likely to be users of the data preparation node and a data sharing infrastructure to facilitate the passing data that is generated by their relevant processes or projects to other market participants.

In future, it is expected that other data sharing infrastructures may be developed in parallel that could use a data preparation node as a facilitator of sharing data and would connect to other data sharing mechanisms or Trust frameworks to provide relevant governance.

Automatic Asset Registration

The Automatic Asset Registration programme (AAR) is seeking to develop capability to register new flexibility assets on the energy system in a consistent way. The Greensync solution being taken forward through innovation enables end to end API bridges between permitted actors and OEM systems. The AAR solution has committed to opening data in line with Data Best Practice guidance. The technical mechanism for wider data sharing is expected to be developed in phase two.

If a data sharing infrastructure technical architecture was developed concurrently, it is likely that AAR will use that mechanism, or will otherwise have to develop their own data sharing mechanism outside the end-to-end API bridges.

Smart Meter Data Repository

The SMDR project was set out to determine the technical and commercial feasibility of a smart meter energy data repository within the Smart Meter Data Access and Privacy Framework. Our understanding of this suggests that any technical framework to share data using a developed SMDR could utilise the architecture of the data sharing infrastructure to enable data sharing.

MHHS

The Market Wide Half Hourly settlement programme will enable a faster, more accurate settlement process for all market participants, introducing site specific reconciliation using half-hourly meter readings. This fundamental market change will see the utilisation of a much richer dataset for settlement purposes. It is technical implementation and architecture involves the sharing of data between participants through the data sharing infrastructure developed by the MHHS programme. It is expected that the data sharing infrastructure articulated through this feasibility study does not overlap, and future use cases of the feasibility study's work could integrate with data sources from MHHS to enable wider system use cases.

Smart Meter Internet of Things

Smart Meter System based IoT sensor devices is the focus of this work, and there is limited technical architecture overlap between this SMIOT and this feasibility study. Data generated by the SMIOT programme sensors may eventually be standardised in the data preparation node to facilitate particular use cases.

Integration with other energy sector digitalisation initiatives (2 of 2)

Interactions between the data sharing infrastructure and other energy sector digitalisation initiatives

Energy Networks data sharing portals

Through the RIIO2 and ED2 price controls the energy networks, working in line with Data Best Practice and Digitalisation Strategies and Action Plan guidance documents, have been redeveloping their capability to publish data. The approaches that are taken across the networks are not particularly well aligned, with each network coming from a different level of underlying capability.

The development of these platforms and the data made available over them would benefit from standardisation that a data sharing infrastructure implementation can bring. The portals themselves largely focus on 'open' data, rather than shared data and therefore do not provide much in the way of interoperability between approaches to shared data. Similarly, the more open data made available on these platforms highlights the divergence in standards between network operators.

The technical implementation of a data sharing infrastructure in the context of this array of data portals would be as an additional 'bolt on'. First, in enabling preparing of data from internal sources to expected data standards, and latterly to provide common API interfaces to enable other participants to access open and shared data.

Ofgem’s Future of Distributed Flexibility CFI

There has been an assessment of the technical requirements of Ofgem's proposed archetypes enabling flexibility that was conducted by IBM.

In this, IBM noted that the data transfer mechanism that would underlie the functioning of the flexibility markets could be enabled by a data sharing infrastructure.

Given the technical specifications are now more fully developed, an initial assessment suggests that the development of the data preparation node aligns with the expectations of what the IBM report functionally understood the 'digital spine' to be doing and is therefore aligned.

OneNet

To facilitate better market functioning, OneNet is creating a unique IT architecture to support innovative mechanisms of platform federation.

An analysis of their technical approach highlighted places of similarity and slight divergence. Given it is pan-European brief and similar challenges, the project will be worth developing a relationship with, if nothing else to exchange concepts and learnings.

OneNet includes containerised deployment with individual microservices/sub-containers as part of the software package and contains similar functions; such as cataloguing, identity management and data access policies, to the 'data sharing infrastructure' and ‘Trust framework' in our overall data sharing architecture. It also has functions around data quality, which to date have not been within scope of the MVP of our data sharing infrastructure.

The OneNet project is further along than our current development and could provide further learnings as the project develops. Alignment and interoperability with OneNet may be a longer term ambition.

Appendix K

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Routes to enable a data sharing infrastructure

Routes to enable a data sharing infrastructure

Summary of routes available to the government for intervention

A route is defined as a selection of a pathway, a governance structure, and a review of existing related programmes nationally and in-sector.

Establishing a data sharing infrastructure involves evaluating a spectrum of routes, each offering advantages and potential challenges. These routes are designed to address diverse sector and policy needs.

Importantly, they are not fixed choices. Government or sector can transition between these routes, although the costs of switching varies.

Deciding on the most suitable route involves a nuanced evaluation of factors like adoption, vendor lock-ins, scalability, integration complexity, and the potential switching costs associated with each route and when a switch takes place.

While there are many pathways for the delivery and governance of the data sharing infrastructure, the six options summarised in the adjacent box and detailed on the subsequent page were considered to account for the and represent the majority of the pathways.

Two categories of possible routes

There are two categories of possible routes, each with three options:

1. **National and sector specific programme alignment driven by government**

   These routes focus on the delivery of the enabling infrastructure through a collaboration of national and sector programmes, enabling effective cross-sectoral knowledge dissemination and optimal use of government funds.

2. **Sector specific procurement of relevant capabilities required to deliver a data sharing infrastructure MVP**

   These routes focus on the delivery of the enabling infrastructure through a sector-specific lens, enabling greater oversight by the sector entities, and industry partners.

Route 1 - National and sector specific programme alignment driven by government

- **Route 1A:** Government encourages alignment of on-going programmes
- **Route 1B:** Government assigns staff to ensure alignment of on-going programmes
- **Route 1C:** Government assembles a “tiger-team” to align programmes to define long-term governance

Route 2 - Sector specific procurement of relevant capabilities required to deliver an MVP

- **Route 2A:** Government procures a data sharing infrastructure
- **Route 2B:** Government mandates a sector strategic entity to deliver a data sharing infrastructure
- **Route 2C:** Government assembles a “tiger team” to roadmap enablement of a mandated task group to oversee delivery of a data sharing infrastructure

Route 1A: Government encourages alignment of on-going programmes

No-regret scenario with minimum cost, resource, and reputational impact

Overview

Government reviews the outcomes of this feasibility study and acknowledges the core components of the data sharing infrastructure can be fulfilled by the Virtual Energy System, Open Energy and the National Digital Twin Programme. It encourages those programmes to collaborate, with their buy-in, to implement the energy sector data sharing infrastructure.

- **Virtual Energy System and Open Energy** collaborate to develop the data sharing mechanism and trust framework
- **CORE as part of the National Digital Twin programme** provides the data preparation node

In this route industry is given ownership of developing, testing, and implementing the data sharing infrastructure, but has government acknowledgement that encourages these programmes to collaborate, but the programmes are not mandated or procured to do so.

Opportunities

Value derived from previous government investment due to effective leveraging of work completed to date.

Data sharing infrastructure is designed and delivered by industry in such a way that it becomes financially independent in the future and generates economic for the UK.

Challenges

Potential vendor lock-in due to the commercial nature of the programmes.

Government has limited oversight and input into the operating model of the data sharing infrastructure. Lack of visibility on ensuring delivery of a data infrastructure delivers benefits all not just those involved in existing programmes.

Low knowledge dissemination across other sectors, or countries.

Funding - enabling infrastructure

No cost to government for funding the enabling infrastructure.

The various programmes can use existing innovation funds, but that is through business-as-usual activities.

There is no funding intervention from the government.

Funding - governance

Cost to government is low, holding only the staff requirements to read, analyse, and acknowledge the feasibility study.

Route 1B: Government assigns staff to ensure alignment of on-going programmes.

A low-risk scenario that encourages further collaboration between national and sector specific government departments

Overview

Government acknowledges the role of the NDTP to support the energy sector in developing the data sharing infrastructure.

A tiger team (~2-4 people) is formed by DESNZ/Ofgem to provide the programme/project leadership and management for accelerating the development of the MVP of the data sharing mechanism and its integration with CORE/NDTP. This team can support the programme in removing financial, technical, and governance hurdles.

This team could sit within DESNZ/Ofgem or be seconded into the NDTP team. Irrespective of their location, they would maintain strong alignment, communication, and collaboration between NDTP and this team.

Opportunities

Faster implementation, compared to route 1A, because of government leadership to make faster operational decisions, or enable conflict resolution between programmes.

