Workstream 5: Digitalisation and its role in unlocking smart regulation: A roadmap to an energy data sharing infrastructure by 2028

Author:	Sarah Hayes
Date:	19/10/23

Contents

Executive Summary: A roadmap to an energy data sharing infrastructure by 2028

Data for net zero

Ofgem can play a leading role in enabling a data sharing infrastructure.

Headlines of this report:

1. **A data sharing infrastructure enabling seamless and secure data sharing is essential to accelerate the path to net zero at lowest true cost.**
2. **A data sharing infrastructure will enable improved central planning and ex ante regulation. It will also make it possible to evaluate the benefits of ex post regulation.**
3. **Ofgem can lead by setting up an Energy Data Sharing Infrastructure Task Group.**

In brief:

Energy network licensees are making progress in applying Data Best Practice**,** but this is not enabling data sharing across energy or other sectors. Energy needs a data sharing infrastructure to enable seamless and secure sharing of data across energy and other sectors to accelerate the path to net zero at lowest true cost, through greater cost transparency and innovation.

This data sharing infrastructure will enable Ofgem to regulate more effectively, having the right information at its fingertips to make decisions. It will enable a fuller evaluation of ex post regulation as secure high quality data exchange becomes the norm. Ofgem can lead the collaboration across industry through a Data Sharing Infrastructure Task Group handing over to an Energy Digitalisation Orchestrator once set up, and the FSO, once ready to take on the role of maintaining an energy data sharing infrastructure.

Ofgem, industry and the public need to understand the true costs and timetable for the transition to a net zero power system by 2035. If Ofgem and industry do not have the right information at their fingertips to make decisions that will lead to a net zero power system by 2035, we will not achieve this fundamental objective. The future nature of price controls is a critical lever in enabling access to this high-quality information.

This report was commissioned by Ofgem, and delivered by Sarah Hayes Independent Consultant. The views expressed within the document are that of the consultant. You can see how Ofgem has adapted these views into Ofgem policy decisions in both the Overview and Framework decision documents.

Regulatory reporting is a form of data sharing. Data sharing enables organisations to have access to the right information, at the right time, for the right purpose and to be of the right quality. Ofgem has made significant progress in the development of Data Best Practice and Digitalisation Strategy and Action Plan guidance, in taking industry forward in its digitalisation journey.

Ofgem needs a data sharing vision where data is shared in a seamless and secure way to take that journey beyond where we are in mid-2023. In order to realise that data sharing vision, it is essential to develop a data sharing infrastructure for the energy sector to break down the barriers to sharing data and which is interoperable with data sharing infrastructure for other sectors (eg transport, water, communications, health, manufacturing etc).

This data sharing infrastructure, as originally envisioned in the National Infrastructure Commission's 2017 report Data for the public good[1] does not yet exist. It needs Ofgem to help put it in place, because the driving force for releasing the benefits of sharing data is the net zero imperative.

Working with FSO, industry and an Energy Digitalisation Orchestrator (as recommended in the Energy Digitalisation Taskforce report published in 2022), Ofgem can help put this data sharing infrastructure in place which will enable organisations across the energy sector (not just licensees) to share data in a seamless and secure way to accelerate the path to net zero. This will enable an ecosystem of connected digital twins to develop across energy and other sectors to understand, plan and manage energy supply and demand and energy security.

The FSO will have powers to request information from network licensees and will need to ensure that they can access this information in both a timely manner and of a requisite quality for making strategic and operational decisions. This will require a data sharing infrastructure to do this properly. The FSO could have a key role to play as the energy

[1] New Technologies - NIC

data sharing infrastructure operator in developing and maintaining the data sharing infrastructure. Ofgem can lead the way by spearheading an interim Energy Data Sharing Infrastructure Task Group which must have both mandate and funding to set up the energy data sharing infrastructure.

A data sharing infrastructure can support any type or mix of regulatory archetypes examined and recommended under the Future Systems Networks Regulation (FSNR) review. Seamless and secure data sharing between licensee and regulator will enable ex ante regulation to work more effectively; at lower cost and at a faster, more agile pace. The regulator is better informed prior to setting the price control and the information asymmetry is reduced. The challenge for Ofgem is to embrace both cultural change aspects required to make this work:

1) A cultural change towards digitalisation and use of data
2) A cultural change towards more agile, adaptive regulation

The evidence and argument for seamless and secure data sharing to enable archetype 1, plan and deliver is clear. A central planner needs to have all information at its fingertips and be assured of the quality of that data for the resulting decision making. Seamless and secure data sharing will also enable ex post regulation to work more effectively than envisaged by participants across the sector currently.

However, evidence suggests that ex post regulation can increase risk in an industry where huge investments are required and whilst ex post regulation might enable networks to invest on their own timetable, they will still need clear guidance from the regulator on the upper and lower boundaries of that investment and hence the regulatory insight required to inform that guidance, can appear more akin to ex ante regulation.

It is likely that as the industry and Ofgem move towards seamless and secure data sharing, the benefits of ex post regulation will become clearer and more feasible. However, the current focus should be on using data and digitalisation to enhance capabilities for central strategic network planning and for incentive regulation. It will be possible to better evaluate the benefits of ex post regulation once seamless and secure data sharing is achieved through a data sharing infrastructure.

This external independent report supporting Workstream 5 of the FSNR on Digitalisation makes the recommendations.

A roadmap to a Data Sharing Infrastructure by 2028 Recommendations:

1. **Ofgem to invest in additional data and digitalisation skills and capability.** (start Q4 2023, complete end 2025 – 2 year programme)
2. **Ofgem to set out a vision for data sharing across energy system and to publish a call for input or consultation for developing the data sharing infrastructure (DSI) for energy** (including trust, prepare, share functions) and governance options, (Q1 2024) leading to:
3. **Ofgem to work with DESNZ to set up energy digitalisation body (Energy Digitalisation Orchestrator)** based on evidence from digital spine study and response to forthcoming industry consultation (start Q3 24, set up Q2 27, needs extra funding). Energy Digitalisation Orchestrator is the ideally the energy arm of a national level cross sector Digitalisation Orchestrator. The Energy Digitalisation Orchestrator is responsible for overseeing the development of the DSI to a point when it can hand over operations and maintenance to FSO. Its purpose is to set direction and be accountable for the delivery and adoption of DSI. Orchestrator procures delivery of later phases of DSI.
4. Prior to formal set up of Orchestrator, **Ofgem lead an Energy Data Sharing Infrastructure Task Group** of energy sector representatives (with a secretariat staffed with secondees). (Q1 2024 needs extra funding) Its function is to oversee set up of DSI working with industry. The prospect of the Task Group becoming the Energy Digitalisation Orchestrator strengthens the Task Group's credibility to set direction for the DSI. The Energy Data Sharing Infrastructure Task Group oversee and procure delivery of first phases of DSI.
5. **Ofgem appoint FSO as the authority (energy data sharing infrastructure operator)** to maintain and develop the data sharing infrastructure for the energy sector working closely with the Energy Digitalisation Orchestrator:
    - **a.** Prior to FSO taking on this role, Ofgem through Energy Data Sharing Infrastructure Task Group leads in supporting ESO convene engagement across industry in co-creating data sharing infrastructure (start Q1 2024)
    - **b.** FSO to convene engagement across industry in co-creating data sharing infrastructure (2024-2028)
    - **c.** Ofgem to set obligations for FSO deliver data sharing infrastructure working closely with the Digitalisation Orchestrator by 2028 (start Q1 2024, V1 by Q1 2026, V2 by Q1 2028)

d. Ofgem to set network licence conditions (for all licensees) to enable rapid adoption of data sharing infrastructure. Ofgem should set a soft requirement to comply by 2026 for all licensees (with incentives) and a hard requirement to comply for all licensees by 2028 (with incentives and penalties) for gas and electricity transmission in RIIO GT3 and ET3, for gas distribution in RIIO GD3 and for electricity distribution in RIIO ED3.

   i. Mandate 1) participation in Trust Framework (Trust) 2) adoption and use of data standardisation mechanism (Prepare) 3) adoption and use of data sharing mechanism (Share)

   ii. Ofgem to incentivise and foster steering groups to cover specific topics as part of wider governance landscape eg Data and Digitalisation Steering Group (DDSG).

e. Ofgem and FSO set up coordination mechanism for use cases where they request same data – "report it once and count it once" (by 2026) as both have powers to request information

6. **Ofgem to offer incentives eg designate a strategic area of SIF to develop connected digital twins in energy (for all vectors) and connect across energy system using data sharing infrastructure** and/or connect with other sectors eg transport, water, communications, manufacturing, health (round 4 2024)

1. Introduction

Data and digitalisation aid a regulator's job

A data sharing vision

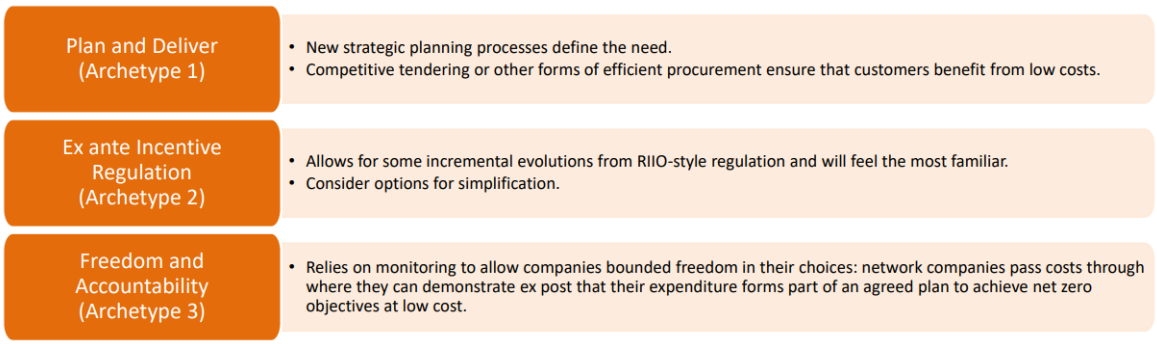
1.1 Better use of data can enable any regulator to do a better job. Data and digitalisation is a fundamental enabler of a lowest true cost accelerated transition to net zero and climate resilience. We cannot get to a net zero power system by 2035 without a greater and more public understanding of the costs of transition and without more innovation. Data enables **transparency, accountability** and **innovation**; the essential ingredients to accelerate our path to net zero. Without them we fail.

1.2 The time it takes us to get to net zero is important. Delay costs us more. The net zero imperative empowers regulators to act now and to do whatever is necessary to accelerate that path to net zero. Data and digitalisation is the fuel injection we need to realise our net zero goal by 2035.

1.3 Ofgem is currently undertaking a review of the Future Systems Network Regulation and is asking the question if the current approach to regulation is fit for the next round of price controls commencing in 2026 (for Electricity Transmission, Gas Transmission, Gas Distribution) and 2028 (Electricity Distribution) and what needs to change to achieve the 2035 net zero goal.

1.4 Workstream 5 on digitalisation forms part of this review and assesses how data and digitalisation can aid the appropriate form of regulation required to facilitate net zero. As an enabler, data and digitalisation can facilitate any form of regulatory archetype under consideration by Ofgem.

Figure 1: Regulatory archetypes set out in FSNR consultation



1.5 However, data and digitalisation can also be seen as a driver of the appropriate style of regulation and mix of regulatory archetypes; data and digitalisation capabilities will partly determine what kind of regulation can be put in place and by when.

2. Background Information

Ofgem Future Systems Network Regulation review

The relevance of data sharing

2.1 Regulatory reporting is a form of data sharing. If the appropriate data sharing infrastructure, for example the data management and data sharing mechanisms (both people related and technology related = sociotechnical) do not exist then, regulatory reporting will be inhibited.

Data and digitalisation to advance our path to net zero

Digital journey

2.2 All organisations are at a different stage in their digital journey, travelling from a non-digital paper based state to full digital transformation.

2.3 The figure below sets out the differences between digitisation, digitalisation and digital transformation.

Figure 2: Digital definitions

UKPN definition[2]	**Definition proposed in this report**
Digitisation – Making non-digital things digital	Digitisation turns information into a digital format
Digitalisation – Realising business opportunities and value, presented by digitisation	Digitalisation makes existing processes and systems digital and relies on digitisation
Digital Transformation – Changing business models with digitalisation	Digital transformation is the transformation of a business model through digitalisation

[2] Download our digital strategy - UKPN DSAP (ukpowernetworks.co.uk)

The energy sector digital journey

Energy sector Data Best Practice is a game-changer

2.4 The introduction of Data Best Practice (DBP) Guidance and Digitalisation Strategy and Actions Plan Guidance into licence conditions under ET2, GT2, GD2 and ED2 marks the biggest step change in the energy sector's digital journey so far, as of mid-2023. The technological and cultural impact of these principles is groundbreaking in moving an industry from non-digital records to relying on digital processes to better serve their customers.