Data sharing infrastructure is designed and delivered in such a way that it becomes the blueprint for other sectors.

Funding - enabling infrastructure

No cost to government for funding the enabling infrastructure.

The various programmes can use existing innovation funds, but that is through business-as-usual activities. There is no funding intervention from the government, unless the tiger team recommends financial support is required to enable the data sharing infrastructure for public good.

Challenges

Potential vendor lock-in due to the commercial nature of the programmes.

While support from government, there is still a lack of a mandate and commercial incentives for the various programmes to collaborate.

Lack of funding can potentially slow down implementation.

Funding - governance

Funding required to pay for salaries, and other overhead, for staff that is assigned to collaborate with NDTP.

Other costs can include workshops, webinars, and travel costs.

Route 1C: Government assembles a “tiger-team”

An approach that looks at sector needs, but aligns to existing national level programmes

Overview

This route considers NDTP and energy sector collaborating, and, in parallel, becomes a first mover to explore sector-specific implementation instance. Thereby, government recognises the need for a task group to support future governance requirements.

Government assembles a “tiger-team” to understand and scope:

- How the energy data sharing infrastructure task group would work in practice. For example, the roles and responsibilities, size, membership, decision making powers, ability to procure (this aligns with an area of further work identified by the digital spine feasibility study)
- The technical integration of NDTP and VirtualES. It would oversee/conduct a detailed study into the technical architecture with the support of the relevant programmes.
- Understand and deconflict any sector-specific requirements or work required to enable the data sharing infrastructure. For example: technical requirements relating to regulatory obligations, conflicts between existing in-sector initiatives.

Opportunities

Industry, and government collaboration in delivery, maximising rate of adoption.

Data sharing infrastructure is designed and delivered in such a way that it becomes the blueprint for other sectors.

Optimal roadmap that can pass responsibilities and ownership to relevant teams as the implementation of the Data Sharing Infrastructure progresses.

Funding - enabling infrastructure

No cost to government for funding the enabling infrastructure.

The various programmes can use existing innovation funds, but that is through business-as-usual activities. There is no funding intervention from the government, unless the tiger team recommends financial support is required to enable the data sharing infrastructure for public good.

Challenges

Defining the remit of a task group existence, and extent of its influence.

While supported by government, there is still a lack of a mandate and commercial incentives for the various programmes to collaborate.

Funding - governance

Funding required to pay for salaries, and other overhead, for staff that is assigned to collaborate with NDTP, and part of the “tiger team”.

Other costs can include workshops, webinars, and travel costs.

Route 2A: Government procures a data sharing infrastructure

A sector-specific initiatives that aims to deliver the whole data sharing infrastructure for sector needs

Overview

Government, through innovation funding (e.g. NZIP, SIF, NIA), directly procures the relevant organisations required to deliver a data sharing infrastructure, as outlined in the delivery routes and holds responsibility for its successful delivery.

To support the delivery of the data sharing infrastructure, government assembles an advisory group of sector and government subject matter experts to evaluate, inform, and support the development of a data sharing infrastructure.

Procurement could happen individually for each aspect of the data sharing infrastructure or as a whole.

See Appendix H for the proposed delivery pathway, and summary of other delivery options to enable data sharing infrastructure.

Opportunities

Government has complete control over scope and delivery with the ability to direct programme in a way that means cross industry interoperability, and consumers economic and social benefits are realised.

Ability to ensure required skills/ capabilities are in place through requirements that organisations responsible for delivery can do so.

Challenges

How to ensure cross industry collaboration and programme alignment, without which, successful delivery and adoption will be limited.

Defining an operating model that supports financial independence of a data sharing infrastructure from government in the long term, and public good.

Funding - enabling infrastructure

Government takes complete ownership of funding the data sharing infrastructure.

Funding - governance

Low cost for governance because existing mechanisms can support programme delivery.

The cost of the advisory group will be minimal, as these individuals can be volunteers from the sector and government. Further ways of working for the advisory group will need consideration, but it should be low effort for the members.

They are providing advice to the delivery team and hold no decision authority.

Route 2B: Government mandates a sector strategic entity to deliver the MVP

A sector-specific initiatives that aims to deliver the whole data sharing infrastructure for sector needs

Overview

Government mandates existing sector programme(s) to deliver the whole enabling infrastructure.

The most likely example of this would be the government supporting ESO to deliver the Virtual Energy System. The support can come in forms of:

- Assembling an advisory group of sector SMEs. i.e., brings different actors together for feedback on technology and data.
- Financial support from existing innovation pots or other means.
- Debottlenecking regulator challenges, where feasible.

Government leaves the delivery, testing, and implementation to the programmes with minimal oversight on day-to-day operations, but retains control of the IP for public good, and future commercial benefits.

Opportunities

Ability to leverage work to date on existing programmes and facilitate some alignment with industry.

Government can ensure across industry, economic and social benefits are realised for all, not just to those involved in delivery.

Government can ensure better knowledge dissemination to other sectors and countries.

Funding - enabling infrastructure

Government funds majority of the infrastructure, but the funding support for the programme can come in many forms:

1. Innovation pot support
2. Price control
3. Mandate, at risk.

See Section 3.3 for more details.

Challenges

Monopoly risks of relinquishing delivery control to a single existing programme given cross industry/ government priorities and requirements.

Time to deliver given programmes or those responsible for its delivery other objectives.

Availability of the correct skills/ capabilities within the programme to ensure successful delivery.

Funding - governance

Low cost for governance because existing mechanisms can support programme delivery.

The cost of the advisory group will be minimal, as these individuals can be volunteers from the sector and government. Further ways of working for the advisory group will need consideration, but it should be low effort for the members. They are providing advice to the delivery team and hold no decision authority.

Route 2C: Government assembles a “tiger team”

A sector approach that collaborates with industry to implement a long-term solution

Overview

Government assembles a “tiger team” to roadmap the enablement of a mandated task group. The roadmap will detail the governance structure, roles and responsibilities, and ways of working requirements.

The task group formed with industry subject matter experts delivers the MVP functionalities. It can, for example, mandate Virtual Energy System by ESO or directly procures the required technology, ensuring delivery meets the requirements as identified in this study, while also, implementing a sector level governance structure for further development and innovation. The two parallel paths:

- Assemble a “tiger-team” to understand and scope:
  - How the energy data sharing infrastructure task group would work in practice.
  - What the tasks of the task group would be.
  - Understand and deconflict any sector-specific requirements or work required to enable the data sharing infrastructure
- Assemble a “task group” to select a ‘pathway’ to deliver the data sharing infrastructure, as outlined in Appendix H.

Opportunities

Optimal roadmap, avoiding governance delays, that can pass responsibilities and ownership to relevant teams as the implementation of the Data Sharing Infrastructure progresses.

Industry and government collaborate in developing, testing, and implementing the data sharing infrastructure. Faster decision making to develop a solution fit for the energy sector needs.

Challenges

How to minimise risks of a monopoly held by the external task force and ensure cross industry collaboration and involvement without which success will be limited.

Defining an operating model that supports financial independence of a data sharing infrastructure from government in the long term, and public good.

Careful consideration around the handover and long-term operations and management of a data sharing infrastructure

Funding - enabling infrastructure

Government funds majority of the infrastructure, but the funding support for the programme can come in many forms:

1. Innovation pot support
2. Price control
3. Mandate, at risk.

See Section 3.3 for more details.

Funding - governance

Funding required to pay for salaries, and other overhead, for staff that is part of the “tiger team”.

Other costs can include workshops, webinars, and travel costs.

In addition, there will be high long-term costs to mandate a task group, in turn, the energy digitalisation orchestrator.

Appendix L

Worked examples of interacting with the data sharing infrastructure through use cases

Worked examples of interacting with the data sharing infrastructure

Two use cases to show how the data sharing infrastructure is interacted with

Overview

A use case driven approach is a systematic and practical way to develop complex systems, starting with low effort and low complexity and gradually building onto more challenging use cases.

For a data sharing infrastructure, low complexity refers to the number of features required, and low effort refers to number of tasks required to develop those features, with the assumption MVP functionality will be required across all use cases.

Next step in the evolution will be taking on more intricate use cases that demand greater effort and complexity.

This can include defining use case specific ontologies, legal agreements, and data sharing specifications.

This appendix outlines two use cases. Appendix L.1 refers to electricity flexibility, a highly complex use case, and Appendix L.2 refers to outage planning, a low complexity use case. Both worked examples provide a perspective on the dependencies needed to enable the use case.

Electricity system flexibility

This use case will aim to improve the timely exchange of information to better understand, use and incentivise the reliance on and provision of flexible assets.

The following dependencies are identified on top of the MVP functionality:

- Standardisation and clarification of asset information requirement needs to happen to increase availability, quality and granularity of data exchanged. Several initiatives are under way, such as Automated Asset Register, DER Information Implement plans, and evaluation of adoption of PAS1878 for smart appliances data exchange.
- Markets for flexibility services need further development, coordination and standardisation. Several initiatives are under way, including Ofgem's Call for Input of Distributed Flexibility, and ENA's Open Network project. Their development, roles of actors, and coordination will better inform the barriers that need addressing for data sharing.
- Agreement on the pre-defined rules to facilitate scalable and flexible data sharing between market participants.

This use case is detailed further in Appendix C.

Electricity network outage planning

This use case is similar to that selected as the use case for the Virtual Energy System common framework demonstrator.

Its aim is to improve the accessibility and reliability of base model and outage arrangement data exchange between ESO and DNOs.

The use case is related to existing on-going data sharing processes between the electricity network operators and owners. Therefore, it doesn't require use case specific legal agreements. The sharing of base models and outage arrangement is mandated by the energy system codes.

In addition, CIM GB is a validated standard that allows for the data preparation node to be configured without further need of improvement. The current revision has the alignment needed to enable this use case.

The following dependencies are identified on top of the MVP Functionality.

- Alignment between ESO and a DNO to test and validate the data sharing infrastructure.

Interaction between use cases and delivery routes

Summary of the impact of use cases on potential delivery routes

MVP functionalities

The MVP technical requirement and functionality of a data sharing infrastructure are detailed in Appendix G, which is common to all use cases.

Observations and assumptions regardless of use cases associated to technical requirements:

- Any data, before shared, will need to be standardised to the minimum required standards, and shared through the common API/connectors.
- A trust framework to manage identifies and user certifications would be required.
- Organisations will need to meet certain minimum technical specifications to engage with the data sharing mechanism.

Further technical functionalities can be required, but that is use case dependent, and are identified in the user stories as ***extended functionality.***

See Appendix C.2 for more details.

Variances by use cases

While the MVP functionalities for each component stays the same, the configurations for each component can vary by uses cases, as set out below:

Data preparation node (prepare): The standards needed to enable each use case are at varying levels of definition; therefore, the configurations, i.e., what standard to transform the data before sharing, will be use case dependent, and require additional development outside the core functionalities. Further developments can be undertaken outside of government intervention.

Trust framework (trust): The legal T&C that sets out the conditions to consume data will differ by use case, and stakeholders. These configurations will be impacted by the risk tolerances and organisational preferences to enable the use case. The trust framework will provide organisations with tools to determine scalable T&Cs, as part of the MVP functionality, but not the detailed configurations required per use case.

Data sharing mechanism (share): As the connector between organisation, use cases will impact the security and governance conditions. I.e., certain use cases, such as city decarbonisation or transport electrification enablement might require increase technical capabilities, which can lead to further development requirements.

L.1

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Worked example: Electricity system flexibility

Worked example: Electricity system flexibility

Typical journey of a user as they share data between ESO and DSOs

Overview

To improve the timely exchange of information to better understand, use and incentivise the reliance on and provision of flexible assets.

Phase one of this journey is to understand the amount of flexibility requirement via a supply vs demand forecasting. Phase two is engaging the market to procure the required flexibility to balance the system.

This use case journey focuses only on the phase 1 of the journey between DSOs & ESO to forecast balancing requirements.

Personas:

- **Data producer**: Joseph, Network Analyst, DSO
- **Data consumer**: Neha, Network Analyst, ESO

Assumptions

Based on user research and stakeholder engagements, it is assumed that phase one of the journey will promote data sharing between organisations, which will improve the effectiveness of forecasting and lead to more confidence in procuring flexible assets.

It is also assumed data granularity, availability and access will be improved by the implementation of phase one and will increase the understanding of flexibility capacity at a given point in time and how to best deploy it.

User journey - operational data publishing

User journey for a network analyst forecasting balancing requirements

Joseph
DSO, network analyst

'I want to better operate my network based on ESO's forecasted balancing requirements.'

Organisations

DSO – Will adapt distribution based on forecasted balancing requirements

ESO – Will publish forecasted balancing requirements.

FSP – Will adapt distribution based on forecasted balancing requirements

Dependencies

- Ontologies that support data standardisation
- Legal arrangements between the market actors
- Verifiable identity through the trust framework
- Resilient and scalable system to support the high volume of data transfers

Sequence of activities ↓

	User journey	Key considerations	Component interaction
Deploy cross-sector data preparation node	Other actors in Joseph's organisation (IT colleagues) look to deploy cross sector data preparation node and set relevant data pipelines.	IT skills of organisations allow for them to set up the node	• Blueprint • Datastore
Register	Joseph checks if their organisation is registered as a data provider. If it isn't the case, other actors in the organisation (IT colleagues) will register them.	Standardisation of registration requirements, and of unique identifiers for asset identify	• Management node • System governance • Trust framework • Security services
Identify data for sharing	Joseph identify what data their organisation own that needs to be made available to ESOs due to current data sharing agreement.		
Connect data source to the node	No action required as the IT team has preconfigured the data source to the node		• Trust framework • Security services • Untransformed data
Align data to minimum operable standards	Joseph monitor that IT colleagues receive the support needed to transform some of the datasets into the right standards and ensure metadata is provided consistently.	Provide a consistent way to access associated asset information.	• ETL • Datastore • Security controls
Publishing the data for sharing	Joseph review that access permission sets follow what has been agreed for a specific datasets, and publish the data for sharing	Legal teams to review and set up any data sharing agreements needed to support the sharing of information.	• Schema assurance • Data catalogue • Trust framework • Security services

User journey - operational data consumption

User journey for a network analyst forecasting balancing requirements

Neha
ESO, network analyst

‘I want to access DSOs’ data to better forecast balancing requirements.’

Organisations

DSO – Will require access to forecasted balancing requirements from ESO.

ESO – Will require access to demand data from DSOs and FSP.

FSP – Will require access to forecasted balancing requirements from ESO.

Dependencies

- Ontologies that support data standardisation
- Legal arrangements between the market actors
- Verifiable identity through the trust framework
- Resilient and scalable system to support the high volume of data transfers

Sequence of activities

	User journey	Key considerations	Component interaction
Search for data	Neha log in a search page. They use the search function to look for data for record on past deployment of demand flexibility services and DER over the last 4 quarters.	Provide a view of the registered asset and available data	• System governance • Data catalogue • Security systems
Request and review access to data	Neha identify they can request a certain view of substation demand level data for a series of DSO across the country for their research purpose thanks to sharing agreement between ESO and DSO.	Enable exchange of aggregated or anonymised view of dynamic data sources	• Management node • System governance • Data catalogue • Security systems • Trust framework
Access the data	Neha access the dispatch data, granular demand data for certain area of the country.	Enable sharing of real time operational data (e.g., asset status data) at required time intervals and granularity	• API/brokering • Datastore • Exploit data • System governance • Security services

L.2

Worked example: Outage planning

Worked example: Outage planning

Typical journey of a user as they share data to ESO as part of the Week 42 process

Overview

The outage planning is part of normal operations for network operators and owners. The actors share outage arrangements and base models as stipulated in the Grid Code and requires organisations to share data with system operator, enabling modelling and analysis of the scenarios. To demonstrate the process, user journeys have been developed that consider the sharing of base model data and operational scenario data to enable the necessary modelling.

DNO Planners as part of their outage planning regulatory needs share a base model of their network, and an outage arrangement for a planned outage.

Personas:

- **Data producer**: Sophia, network planner at DNO
- **Data consumer**: Alvin, network planner at ESO

Assumptions

This journey assumes **only** the MVP functionality are developed and tested, and any extended functionality will not be required.

MVP functionalities are defined as ‘minimum’ core functions that are needed for all use cases. i.e., each of these functions are needed to enable a data sharing infrastructure.

User journey – base model & outage arrangement publishing

User journey for an operational planner developing and publishing scenarios

Sophia
Network Planner

'I want to reduce the time spend on sharing outage arrangements to ESO.'

Organisations

DNO - Will publish scenarios setting out proposed running arrangements for the distribution network.

ESO - After analysis of published scenario, ESO may update and republish scenario to DNO to resolve outstanding issues.