2.5 It is relevant to note that much of this transformational change derives from the clear industry mandate given through the recommendations made in the Energy Data Task Force[3] (EDTF report) and Energy Digitalisation Task Force[4] (EDiT report) reports.

2.6 Networks are making progress in applying DBP but it is noted that it is difficult to measure and compare compliance with DBP as the networks are at different stages of their digital journeys. Distribution Network Operators are at the forefront of this digital transformation, whereas there is evidence to support the view that Gas Distribution Networks are earlier in their digitalisation journey and will need to make significant investments to meet a strong digitalisation baseline.

2.7 It is important to assess individual companies' digital maturity when considering the digitalisation of the energy sector, however, digital maturity is difficult to assess and measure fairly. Digital maturity can often be confused with levels of automation and levels of sophistication and complexity. Technology should be assessed on the basis of the purpose it was designed for. For example, it may not be appropriate to have a highly automated vulnerable customer response service, guided by AI, if the purpose of the service is to support vulnerable customers at a personal level during outages. The service may score highly in terms of digital maturity and levels of sophistication but might score low from the customers suffering outages and a lack of personal support.

[3] Energy Data Taskforce | A Modern Digitalised Energy System (catapult.org.uk)
[4] Energy Digitalisation Taskforce - Energy Systems Catapult

2.8 There are a plethora of digital maturity scales, and the table below shows a selection.

Figure 3:3 different reports outlining methods to measure digital maturity.

Organisation	Report/link	Digital maturity measures/levels
IET	Digital twins for the built environment (theiet.org)	0 - reality capture 1 – 2D map or 3D model 2- Connect model to data eg (BIM) 3 – Enrich with real-time data 4 – 2-way data integration and interaction 5 – autonomous operations and maintenance
DUET	Digital Twin Maturity Model | DUET (digitalurbantwins.com)	Awareness of Twins Experimental Twins Predictive Twins Intelligent Twins
Centre for Digital Built Britain	About the Digital Twin Toolkit project - DT Hub Community (digitaltwinhub.co.uk)	Levels of sophistication (not maturity): Descriptive Informative Predictive Prescriptive Cognitive

2.9 Whilst maturity models can be helpful for understanding where an organisation is relative to an organisation specific maturity model and goal, maturity models which are not mapped relative to a common starting point are not a helpful way to assess maturity of progress across organisations. For example, NCSC have moved away from maturity models to a risk management approach[5].

2.10 It should be understood that all networks will be at a different point on their digital journey and that benchmarking is not straightforward. Two lessons learnt

[5] Maturity models in cyber security: what's happening to the... - NCSC.GOV.UK

from the Centre for Digital Built Britain[6] (CDBB) phase of the National Digital Twin Programme suggest the following:

(1) Enabling and facilitating organisations further on in their digital journey to progress helps to accelerate progress across an industry – "run with the willing".

(2) Sharing data across organisations aids collaboration and the combination enables faster advancement of the less digitally capable organisations. "learn by doing, progress by sharing[7]".

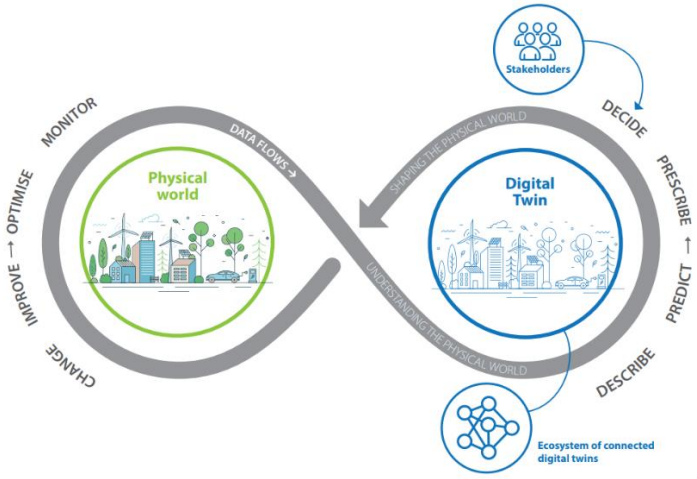
What are digital twins?

2.11 A digital twin can be defined as a digital representation of assets, processes or systems[8]. There a multiple definitions of digital twins across different disciplines and sectors but at their core, these definitions convey some relationship between the physical world and the digital world through data, and the use of the digital twin to make a decision which has impact in the physical world.

2.12 Whilst some may distinguish between a digital model, shadow and twin[9], this report recommends that the focus be on the purpose of the digital twin. If the purpose requires static data or a live data connection, then the twin should receive the level of data it requires to perform the function asked of it.

Figure 4 Digital Twin toolkit[10]: what is a digital twin

[6] Centre for Digital Built Britain completed its five-year mission and closed its doors at the end of September 2022 | This website remains as a legacy of the achievements of our five-year foundational journey towards a digital built Britain (cam.ac.uk)
[7] Motto for Digital Twin Hub - DT Hub Community
[8] TheGeminiPrinciples.pdf (cam.ac.uk)
[9] Digital Twins: Model, Shadow, Twin - The case for policy use - Energy Systems Catapult
[10] About the Digital Twin Toolkit project - DT Hub Community (digitaltwinhub.co.uk)



2.13 As figure 4 sets out, data flows from the physical world to the digital world and is used to make a decision which impacts on the physical world. It is important for digital twins to have specific use cases which may fall in the three broad categories of 1) strategic planning, 2) managing assets and 3) assurance[11].

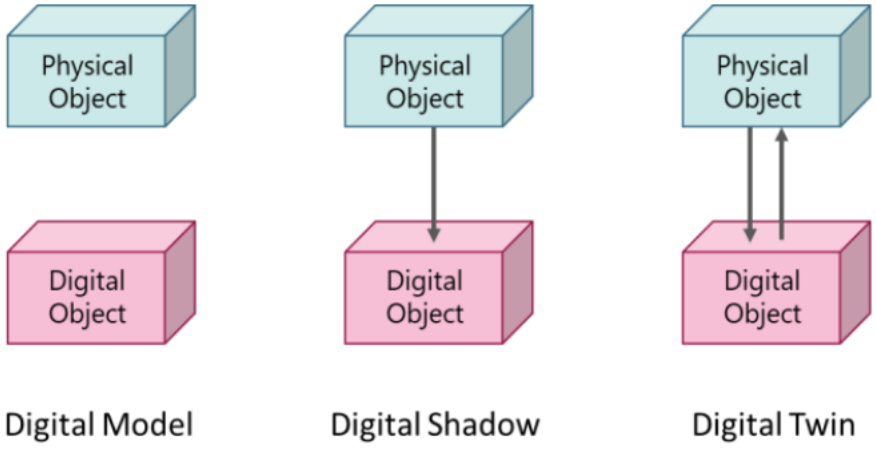
2.14 Many asset owning organisations embarking on their digital journeys, such as energy networks, have the aspiration to build a digital twin of their network. Full digitisation and digitalisation would mean that an organisation has reached the stage where the organisation has a digital replica of the organisation's assets, processes and systems and so has functioning digital twins. However, a digital twin can be much simpler than a fully functioning digital representation of a physical network with bi-directional data flows. It is not helpful to be dismissive of digital twins or models that do not meet this bi-directional data flow criteria. What matters, is what the digital twin is developed for: it's purpose.

2.15 The Gemini Principles published in 2018, set out that chiefly digital twins must have "purpose, enable trust, and function effectively". The sophistication level of the technology must be dictated by the function or service it needs to perform. Energy Systems Catapult refers to digital models, digital shadows and digital twins as Digital Twin Technologies[12], drawing distinctions as follows:

[11] About the Digital Twin Toolkit project - DT Hub Community (digitaltwinhub.co.uk)
[12] Digital Twins: Model, Shadow, Twin - The case for policy use - Energy Systems Catapult

- *Digital Model – A digital representation of a physical system or object e.g. a network infrastructure map which utilises data from a fixed point in time*
- *Digital Shadow - A digital model which integrates automated one-way data flow from the physical system or object e.g. A network infrastructure map which pulls data from the system to dynamically update inventory, asset state and constraints*
- *Digital Twin - A digital model which integrates two-way data flow between the model and physical object or system. Where making a change to one can change the other for example a control centre network map which displays real time system status and enables engineers to control assets to mitigate issues.*

Figure 5: Digital Twin Technologies (Energy Systems Catapult)



2.16 Distinguishing between different types of digital twin technologies can help to be more precise in describing a model and how it uses data, and it's important not to exclude one organisation's view of a digital twin from a broader description. The term "digital twin" can generate enthusiasm for using data to solve a problem and therefore if the point of digitalisation is to achieve better outcomes from data, then it's important not to suggest that one person's definition of a digital twin is inferior to another.

2.17 This report recommends that digital twins are seen as a means of organisations better understanding, running and planning their networks. Organisations should seek to develop digital twins with specific purposes. Connecting up digital twins

within organisations and across organisations provides a means of sharing data to solve specific and shared problems. However, we lack the data sharing infrastructure to connect up digital twins.

Data and digitalisation to advance our path to net zero

The benefits of sharing data

2.18 Connecting up digital twins enables the sharing of data within organisations, across organisations and across sectors. The National Infrastructure Commission's 2017 report Data for the public good[13] set out how the benefits of sharing data accrue across many parties not just the data provider or the data consumer. There are many barriers to sharing data: legal, technical, commercial, economic, regulatory and cultural. This results in market failure so not enough data is shared across energy and the wider economy.

2.19 Net zero targets are hard to meet because it is difficult to measure progress, cost and impact. The data sharing market failure inhibits our ability to reach net zero. If we can't measure and record our greenhouse gas emissions accurately and we don't understand the cost of reducing greenhouse gas emissions and we can't track our progress, we are aiming for an unmeetable target. If we don't understand the systems impact, we cannot understand the impact of a large number of interventions designed to reach net zero. We cannot reach net zero without data to understand, track and plan our progress.

The need for a data sharing infrastructure

2.20 DBP lays the foundations for networks to use and share their data to accelerate the path to net zero. It does not provide an infrastructure for networks to share their data. The market does not provide an infrastructure for networks to share data, and in the absence of intervention there is a risk that the larger networks will create such an infrastructure for their own benefit, strengthening digital monopoly power in the energy sector.

[13] New Technologies - NIC

2.21 There is a risk that left unfettered National Grid Electricity System Operator (ESO) could develop the Virtual Energy System (VES) as part of the data sharing infrastructure based on their own interests rather than the interests of the industry as a whole. Due to the market failure outlined above, the incentives do not exist for private companies to coordinate on creating a data sharing infrastructure because they will not be able to capture all the benefits or charge for them.

2.22 Following on from the recommendations of the EDiT report published in 2022, DESNZ commissioned a feasibility study for the digital spine[14]. The findings of this report should be considered alongside the findings of the Digital Spine Feasibility Study, when published.

2.23 A data sharing infrastructure requires a trust framework, a data standardisation mechanism and a data sharing mechanism. Evidence and experience from recent data sharing initiatives (for example CReDo) shows that the appropriate data sharing architecture for such infrastructure is a distributed architecture which allows prioritisation of security and scalability.

Figure 6: CReDo

CReDo[15] is a Climate Resilience Demonstrator sharing data across energy, water and telecoms sectors to build a system level view of interdependencies across the infrastructure system. As a climate change adaptation digital twin, CReDo is being developed to enable asset owners to simulate the effect of extreme weather events across their networks to identify which assets are most critical to protect for system resilience. CReDo, set up by Centre for Digital Built Britain in 2021 and taken forward by Connected Places Catapult since 2022, trialled a centralised data sharing architecture in phase 1 but found that it did not enable scalability. In phase 2, CReDo has investigated the development of a distributed data sharing architecture to bring the data together to run through the CReDo models whilst maintaining security and enabling scalability.