Dependencies

- None

Sequence of activities

	User journey	Key considerations	Component interaction
Deploy cross-sector data preparation node	Other actors in Sophia's organisation (IT colleagues) look to deploy cross sector data preparation node and set up the relevant data pipelines.	IT skills of organisations allow for them to set up the node	• Blueprint
Register	Sophia checks if their organisation is registered as a data provider. If it isn't the case, other actors in the organisation (IT colleagues) will register them.	Standardisation of registration requirements, and of unique identifiers for asset identify.	• Management node • System governance • Trust framework • Security services
Identify data for sharing	Sophia identifies the base model and outage arrangements that needs to be shared with ESO as part of grid code.		
Connect data source to the node	No action required as the IT team has preconfigured the data source to the node		• Trust framework • Security services
Align data to minimum operable standards	Sophia uses existing processes for creating base models and outage arrangements. No new ETL pipelines required to align data to minimum operable standards	Validation the data does not need to be transformed any further	• Datastore • Security controls
Publishing the data for sharing	Sophia review the access permissions are aligned with the grid code requirements, and the data is visible only to the selected actors.	Legal review not required as data is shared per license requirements	• Schema assurance • System governance • Trust framework • Security services

User journey – base model & outage arrangement consumption

User journey for an operational planner assessing and merging operational scenarios

Alvin
Network Planner

‘I want to reduce the time spend on consuming 1000s of outage arrangements shared to me by DNOs’

Organisations

DNO – Data producer, validates the right entity is accessing the relevant files

ESO – Data consumer, looking to access data models and outage arrangements

Dependencies

- None

Sequence of activities

	User journey	Key considerations	Component interaction
7. Search for data	Alvin uses the search function to look for the base model from the DNO	Provide a view of the registered asset and available data	• System governance • Data catalogue
8. Request and review access to data	Alvin identifies the data needed and requests access. Sophia receives the request and approves the request	Enable exchange of aggregated or anonymised view of dynamic data sources	• Management node • System governance • Data catalogue • Security services • Trust framework
9. Access the data	Alvin access the base models and consumes it for day-to-day business operations	Enable a choice to stream the outage arrangements, reducing the need for multiple downloads, or consumes as one-off event	• API/brokering • Received datastore • System governance • Security services

Appendix M

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Market failure

Market failure

Overview and types of market failures

Overview

The Energy Digitalisation Taskforce recommended the need for a data sharing infrastructure (delivered through a digital spine and a data sharing fabric). It considered that their absence would result in a loss of 'optionality' in how the future energy system is developed.

The alternative to a common data sharing infrastructure (for example numerous proprietary data transfer solutions that are not deployed in a widespread manner or not interoperable with other systems and processes) was considered to create barriers that could slow or stifle progress in instances where data is required to be shared between market participants.

In addition to described data sharing infrastructure which increases visibility and reduces market entry challenges, it is expected that wider societal benefits will occur from exchanging data over public domains, rather than private or proprietary technologies.

Ofgem's recent call for input on the "Future of Distributed Flexibility" cited 'imperfect information and information asymmetries' as a primary market failure, with the lack of available data hindering market operation. It proposed that a data sharing infrastructure would help avoid this market failure.

Types of market failures

In the context of a data sharing infrastructure, the following types of market failures are considered, with the page overleaf highlighting how the governance assessment relates:

- **Provision of information:** Lack of shared information between market participants is a failure of the current market set up and is created by an uncoordinated approach to data sharing. This raises barriers to entry for new market participants and creates challenges for systems planning.
- **Absence of an interoperable way to share:** Data is a heavily congested area of commercial opportunity and risk for organisations, leading to a diversity of approaches across organisational types.

  This diversity is a function of a healthy competitive digital market, but the lack of interoperability in these provisions creates market breakdowns for interoperability outcomes.

  Lack of interoperability creates data silos, meaning those dependant on data from different participants must rely on time consuming and expensive integration challenges, including the regulator.
- **Lack of structural trust:** Trust between actors with limited data sharing creates a necessity for organisations to operate with significantly more conservative estimates in the absence of the real operational data that is required for the efficient operation of systems and markets.
- **Data monopolies**: The energy system, like many others, also has data monopolies, where market data is wholly controlled by a singular entity.

  With an increasing distribution of both energy sources, and therefore data sources, these data monopolies may have market wide impact by *not* sharing their data, or doing so in a way that impacts on the ability for other market participants to leverage it effectively.
- **Increasing complexity of the energy markets:** with the emergence of flexibility, heat network regulation and the possibility of DSRSPs (Demand side response service providers) being regulated, the variety of data sources for market operation, settlement and regulatory purposes will increase, and require some level of coordination.

Mitigating market failure

How the governance assessment approach considers market failure

Failure type	Criteria	Evidence
Provision of information	Accessibility	Ensuring multiple levels of accessibility requirements are met will enable users with varying knowledge, infrastructure access, vulnerable customers, and disabilities to engage with a data sharing infrastructure minimising barriers to entry for new participants.
	Training	Provision of training sessions, user manuals, video tutorials, or any other resources that help users understand a data sharing infrastructure functionality and features in plain English and at different levels for different types of users will ensure consistency.
	Social value	Ability to provide a granular system, market data and service that can be accessed and interpreted by third parties, including academics and SMEs. This will minimise barrier to entry and ensure system can be engaged with by all in a consistent way.
Absence of an interoperable way to share	Technology	Delivering a data sharing infrastructure to be tech stack agnostic and minimising requirements for organisations to invest in new systems or technologies will support interoperability for those that engage with it and minimise siloing and costs through ease of use.
	Accessibility	Ensuring multiple levels of accessibility requirements are met will support better interoperability by all user types and drive efficiencies for all user types.
	Training	Provision of sufficient training material and documentation will minimise interoperability challenges through driving adoption and standardisation in data sharing.
Lack of structural trust	Risks	Mitigating single provider dependencies and lock-ins will support wider engagement and trust in the system.
	Governance	Provision of an effective steady-state governance mechanism requires the provider to have the ability to engage with the required stakeholders and have the reputation and authority to manage these challenges as well as provide continuous improvement plans to support addressing challenges.
Data monopolies	Technology	Ensuring a data sharing infrastructure is technology agnostic will encourage adoption and sharing.
	Accessibility	Considering and accounting for different accessibility requirements will enable all to engage with and interpret the data that shared.
	Training	Provision of effective training and documentation materials will increase people’s ability to engage with a data sharing infrastructure and data that is shared, minimising the risk of participants not being able to engage with it.
Increasing complexity of the energy market	Flexibility and scalability	Ensuring the implementation and steady-state routes can deliver against and adapt to the increasing complexity of the market.
	Skillset	Establishing the provider(s) have the correct skillsets to understand the increasing complexities, engage with the correct stakeholders will ensure a data sharing infrastructure can be continuously adapted to meet these requirements.

Linking market failure to government objectives and policy

A summary of the ways a data sharing infrastructure can support government objectives in relation to market failure

Impact of data sharing on government objectives

The impact of a data sharing infrastructure on the government's objectives for energy is considered as:

- **Delivering security of energy supply**: The future energy system is a decentralised coordination challenge, and the timely delivery of data to various participants is a security of supply prerequisite.
- **Ensuring properly functioning energy markets**: Ofgem has identified a market failure in flexibility provisions that, in part, can be solved with greater market access to standardised data.
- **Encouraging greater energy efficiency**: The ability to optimise systems for energy efficiency across differing scales (local, regional, national) will require the timely delivery of data and ability to compare sources in standardised formats.
- **Seizing the opportunities of net zero to lead the world in new green industries**: The emergence of new flexibility markets will be underpinned by data exchange. To seize the opportunity of this new market, provisions for the flow of information need to be made in a way that can coordinate with the whole system.

Impact of data sharing on Strategy and Policy

The government recently published their Strategy and Policy statement for the energy sector. The impact of a data sharing infrastructure on this is considered as:

- **Enabling clean energy and net zero infrastructure:** The acceleration of clean energy and infrastructure required needs effective planning, coordination and justification of action taken by parties across the value chain. Facilitating the exchange of data in an interoperable way will be a core challenge to ensure this outcome can be met.
- **Ensuring energy security and protecting consumers:** As noted in the case study on the August 2019 blackouts (see the next page for more information), the provision of data between market participants is identified as a key component in mitigating risks of blackout events.
- **Ensuring the energy system is fit for the future:** The coordination of national and local energy markets, enabling technologies across all scales to support economic growth has a prerequisite of timely information being presented to a wide array of market participants with complex relationships.