[14] Energy system 'digital spine' feasibility study (closed to applications) - GOV.UK (www.gov.uk)
[15] What is CReDo? - DT Hub Community (digitaltwinhub.co.uk)

Cross sector digital journey

2.24 The benefits of sharing data are not limited to the energy sector. As the report "Data for the public good" set out, there are significant benefits from sharing data both within sectors and across sectors. The energy sector is at the heart of this digital revolution which must enable an accelerated least true cost path to net zero.

2.25 An element of the work to develop a data sharing framework, as originally recommended by the National Infrastructure Commission in Data for the public good is being taken forward at the national level by the National Digital Twin Programme (NDTP)[16]. The National Digital Twin Programme is developing a combination of high-level principles and more granular demonstrator projects to provide non-binding guidance to sectors in developing digital twins. The NDTP is developing an integration architecture core which performs the function of a data standardisation mechanism and some of the functions of a data sharing mechanism.

2.26 As sectors develop their data sharing infrastructure, it is essential to ensure that this data sharing infrastructure is connected up across sectors, in the same way that power lines need to connect to physical water, communications and transport networks. This is not currently happening enough or fast enough.

3. Literature Review

Documents and resources

3.1 This study has included a rapid review of the follow literature and online resources:

a) Accelerating electricity transmission network deployment: Electricity Networks Commissioner's recommendations - GOV.UK (www.gov.uk), Electricity Networks Commissioner, August 2023

[16] National Digital Twin Programme - DT Hub Community (digitaltwinhub.co.uk)

b) Consultation - RIIO-ED2 Draft Determinations – Core Methodology Document, Ofgem, June 2022

c) Consultation on frameworks for future systems and network regulation, Ofgem, March 2023

d) Consultation responses to the FSNR, May 2023

e) Data for the public good, National Infrastructure Commission, December 2017

f) Decision on the Electricity System Operator Business Plan: IT Investment Plan Guidance, TBM Taxonomy, December 2021, Ofgem

g) Decision on the initial findings of our Electricity Transmission Network Planning Review | Ofgem

h) Digital Twin Maturity Model | DUET (digitalurbantwins.com)

i) DNO Digitalisation action plans 30 June 23

j) DNO Digitalisation strategies 1 April 23

k) EDiT Annex Digitalisation Governance Moving to Action: Digitalising our Net Zero Energy Future (383apps.com), Zuhlke, January 2022

l) Enabling the transformation of the energy system, Recommendations from IGov, IGov University of Exeter, October 2019

m) Energy Data Taskforce Report, A strategy for a modern digitalised energy system, Energy Systems Catapult, 2019 Energy Data Taskforce | A Modern Digitalised Energy System (catapult.org.uk)

n) Energy Digitalisation Taskforce (EDiT) Report, Delivering a Digitalised Energy System, Energy Systems Catapult, Energy Digitalisation Taskforce - Energy Systems Catapult January 2022

o) Getting energy governance right: Lessons from IGov, IGov University of Exeter, October 2019

p) Innovation zero, The context for innovation in achieving net zero, The Context for Innovation in Achieving Net Zero | Catalyst Forum D1 - YouTube, June 2023

q) Maturity models in cyber security: what's happening to the... - NCSC.GOV.UK

r) Net zero crunch time, Helm Talks podcast, Net zero crunch time by Helm Talks Podcast (soundcloud.com), Dieter Helm, June 2023

s) Regulating energy networks for the future RPI-X@20, Ofgem 2010 Regulating energy networks for the future: RPI-X@20 decision document | Ofgem

t) Skills and capabilities required to develop the National Digital Twin, CDBB, 2021

u) Strategic Investment and Public Confidence, National Infrastructure Commission, October 2019

v) Strategy and Policy Statement for Energy Policy in Great Britain Consultation May 2023

w) The case for ex post regulation of energy networks, LECG, October 2009 - The case for ex post regulation of energy networks - report by LECG for Ofgem | Ofgem

x) The Gemini Principles, Centre for Digital Built Britain (CDBB), December 2018

y) VES common framework - Virtual Energy System – Common Framework Demonstrator | ENA Innovation Portal (energynetworks.org)

Key points

3.2 The key points emerging from the literature are referred to throughout this report and can be summarised as follows:

a) The UK is allegedly currently not on track to reach net zero. The lack of monitoring and tracking capability, hindered by low levels of digital capability across the energy and other sectors, makes it difficult to measure progress.

b) It is difficult to assess the true cost of reaching net zero without access to high quality data across the energy industry.

c) There has been a vacuum in energy policy setting out a clear path to net zero and the appropriate governance arrangements.

d) There are legal, technical, economic, commercial, regulatory and cultural barriers to sharing data meaning that we do not realise the full value of data across the economy.

e) Data sharing enables innovation which is a key driver of net zero.

f) Ofgem's approach to RIIO style regulation has a long history and strong industry support and puts Ofgem in a strong position to temporarily lead the digitalisation of the energy sector while the appropriate governance framework is established.

3.3 Reaching the UK's legally binding target of reaching net zero by 2050 requires planning, monitoring and measuring. Experts such as Dieter Helm have warned that the UK is not on track to reach net zero[17]. In order to plan and track progress to net zero, data is required.

3.4 An important component of reaching net zero in the UK is expanding transmission capacity and allowing the connection to offshore wind capability, as set out in the Electricity Networks Commissioner's report[18]. Recommendations from this report include 1) the development of a Strategic Spatial Energy Plan and 2) incentives on transmission operators to deliver capacity upgrades to time and cost. Both require data.

3.5 The National Infrastructure Commission 2017 report, Data for the public good set out the benefits of sharing data across infrastructure sectors and set a vision for a National Digital Twin as an ecosystem of connected digital twins. The report referred to the use of aggregated and anonymised smart meter data as an enabler of more targeted investment in the energy sector and the use of digital twins to reduce energy consumption. The report references the use of data as an enabler of innovation.

3.6 The discussion between experts at the Innovation Zero conference in 2023[19], draws the link between data, innovation and net zero. Innovation in technology is required to forge the path to net zero and data is an essential input to innovation.

3.7 The Energy Data Taskforce report of 2019[20] followed on from Data for the public good quoting it in the introduction "simply having the data is not enough. It needs to be shared across the public and private sectors with the appropriate levels of secure access to enable its value to be fully leveraged for public benefit." The Energy Data Taskforce report set out the need to embrace digitalisation across the energy sector to enable decarbonisation and decentralisation and facilitate the energy transition.

[17] Stream Net zero crunch time by Helm Talks - energy climate infrastructure & more | Listen online for free on SoundCloud
[18] Accelerating electricity transmission network deployment: Electricity Networks Commissioner's recommendations - GOV.UK (www.gov.uk)
[19] The Context for Innovation in Achieving Net Zero | Catalyst Forum D1 - YouTube
[20] Energy Data Taskforce | A Modern Digitalised Energy System (catapult.org.uk)

3.8 The Energy Digitalisation Taskforce report of 2022[21] took this further by stating the "future net zero system will not be able to function without deep digitalisation" and set out a number of recommendations for a modern, decarbonised, digital energy system. The report strongly references the link between data and innovation. The recommendations included using smart meter data for public good and the delivery of interoperability through the development and deployment of common digital assets.

3.9 The report recognised the need for coordinated common digital assets as the "energy system is becoming increasingly decentralised, there are more actors and assets than ever before, and this is set to continue to increase as we deploy the solutions required to reach Net Zero. Each of these assets can be a valuable part of the Net Zero energy system, delivering resilient, reliable services that customers need, but only if they can be coordinated to work together effectively." The report set out the need to set up an independent delivery body for public interest digital assets.

3.10 Reports such as IGov's "Enabling the transformation of the Energy System" 2019, described a "lack of direction-setting and transformation management" from government and said it is "unclear where responsibility lies for energy system transformation over time" noting that Ofgem did not have a specific responsibility for encouraging innovation. The National Infrastructure Commission's 2019 report, Strategic Investment and Public Confidence, also referenced the point that "the UK's current regulatory system was not designed to deliver transformational change. The system needs to be updated to adapt to the coming challenges of achieving net zero, digitalisation and building resilience to extreme weather events."

3.11 The National Infrastructure Commission report also called for the publication of Strategic Policy Statements every five years, at a time when no Energy Strategic Policy Statement had been published since the concept was introduced in 2013 in

[21] Energy Digitalisation Taskforce - Energy Systems Catapult

the Energy Act. The first draft Energy Strategic Policy Statement was published in May 2023[22].

3.12 The Zuhlke report[23] on energy system governance stated "Net Zero will not be achieved without digitalisation of energy services" and "The conclusion is that for rapid progress towards Net Zero to be made, much greater digital capabilities and interconnected data and information are now vital to enhancing our national energy system. Ultimately, the requirement is to connect parties and assets in a vast and complex system-of-systems across the Net Zero economy."

3.13 The report set out the case for effective governance of energy sector digitalisation to provide a framework for harnessing the benefits of a digitalised energy system. The report called out for an Energy Digitalisation Delivery Body as an independent body to lead the governance of energy sector digitalisation working with a stakeholders' panel and delivery orchestrators. The recommendations set out in section 4 should be seen as an evolution of this recommendation building upon the thinking outlined in this report.

3.14 Consultation responses to Ofgem's Future Systems Network Regulation Review demonstrated strong support for Ofgem's approach to incentive based regulation. Previous studies[24][25] to assess the pros and cons of ex ante and ex post regulation have provided evidence to support the continuation of ex ante regulation. The strength of support for Ofgem's RIIO-style regulation provides evidence for industry support for Ofgem's leadership in the energy sector and the basis for the recommendations in section 4, proposing Ofgem temporary leadership in the digitalisation of the energy sector whilst the appropriate governance arrangements are put in place, in order to facilitate and accelerate the path to net zero.

[22] Strategy and Policy Statement for Energy Policy in Great Britain: consultation (publishing.service.gov.uk)
[23] Moving to Action: Digitalising our Net Zero Energy Future (383apps.com)
[24] The case for ex post regulation of energy networks - report by LECG for Ofgem | Ofgem
[25] Regulating energy networks for the future: RPI-X@20 decision document | Ofgem

4. Methodology

Terms of reference

4.1 Ofgem engaged Sarah Hayes Independent Consultant (the "consultant") for a three-month study to gather evidence for digitalisation and monitoring beyond RIIO-2. The format of this study comprised the following areas:

a) Managing stakeholder engagement to harness a wide range of views on the impact of data and digitalisation on future price controls.

b) Carry out a literature review on digitalisation and digital twins relevant to energy sector regulation.

c) Provide recommendations to GEMA on the key decisions for Ofgem to consider to achieve a more flexible regulatory approach in delivering whole system benefits and consumer benefits.

4.2 The key strategic questions to be addressed during the course of the study were outlined as follows:

a) What digital tools, up to and including a digital twin, can we deploy to close the loop between planning and monitoring – what is needed, and what is feasible by when? [to support Archetype #1].

b) What is current Technical Readiness Level of Digital Twins in gas and electricity T&D companies? What is current TRL of Digital Twins in other industries? (for context)

c) Is developing digital twins the right output/goal for the next price control period; if not – what are the other options? If yes - what are the key enablers and what are the delivery timescales?

d) What fundamental technological elements *must* be in place for these to synchronise?

e) Who should take a leadership role for the process and strategy on digitalisation in the energy sector (to specifically deliver these ends)?

f) How could a distributed and decentralised data architecture facilitate the assessment of optimal national, and regional, balance between flex and network investment requirements?

g) What other use cases (industry and societal) could be delivered if comprehensive digital twins were in place for the gas and electricity sectors?

4.3 This report summaries the findings and recommendations arising from the study.

Approach to gathering evidence and developing recommendations

4.4 To address the strategic questions and to investigate how data and digitalisation could enable and improve future regulation, the consultant carried out a series of interviews which are detailed in appendix 2. The consultant carried out a review of literature detailed in section 2. The consultant supported Ofgem in leading these stakeholder workshops:

1) FSNR workstream 5 Working Group #3: Digital Twins and archetypes 1 and 2
2) FSNR workstream 5 Working Group #4: Digital Twins and archetype 3
3) FSNR workstream 5 Working Group #5: Governance
4) NDTP workshop 1
5) NDTP workshop 2

4.5 During the course of the study the consultant tested recommendations with Ofgem teams and refined the recommendations for the final report.

4.6 An important part of the process was to engage with the team contracted to DESNZ for the Digital Spine Feasibility Study and with the team from the Department of Business and Trade working on the National Digital Twin Programme.