Summary

Underpinning each of these key sets of objectives and policies is a pre-requisite of effective, interoperable data sharing to combat specific negative outcomes.

For example, in market failure identified in flexibility or resulting from blackout events (see the next page for more information), the information provision, timely access and standardised exchanges would have helped better predict the outcomes of a more renewable dominated energy system.

Fundamentally, each of governments priorities have a level of dependency of resolving the challenge of interoperable data sharing.

While it is likely that each specific objective or outcome will be achieved by a mixture of projects, decisions, and priorities across the energy domain, data sharing will be a fundamental enabler of each in some capacity

It is considered that the most economically efficient resolution is to develop a solution that captures as broad a set of requirements as practical to mitigate the market failures identified and enable the sector to implement its use to overcome specific challenges, such as those described in the use cases (see R4).

The role of governance

Governance to mitigate market failure events

Market failure and the need for governance

The energy market already has strong previsions for the sharing of operational data related to system operation or financial flows within the energy retail market where organisations such as RECCo or ElectraLink facilitate data transfer with market participants to discharge their code for licence obligations. The codes are then governed by a strong framework that has iterated over time to deliver for the market needs.

Each of these data transfer services are governed in part to enable data standards, timeliness, formats and other considerations that facilitate the transfer of data in an efficient and understandable manor.

The agreement of these types of standards is a core function of a governance mechanism that overcomes a common market failure, which is a lack of information. The governance of these codes manifests in the adoption and utilisation of common data standards for the core functions of market operation.

The five prioritised use cases suggest that information provisions for each is lacking and may represent an information provision market failure of some degree.

Level of governance needed

Governance to resolve market failures of information provision within the energy sector has focussed on creating roles for organisations to perform a specific market function to facilitate that information exchange.

With the evolution of technology enabling a distributed approach to data exchange, a re-examining of the appropriate governance mechanisms is required.

The provision of use cases for a data sharing infrastructure is very wide-reaching touching multiple sectors and potentially impacting a huge diversity of regulated and non-regulated organisations.

It would be unreasonable to expect a single central organisation to cover the breadth of outcomes a data sharing infrastructure could facilitate via the identified use cases, and certainly not the other uses it may enable.

Therefore, the level of governance required for such a solution should reflect the technical maintenance and core functions of the data sharing.

A decentralised and distributed approach to governance, reflecting the proposed distributed technological implementation will mitigate the described market failure risks (e.g., digital monopolies developing).

Case study - blackouts

The events of Friday 9th August 2019, where over one million customers experienced backouts across England, Wales, and some parts of Scotland drew back into focus elements of our energy security and ability to recover the energy network.

Notably, the investigation provided lessons learnt, including '***Significant improvements are required in the data availability, adequacy and communication between the DNOs and the ESO on the performance of distributed generation***'. Noting that Ofgem should consider options to improve the real-time visibility of distributed generation to the DNOs and ESO.

The lack of visibility of distributed generation has been a challenge, with part of the solution potentially coming through the Automatic Asset Registration programme and its interaction with a data sharing infrastructure.

The identification of particular use cases for energy security considerations, such as strengthening energy security to mitigate blackout risks, will need to consider the governance mechanisms best used to deliver that, such as code modifications, and how those mechanisms intersect with the technical and governance solution of a data sharing infrastructure itself.

Market failure and electricity flexibility use case

Use case examined as a case study in the context of market failure - electricity flexibility

Overview

The challenge of the electricity flexibility use case is that the data availability, granularity and access is a core problem encountered when looking to understand the flexibility capacity available at a given point in time and how to best deploy it (visibility of relevant assets being a key blocker). Lack of data sharing also hinders the effectiveness of forecasting leading to less confidence in procuring flexible assets.

The goal of this use case is to improve the timely exchange of information to better understand, use and incentivise the reliance on and provision of flexible assets.

Through the lens of market failure, this use case is a direct response to the challenge posed by Ofgem regarding the emerging flexibility market.

The use case can have a direct result overcoming market failures specific to flexibility, amongst these are real time data exchange being too demanding for smaller providers, putting in place data sharing agreements and inability for ESO to rely on Excel data transfers to support the balancing system.

Relation to government objectives

Government objectives and the energy policy statement have provided context, around which we can test how the use case would specifically support those objectives as they relate to market failure.

Were a data sharing infrastructure to be deployed and the electricity flexibility use case prioritised, it would be reasonable to expect that the DESNZ objectives of delivering security of energy supply, ensuring properly functioning energy markets, encouraging greater energy efficiency, and seizing the opportunities of net zero to lead the world in new green industries would each be supported. Each of those objectives is reflected in the proposition that an established and well provisioned flexibility market would have for the broader energy system.

Where the wide scale utilisation of assets through improvements to data provision to devices, system operators and other market participants is not catered for, it – as noted in Ofgem's call for input - is likely that the flexibility market will not function effectively. Nor will the system be able to efficiently provision the use of consumer devices, reducing the system's security of supply if those assets are underutilised.

In addition to the objectives, the energy policy statement set out the following priorities: Enabling Clean Energy and net zero Infrastructure, Ensuring Energy Security and Protecting Consumers, and Ensuring the Energy System is fit for the Future.

Related to these the digital monopolies challenge as well as structural trust challenge noted earlier provide context to how the policy statement priorities may be difficult to achieve in the context of the Electricity Flexibility use case. Where a lack of market participants have sufficient data to achieve the outcomes their role/business requires, the decisions they make will unlikely reflect the priorities set by government and put at risk those priorities where it necessitates organisations acting in particular ways.

In this poor information environment, conservative assumptions must be made on capability, and additional resources are required to build trust between market participants in the absence of data to support it. The data that can support operations and trust building then becomes more valuable, and prone to capture and to be closed off by commercial interests. An inability to resolve data provision challenges in an interoperable way may lead to outcomes that conflict with governments priorities outlined above.

Appendix N

Social value delivered by a data sharing infrastructure

Social value

How can a data sharing infrastructure provide social value?

What is social value?

Social value refers to the “wider financial and non-financial value created by an organisation through its day-to-day activities in terms of the wellbeing of individuals and communities, social capital created and the environment”, as defined by the Public Services (Social Value) Act (2013).

In the context of this feasibility study, future data sharing infrastructure and associated initiatives, it is key to establish how the solution and the organisations involved in its delivery will ensure the realisation of wider outcomes that benefit society.

This appendix outlines the social value opportunity that could be realised through the delivery of a data sharing infrastructure, case study examples to provide evidence for the reasoning, and detail on how the consortium involved in the feasibility study have contributed thus far.

How data sharing contributes social value

A data sharing infrastructure is critical to achieving net zero which inherently contributes to social value. The initiative will foster collaboration, driving a sector wide push that will also drive individuals, organisations and other sectors to act similarly.

Using the breadth of expertise provided by the consortium, six broad ways a data sharing infrastructure will drive this have been identified:

1. Grid Management
2. Improved Resilience
3. Renewable Integration and Sustainable Electrification
4. Promotion of Collaboration, Innovation and Research
5. Data Driven (evidence-based) Policy Making
6. Empowering Energy Consumers with Data

Details of these with supporting evidence can be found in the remainder of the appendix.

How the feasibility study contributed to social value

The commission was delivered by a diverse supply chain leveraging public (Energy Systems Catapult), private (Arup), and academic organisations (University of Bath) to ensure social value was at the core of all recommendations.

In addition, the following was achieved or is in the process of being delivered with details provided in the remainder of the appendix :

- University of Bath workshop
- Development of open-source documentation
- Engagement with UKRI centres for doctoral training
- Building open-source foundations
- The University of Bath’s digitalised net zero energy systems lab
- Engagement with wider research community (Digital Stock Model, UCL)
- Inspiring the next generation of energy leaders

Social value model

Analysing the proposed data sharing infrastructure through the lens of a Social value model

Social value model

The Public Services (Social Value) Act (2013) requires commissioners of public services to consider social value.

Subsequently, a social value model was created in June 2018 which outlines five themes under which social value could fall. These are:

1. COVID-19 recovery
2. Tackling economic inequality
3. Fighting climate change,
4. Equal opportunity, and
5. Wellbeing.

Applying the social value model

A data sharing infrastructure aligns with several themes in the social value model, with the key Model Award Criteria (MAC) identified below:

Tackling Economic Inequality (2):
- Creating new businesses, jobs and skills by providing opportunities for entrepreneurship and supporting the growth of new organisations (MAC 2.1).
- Creating employment and training opportunities (MAC 2.2).
- Increasing supply chain resilience and capacity by establishing a diverse supply chain (MAC 3.1).
- Supporting innovative and disruptive technologies (MAC 3.2).
- Developing scalable and future-proofed productivity methods (MAC 3.3).