5. Findings, Analysis and Conclusions

Energy industry is making progress in data and digitalisation, but a next step is needed

5.1 Evidence gathered during consultation from interviews and consultation responses suggests that industry is making progress in applying Data Best Practice (DBP) and developing Digitalisation Strategy and Action Plans (DSAPs). This progress should be seen in the context of the wider economy and the absence of Data Best Practice Guidance and regulation in other sectors. For example, water, communications and transport do not have such Data Best Practice guidance from their respective regulators.

5.2 Network licensees are at different points in their digital journeys, and this is reflected in their ability to implement Data Best Practice. In the FSNR digitalisation workstream working group sessions (referred to as the "working group sessions") convened by Ofgem, participants explained that it can be difficult to assess compliance with DBP. Evidence set out in Appendix 1.1 shows that whilst DNOs should be producing data which is interoperable, in practice data from the DNOs is in different formats and means different things. Ofgem needs to be able to set out a regime for assessing progress in implementing DBP aligned with regulatory incentives.

Data sharing and regulation

5.3 Regulatory reporting is a form of data sharing. Digitalised regulatory reporting could have direct benefits for industry and Ofgem and indirect benefits to the consumer through more targeted investment and efficiency.

5.4 Greater digitalisation and data sharing capability would support any regulatory archetype or mix of archetypes. In the working group sessions convened by Ofgem, participants noted that to facilitate the strategic planning use case (archetype 1), a significant amount of effort is needed to standardise data and establish common rules for sharing.

5.5 Similarly, participants agreed that for data sharing to better support incentive regulation (archetype 2), further foundational work on interoperability is required. Participants noted the issues with uncertain data quality, varying levels of trust and the question of what the data was being used for and the appropriate

granularity of the data. In particular, networks raised the point that when a data request is issued by Ofgem, it is not always clear what the data will be used for. This in itself can erode trust between network and regulator.

5.6 However, there was a recognition that if trust were built and maintained then greater data sharing between network and regulator could facilitate the business plan approval process as part of the existing RIIO approach to regulation. Participants noted that if improved data sharing between networks and regulators enabled rationalisation of data requests then this would lead to cost reductions.

5.7 Greater digital capabilities across networks and Ofgem could enable archetype 3 (freedom and accountability through ex post regulation) to function effectively but networks suggested that archetype 3 is currently most applicable to a restricted range of activities, both verbally and in consultation responses. In the working group sessions, Data Best Practice was seen to be a positive enabler of archetype 3. However, participants noted that networks are at different stages of their respective digital journeys and therefore benchmarking may not be straightforward.

5.8 Data sharing and digitalisation offer more immediate benefits from informing archetypes 1 and 2 but there are barriers to sharing data and to achieving benefits of data and digitalisation. Participants in the working group sessions indicated support for streamlining reporting requirements and agreed that improved data sharing and digitalisation would support this.

Ofgem needs a data sharing vision

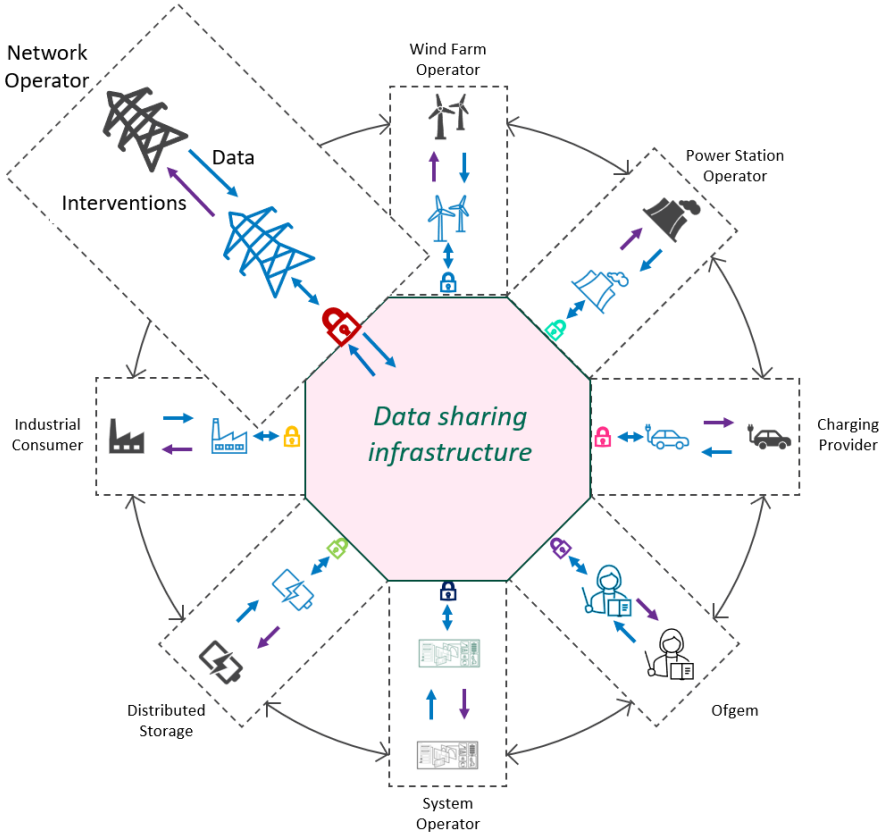
5.9 In order to overcome the barriers to sharing data and to get the most value out of data to accelerate our path to net zero we need a data sharing vision. A data sharing vision for Ofgem could look like this:

1. Seamless and secure data sharing across energy system and with Ofgem
2. Getting it **right**: People (across industry and Ofgem) have the right level of access to the right information at the right time in the right place and of the right quality.
3. Data sharing enables greater collaboration across industry and with Ofgem

5.10 A data sharing infrastructure is an integral part of the data sharing vision to support data sharing across energy industry to enable accelerated lowest true cost path to net zero. Figure 7 shows how a data sharing infrastructure would

facilitate the sharing of data across different parts of the energy system incorporating access, security and quality protocols (the padlocks) to ensure data is shared appropriately.

Figure 7: Data sharing vision[26]



5.11 A participant at a working group session, made the suggestion that in a data sharing vision with a data sharing infrastructure, a key use case is to promote and enable carbon accounting as a net zero driver. Other participants suggested use cases including flexibility and cross vector local planning.