Fighting Climate Change (3):
- Encouraging the transition to net zero greenhouse gas emissions (MAC 4.1).

Wellbeing (5):
- Improving community integration through collaborative co-design of the data sharing infrastructure with stakeholders (MAC 8.1).

How is social value is explored in this report?

The following pages explore social value in two ways.

Firstly, the social value delivered by the feasibility study is explored and evaluated. This includes a deeper look into the social value provided by the workshop held at the University of Bath on 31st March.

Finally, the direct and wider social value, that could be realised if a data sharing infrastructure were to be implemented, is explored.

N.1

Social value delivered through the feasibility study

Social value delivered through the feasibility study

How social value has already been delivered through the feasibility study

Overview

The commission was delivered by a diverse supply chain leveraging public (Energy Systems Catapult), private (Arup), and academic organisations (University of Bath) to ensure social value was at the core of all recommendations.

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- Inspiring the next generation of energy leaders

Delivery through a diverse supply chain

The combination of project partners intrinsically created a highly diverse supply chain from public, private, and academic sectors. Each partner is individually committed to diverse delivery, and through the University of Bath we have engaged with and used industry entrepreneurs and SMEs to assist in delivery.

Engaging a broad range of stakeholders in the project (e.g. through workshop) promotes social value by reducing inequality and corruption in supply chain development and delivery, and encourages participation with a diverse range of businesses. The workshop also added to social value by advertising the opportunity of a data sharing infrastructure to potential actors, to allow fair assessment and thus, structuring of the supply chain.

Examples of SMEs and innovators included, and their interests are:

- Propflo – develop 'flexibility ratings' for properties
- Clean Energy Prospector – local heat networks
- Bath and West Community Energy – community owned, local, clean energy supply for low cost energy

University of Bath workshop

This collaborative workshop focused on understanding the social value impacts and outcomes of a data sharing infrastructure, particularly through fostering a marketplace for entrepreneurship and inspiring and upskilling students. The workshop was attended by a diverse group of 30 stakeholders from the University of Bath, National Grid Electricity Distribution, National Grid ESO, UKRI, Clean Energy Prospector, Propflo, Arup, ESC, Amazon, Palantir, Ofgem and DESNZ.

The session introduced the data sharing infrastructure concept, initial thinking and learnings from Intel & Healthcare for Open Innovation, as well as a presentation on High Impact Coalitions. This drove breakout sessions on common vision, purpose and functionality, data standards, security and governance, stakeholder engagement and collaboration, technological implementation, risks and challenges as well as social value and impact.

The outcomes of the workshop were documented and used to inform the recommendations put forwards in this feasibility study. Social value was achieved through cross sector collaboration covering public, private and academic stakeholders, and drive of innovation through the development of a new network of entrepreneurs.

Social value delivered through the feasibility study

How social value has already been delivered through the feasibility study

Development of open-source documentation

Engagement with EPRG – an open-source journal – from the University of Cambridge has been initiated. This outlines at least two reports that will be published:

- Do we need a data sharing infrastructure?
- How can data sharing promote social value

These two reports will outline:

- How to go about defining a data sharing
- Which stakeholders should be included, and
- How social value can be gained through a data sharing infrastructure

A review of data sharing infrastructures in other sectors will be published on the Supergen Hub for Energy Networks website.

The University of Bath are initiating an IET special issue call for international contributions to data sharing infrastructure related papers, focusing on the cost/benefit/risk analyses, core designs, delivery options, and governance.

These reports will meet the proposal goals and ensure that digital and energy communities share common understanding and abilities to deliver social value. This open-source documentation further promotes social value by reducing inequality in access to information.

Engagement with UKRI centres for doctoral training

The UKRI sponsored AAPS CDT, postgraduates and undergraduates from Centre for Sustainable Energy Systems and Economics have played an active role in:

- Organise/run the workshop at the University of Bath.
- Summarise the proceedings of the workshop in a document that was disseminated to the attendees.
- Conduct research into data sharing infrastructures in other sectors and synthesised key learnings for the energy sector.

Two AAPS students heavily involved in the feasibility study for a data sharing infrastructure, led the literature review. One of the PhD students is continuing conversations with key data sharing infrastructure stakeholders to integrate her PhD research with their data generation services. Communication has been made with the ART-AI and TIPS-at-scale CDTs to encourage future research projects which align with the goals of the data sharing infrastructure.

This has and will achieve social value by providing opportunities for bright ideas from new entrants and existing actors to flourish. For the PhD students involved, the feasibility study has provided opportunities for: Knowledge expansion, networking collaboration, access to real-world data, and development of skills.

Building open-source foundations

The feasibility study has recommended DESNZ build the foundational components using an open-source software technology stack.

This will help drive collaboration within the wider energy community, removes the risks with vendor lock-in and increases accessibility by lowering the barrier to entry associated to costs.

Whilst the foundations would remain open-source it is recommended participants to be able to and commercially incentivised to develop and deploy their own closed-source modules and applications on top of the open-source components to drive innovation.

This will achieve social value through lowering barriers to access, driving the advancement of technology, job creation, economic growth, and the potential for the development of ground-breaking solutions to address energy challenges and benefit society.

Social value delivered through the feasibility study

How social value has already been delivered through the feasibility study

University of Bath's Digitalized Net-Zero Energy Systems Lab

The digitalised net zero energy systems lab is making its whole-system modelling open-source which will enable the interrogation, integration, and extension of whole-system high fidelity modelling functions (city and country levels),and by differing domain experts to enhance energy efficiency, stability, and resilience.

To hear the perspectives of a diverse range of academics to inform the needs a survey was conducted following the dissemination to the energy research community at the University of Bath. The questions asked included:

- Why do we need a data sharing infrastructure?
- What data would you like to be able to access for your research?
- Rank the potential features of an energy system data sharing infrastructure in order of perceived importance: (1) Data accessibility, (2) data standardisation, (3) data quality assurance, and (4) data security.
- What are some of the potential use-cases for an energy system data sharing infrastructure?
- How can you extend the functionality of the data sharing infrastructure for net zero energy systems lab and potential benefit?

Engagement with wider research community (Digital Stock Model, UCL)

To achieve and identify further social value from the feasibility study five academics from University College London's (UCL) Digital Stock Model have been contacted to gain their insight on how data sharing infrastructure can aid researchers, and subsequently provide social value to both themselves and the wider society.

The Digital Stock Model integrates data from numerous sources to effectively and accurately portray the efficiency of the built environment. This aids with planning and development of new and existing properties to identify areas with high population densities but low amenities. Enhancing the quality of the data fed into these models will improve the ability to perform these actions, and therefore promote social value with better home, transport network, and amenity provision.

An informal interview has been set up to discuss the key features that a data sharing infrastructure requires in order to provide these benefits, and how a research-driven model like the Digital Stock Model would interact with it. Dissemination of information on the project also continues to support the open-source goals of the project and encourage further innovation.

Inspiring the next generation of energy leaders

In addition to direct benefits gained through the feasibility study, value is also added for the future. Engaging both undergraduate and postgraduate students from the University of Bath increases the transparency of the energy network. Sharing this information inspires young people to be involved with the energy system, by enabling them to identify where their skills and interests lie best.

This has been demonstrated and achieved social value as undergraduate students from the University of Bath, who were involved in the 31st March workshop, have entered into the energy networks professional sector following the inspiring talks, the connections made during the workshop, and expanded vision in whole-system approach.

For example, all four undergraduate changed their career paths to the energy sector, one secured a senior at ESO's Holistic Network Planning, which would be beyond the reach of fresh graduates. This aligns with the proposal's goal of demystifying the digital and energy landscape, to previously excluded groups and fulfil their potential and ambitions.

Social value workshop (31st March)

Summary of the social value workshop conducted as part of this feasibility study

Workshop summary

The workshop, hosted by the University of Bath, was a timely opportunity to bring together a diverse collection of industry leaders to discuss the definition, purpose, and possible use cases of an energy system data sharing infrastructure.

The workshop brought together a range of industry stakeholders including representatives from:

- Arup
- Energy Systems Catapult
- University of Bath
- Department of Energy Security and net zero
- OFGEM
- National Grid ESO
- National Gas Transmission
- Amazon Web Services
- Palantir
- Propflo
- Clean Energy Prospector
- Bath & West Community Energy

Student participation

Four undergraduate students and four PhD students from the University of Bath were involved in the organisation and running of the workshop, as well as being invited to present an early-stage researcher perspective on the proposed data sharing infrastructure.

During the workshop, the undergraduate students shared their recent work on a novel split market design to decouple wholesale electricity market from gas, whilst the PhD students focused on highlighting how a data sharing infrastructure might enhance their research capabilities and boost overall productivity.

In the two breakout discussions, all students dispersed around the room to act as moderators and scribes. At the end of these sessions, the students summarised the proceedings to the rest of the room.

In addition, the PhD students were selected to chair some of the discussion sessions. Not only did the workshop provide an excellent learning opportunity and a platform to showcase the student's work, but it also enabled the students to network with many industry professionals and gain valuable contacts, which could enhance their future career prospects.

Social value summary

- **Wider Society:**
  - Enabled broad and diverse stakeholder participation in data sharing infrastructure design.
  - This leads to a more holistic and better designed data sharing infrastructure.
  - Improved data sharing infrastructure benefits wider society.
- **Academics:**
  - Expanded knowledge through exposure to real-world experiences and challenges.
  - Networking and collaboration opportunities with industry players.
  - Access to real-world data for research.
  - Opportunity for students to develop valuable communication skills.
- **SMEs and Innovators:**
  - Increased visibility and exposure.
  - Access to skilled students and researchers.
  - Potential collaborative opportunities with larger companies and academic institutions.
- **Large Companies:**
  - Talent recruitment from academics.
  - Proactive engagement enhances reputation.
  - Potential partnerships with SMEs & innovators

Social value workshop (31st March)

Summary of the social value workshop conducted as part of this feasibility study

Academia

- **Knowledge Expansion:** Students and researchers had the opportunity to learn from real-world experiences and challenges faced in industry which can enrich their understanding of practical applications of their research areas.
- **Networking and Collaboration:** The workshop fostered potential research collaborations which could lead to joint projects, publications and opportunities for students to intern or work on industry-relevant problems.
- **Access to Real-World Data:** Researchers were given opportunities to access unique datasets provided by the attending companies, enhancing the quality or their research.
- **Development of Communication Skills:** Students were given the opportunity to showcase their research and gained experience in presenting and chairing sessions in a professional setting.

SMEs and innovators

- **Visibility and Exposure:** Participation in the workshop allowed SMEs and Innovators to present their ideas and capabilities to a broad audience, potentially attracting investors, partners or customers.
- **Access to Talent Pool:** The workshop allowed SMEs and Innovators to tap into the diverse pool of talented students and researchers who can contribute their skills to the development of new technologies and solutions.
- **Networking and Collaboration**: Collaborating with larger companies and academic institutions like the University of Bath could lead to mutually beneficial partnerships in the future.

Wider society

- **Holistic Design:** Conducting a workshop to discuss the features of a data sharing infrastructure enables more stakeholders to contribute to its design. By representing the needs and requests of a broader range of energy-system actors, a more holistically designed data sharing infrastructure will result, providing a better ecosystem for a wider array of actors, customers, and society to interact with and benefit.

Large companies

- **Talent Recruitment:** Engaging with academics and students gave these larger companies the chance to identify and recruit promising talents who can help bring fresh perspectives and expertise to their teams.
- **Social Responsibility and Reputation:** Participating in workshops focused on social and environmental challenges can enhance a company’s reputation for being proactive in addressing societal issues and promoting sustainability.
- **Open Innovation and Partnerships**: Larger companies were given the opportunity to discover potential partners among SMEs, innovators and academics for new collaborative projects that drive innovation and accelerate the development of new products and services.

N.2

Social value delivered through a data sharing infrastructure

Future social value delivered by a data sharing infrastructure

Key ways in which social value could be realised through a data sharing infrastructure

Grid management

Real-time data sharing would allow grid operators to monitor energy supply and demand, ensuring a stability and reliability. Improved demand response can reduce network congestion and the need for costly grid upgrades, as well as reduce the need to run fossil-fuel based plants to meet peak demand.

There is social value in preventing blackouts and minimising disruptions to essential services. More effective grid management can reduce carbon intensity at peak demand and lower costs for consumers.

Renewable integration & sustainable electrification

The improved forecasting, whole-system visibility, and device control resulting from improved data sharing would enable better integration of renewables. Data sharing would also help to identify underserved areas and improve planning for electrification projects.

Optimising the use of clean energy reduces fossil fuels reliance, leading to cleaner air, improved public health and a safer future for society. There is also social value in bringing electricity to remote communities, improving living conditions and supporting economic development.

Improved resilience

Real-time data sharing would be extremely valuable during emergencies and disasters. Whole-system visibility, enabled by seamless data sharing can improve response times to equipment faults and damage caused by adverse weather.

By quickly assessing damages and restoring energy supply, the infrastructure helps communities recover faster, safeguarding lives, property, and critical infrastructure.

Promoting collaboration, innovation and research

A shared data infrastructure would grant researchers and innovators access to valuable data to develop new technologies and test and integrate solutions that improve energy efficiency and sustainability.

There is social value in the advancement of technology, job creation, economic growth, and the potential for new solutions to address energy challenges and benefit society.

Data-driven policy making

Better availability and accessibility of energy-related data would allow policymakers to make evidence-based decisions that support a more sustainable and efficient energy system.

The subsequently well-informed policies would reduce carbon emissions, promote renewable energy adoption, and ensure equitable access to energy services. Overall, this would lead to societal benefits in terms of environmental protection and energy affordability.

Empowering energy consumers with data

Sharing data on energy consumption patterns would empower consumers to make informed choices, leading to reduced energy usage and lower utility bills.

The social value lies in cost savings for consumers, increased disposable income, and a more sustainable energy system, which benefits society by lowering overall energy demand and reducing harmful environmental impacts.

Wider social value from a data sharing infrastructure

Key ways in which social value could be realised through a data sharing infrastructure

Jobs and upskilling opportunities

The design, implementation, and maintenance of a whole-system data sharing infrastructure will result in increased job and upskilling opportunities, leading to increased social value from both incentivising sense-of-purpose and increased salaries from more-impactful job roles.

Job opportunities will emerge and evolve throughout the life span of a data sharing infrastructure, with representatives from key stakeholders being required to have both organisational structural knowledge as well as bigger-picture system knowledge when designing the data sharing infrastructure.

Implementation

Implementation of the whole-system approach will likely require higher levels of digital literacy in addition to design skills; whilst some organisations may have existing employees who are able to fulfil these roles, many will likely need to create new job roles or invest in upskilling of their existing employees.

Maintenance

Once a data sharing infrastructure is implemented, maintenance will be crucial to ensure continued, seamless data sharing to enable all the identified benefits. For this, existing Chief Data Operators (CDOs), or equivalent, within each organisation may be most suitable to prevent resource intensive retraining, however some stakeholders may not have a CDO, or may need to employ additional members to support an existing CDO. For this reason, upskilling will be a vital feature associated with a data sharing infrastructure which will subsequently provide more opportunities for employees.

Wider upskilling

In addition to those directly responsible for a data sharing infrastructure, the nature of a whole-system approach will also require upskilling amongst other job roles. For example, new data-sharing contracts will result from an interconnected energy system, for which in-house lawyers will need to become accustomed to managing in order to prevent unnecessary barriers forming.

Behaviour

Behavioural sciences show that individuals follow ‘norms’, including a norm of sustainable behaviour. A data sharing infrastructure, if its sustainable qualities are salient, could set this norm and promote sustainable behaviour in individuals. Furthermore, most individuals are ‘conditional co-operators’, so are more likely to act pro-socially if others do; this can also cause a ‘warm-glow effect’ - feeling happiness from contributing to wider society - further promoting social value. A national push for net zero through a data sharing infrastructure may incite these effects and push individuals beyond the ‘social tipping point’ for action.

Sustainability

A data sharing infrastructure would improve the sustainability of the energy system in the UK, with relation to reduced environmental impact, reduced consumer costs, and increased energy security. This would have a direct contribution to social value as approximately 75% of UK adults reported feeling very or somewhat worried about climate change in a 2022 ONS survey. Furthermore, the increased data quality and resolution provided by a data sharing infrastructure would aid the net zero transition and thus, further contribute to social value.

Appendix O

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Areas of further work

Areas of further work

Recommendations for areas for further work identified through the delivery of this feasibility study

Overview

Through the delivery of this feasibility study, and through the extensive stakeholder engagement activities conducted, several areas were identified that could benefit from further work. This further work was not conducted as part of the feasibility study as it was outside of the project scope.

These areas, outlined over the subsequent pages, can be grouped into three categories:

- **Developing the technical solution**
  - Development of technical components
  - Security framework
- **Facilitating appropriate governance and skills**
  - Integration of existing initiatives
  - Data Sharing Infrastructure Task Group
  - Detailed analysis of delivery and governance
  - Foster a culture of data sharing
  - Trust framework
  - Knowledge dissemination activities
- **Developing standards and blueprints**
  - Data sharing infrastructure detailed blueprints
  - Management of standards
  - Detail review of licenses, codes, and legislation

Integration of existing initiatives

Over the course of the feasibility study, it was determined that there are existing sector initiatives that can provide the three functional components of the data sharing infrastructure.

These three initiatives are:

- **National Digital Twin Programme:** This programme has developed functionality similar to requirements of data preparation node (prepare).
- **Open Energy:** This initiative has developed functionality similar to the requirements of the trust framework (trust).
- **Virtual Energy System:** This initiative has developed functionality similar to the requirements of data sharing mechanism (share).

It is considered that these three initiatives could form the basis of the MVP, and rapidly accelerate the development of the data sharing infrastructure. Each initiative is also directly or indirectly funded by government already.

There is further work required to align the technical, governance, and policy aspects between the three initiatives.

Data Sharing Infrastructure Task Group

It is recommended that a Task Group be established and given the mandate to accelerate the development of the data sharing infrastructure.

This can be achieved by allocating specific funding to release industry experts from their existing roles via secondments or by using specific innovation funds, such as NZIP.

Additional work needs to be undertaken to understand the scope, cost, and timelines of the Task Group.

This further work includes:

- Terms of reference for the Task Group
- Potential funding routes for the Task Group, and the data sharing infrastructure
- A roadmap to initiate the Task Group and evolving it into the ***Energy Digitisation Orchestrator***.
- The specific skills required in the Task Group.
- A ways of working reference for the Task Group and its members.
- Ensure robust cybersecurity assessment of the Data Sharing Infrastructure

Areas of further work

Recommendations for areas for further work identified through the delivery of this feasibility study

Data sharing infrastructure detailed blueprints

This feasibility study intentionally only developed a high-level design for the data preparation node.

It did not create high-level designs for the data sharing mechanism or trust framework. This is because the original scope of this feasibility study was to detail the technical architecture of the data preparation node (referred to as the "digital spine").

During this feasibility study it was realised that the wider data sharing infrastructure also had to be considered, and so outline designs for this were developed and tested.

It is recommended that further design work, including the creation of high-level and detailed designs is developed for all components of the data sharing infrastructure. The design for the data preparation node, data sharing mechanism, and trust framework must be developed holistically from the perspective of the entire data sharing infrastructure. This will form the required detailed blueprints to develop and test the components against a use case.

This activity should include extensive stakeholder engagement and testing.

Detailed analysis of delivery and governance

The stakeholder engagement performed during the feasibility study identified governance as a key enabler to a data sharing infrastructure. The lack of clear digital governance across the energy sector was also identified as a critical gap across the use cases and user story developed.

High-level delivery routes and governance models were developed to demonstrate the breadth of what would be required in order to be successful during implementation and steady-state phases

However, the models put forwards in this feasibility study were intentionally high-level and did not cover or assess potential alternatives. Further detailed investigation was outside of scope of the project.

It is recommended that the delivery route models undergo further detailed analysis.

This should incorporate an assessment with weighted factors that consider the requirements of a data sharing infrastructure and incorporate learnings from other programmes. This would ensure all delivery routes are robust and support the needs of a data sharing infrastructure and the industry.

Development of technical solution

The build, implementation and testing of a data sharing infrastructure will need to be done, using the published blueprints for each component. This should include creating relevant architecture artefacts and software applications that can be tested against a specific use case to gain feedback on its usefulness and where further development effort needs to be placed.

Additional functional components which have not been scoped for the MVP may need to be developed. This may include functionalities pertaining to data quality, and other data management components, such as data lineage, to facilitate data trust and decision making. These additional components may be delivered by the sector or by entities delivering the blueprints.

A clear MVP development roadmap should be created that clearly describe which functionalities an MVP data sharing infrastructure will offer and who is building them. Market players should be incentivised and encouraged to develop additional functionalities (e.g., extra modules for the data preparation nodes). This should drive continuous improvement for a data sharing infrastructure to ensure usefulness.

Areas of further work

Recommendations for areas for further work identified through the delivery of this feasibility study

Management of standards

During stakeholder engagement sessions to determine potential delivery routes, a key concern raised by stakeholders was the need for the management of standards.

One critical dependency for the data sharing infrastructure is the alignment of standards that the data preparation node will need to transform the data to. Therefore, it is vital to understand the mechanisms that can be used to propose and approve new standards.

As a result, further work is required to understand how the management of standards will work in the context of the data sharing infrastructure. This should consider technical, policy, and governance perspectives.

Detail review of licenses, codes, and legislation & planning consideration

As highlighted by BEIS commissioned Independent Electricity Engineering Standard Review: '*whilst the industry is active in maintaining and enhancing standards, the level of change now and expected in the future is challenging this legacy*".

To ensure that existing licenses, codes, legislations, and standards remain fit for purpose in a fast-paced digitalised world, they must be reviewed, updated, and/or created to reflect the nature of digital assets and the needs and offerings of the infrastructure.

Getting this right is critical to shaping how smart, flexible energy systems operate, enabling progressive and mutually beneficial interactions with energy customers, the energy industry, markets, policies, technologies, and the institutional environment.

A review is needed to understand whether the current codes, and licenses should be amended to accommodate the data sharing infrastructure, or a specific 'energy digitisation' code or regulation is needed.

Stakeholder engagement & knowledge dissemination activities

The scope and constraints of this feasibility study limited the quantity of stakeholders that could be engaged with, and the knowledge dissemination and information sharing activities that could be conducted throughout its development.

There was significant energy sector and cross-sector interest and engagement in this feasibility study, and value in stakeholder engagement and testing received during its development.

Therefore, it is recommended that further explicit knowledge dissemination and information sharing activities are conducted to publicise and share openly the outcomes.

This open and transparent communication will foster engagement, encourage open innovation, and help build consensus on the development of a data sharing infrastructure.

Areas of further work

Recommendations for areas for further work identified through the delivery of this feasibility study

Trust framework

Through the stakeholder engagement activities, it became apparent that one aspect of a data sharing infrastructure that needed greater consideration and evaluation was the trust framework.

The trust framework encompasses critical people and process aspects related to the data sharing infrastructure. It can support a culture of data sharing, increase collaboration between actors, and reduce barriers to entry for new market participants.

In summary, a trust framework enables the exchange of data with varying privacy and commercial sensitivities by providing a structure for organisations to share data securely and confidently. For example, real-time operational data, consumer data, or trade data.

Further work needs to be undertaken to explore the framework that allows for the setting of scalable terms and conditions, and the ways that the framework can be made to scale across multiple use cases and actors. In addition, it needs to inform the technical architecture, ensuring it is sufficiently flexible to accommodate all attributes, roles, controls, and functions.

Foster a culture of data sharing

Fostering a culture of data sharing is critical to ensuring that the industry and others engage with and adopt a data sharing infrastructure. It is crucial to set the culture of the transformation programme from the outset.

It helps organisations broaden their thinking beyond traditional business models and individualistic objectives to understand the opportunities presented by data sharing across the energy sector and more widely. Further work is required to understand the motivations and incentives that will be required to foster a culture of data sharing.

This may require business and value cases to communicate the benefits of data sharing. IT and data strategies across the sector may also need to be published to encourage and foster a culture where data is treated as a product that can be shared securely.

This scope links with the establishment of the ***Data Sharing Infrastructure Task Group*** as the Task Group, through its oversight remit, will set the tone and culture of the data sharing infrastructure.

Security framework

As a system, a data sharing infrastructure will need to provide trusted, secure, and resilient sharing of information. To do this, stakeholders will need to be confident that the solution aligns with key security standards and practices, such as ISO27001, NIST, the NIS Directive, as well as applicable data privacy legislations.

In order to ensure that the future solution is secure-by-design, the development of a data sharing infrastructure will need to adopt a risk-based approach to defining clear security outcomes and principles that should be implemented. This should be underpinned by a clear approach to security risk assessment, governance and assessment cycle.

This level of detail was outside of scope of this feasibility study. It is recommended that further and more detailed investigations into security are conducted.

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