Energy needs a data sharing infrastructure

5.12 It is important to be clear that Data Best Practice does not achieve that data sharing vision, it is an enabler of that vision and it sets the foundations. Presumed open data in the energy sector is a significant enabler of data sharing

[26] Data sharing architecture template - DT Hub Community (digitaltwinhub.co.uk)

and helps to realise the benefits of data sharing but it does not solve the problem of sharing data which has a good reason not to be shared openly eg commercially sensitive data or data that, if made openly available, would present a critical national security risk.

5.13 It also does not solve the problem that data is in different formats and can have different meanings, so data consumers have to spend time and resources cleaning up that data ready for use.

5.14 For example, Advanced Infrastructure works with energy networks in developing tools to support local authorities to develop net zero plans. The data that Advanced Infrastructure receives directly from the network through its contractual arrangement or via the open data portal is in different formats and is not directly comparable across networks.

5.15 Advanced Infrastructure, like many SMEs operating in this space, must go through a process of data engineering to clean up the data and pull it together into a useable format. Appendix 1.1 gives examples of how different the data formats are. In an organisation of around thirty people, eight work in the data team. One person of that eight, is full time on data cleaning. There are many such people working in these roles who could be working directly with the energy networks to help them apply data standardisation toolkits to clean up the data at source.

5.16 Applying the principle of "clean it one, reuse it many" developed by Boro Solutions[27], would mean that instead of many data specialists spending time cleaning the same piece of data, the data could be cleaned at source within the energy network and reused many times and those data specialists could be doing many other essential roles in the data ecosystem.

5.17 Participants at the working group sessions agreed on the need for an energy data sharing infrastructure and emphasised that it must be cocreated and in combination with skills development. Participants noted in particular key blockers to data sharing as including data rights, liability transfer and legal elements.

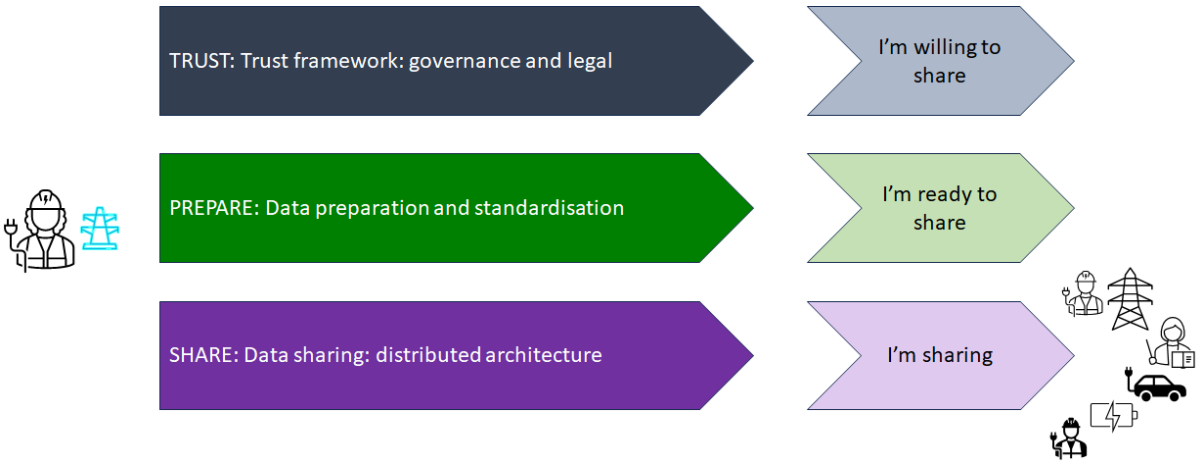
[27] CReDo Technical Report 5 CReDo and the Information Management Framework March 2022 (unpublished)

5.18 We need to find a way to share that data with the parties who need to see it (in order to facilitate the path to net zero). The way to share that data is through a data sharing infrastructure. A data sharing infrastructure is necessary to overcome the cultural, technical, legal, commercial, economic barriers to sharing data. Current guidance and resources for the energy sector do not include a data sharing infrastructure.

5.19 Discussions with the Digital Spine Feasibility Study team helped to clarify the consultant's understanding of the components of a data sharing infrastructure. The consultant considers a data sharing infrastructure has three key functions:

1) Trust: Trust framework
2) Prepare: Data standardisation mechanism
3) Share: Data sharing mechanism

Figure 8: Functions of a data sharing infrastructure



5.20 The market (the energy industry in this case) will not develop a data sharing infrastructure by all for all. There is a market failure as the bigger players with digital market power (and more valuable data) will develop a sharing mechanism that works in their favour. Therefore, it is important *how* this data sharing infrastructure is developed.

5.21 Government and the regulator must intervene to set up a common data sharing infrastructure for the benefit of all. There is a risk that ESO in its current form, if it proceeds with its vision for a Virtual Energy System as part of the data sharing

infrastructure, may develop such infrastructure with primarily its own interests in mind.

5.22 However, as the ESO transitions to the Future System Operator (FSO), these interests will change and it is paramount for Ofgem and the Government to ensure that the interests of all can be catered for in a future where the FSO leads in developing and maintaining the data sharing infrastructure.

Current initiatives emerging

5.23 In the absence of clear policy and intervention, different initiatives are emerging but are not cohering. For example, Open Energy has been funded by Innovate UK Modernising Energy Data Access (MEDA) and has developed a trust framework model for the energy industry based on the trust framework model operational in the banking sector, Open Banking. The trust framework forms a thin layer enabling access in the data sharing infrastructure but needs to be joined up with a data standardisation mechanism and a data sharing mechanism.

5.24 Following from the recommendation of the EDiT report, government (DESNZ) commissioned a Digital Spine Feasibility Study. This study is assessing the needs case, benefits, scope and costs of an energy system digital spine..

5.25 In the absence of a data sharing infrastructure, and driven by the need to access data across the energy industry, ESO have developed the concept of a Virtual Energy System built up of a common framework and many use cases. It would appear that there is some overlap with Open Energy (a catalogue) and a data standardisation mechanism.

5.26 The National Digital Twin Programme is developing an integration architecture core which performs functions associated with the data standardisation mechanism and the data sharing mechanism.

5.27 CReDo the Climate Resilience Demonstrator, has tested out the development of a distributed architecture so that data can be accessed at source from different organisations, through a data licence, without storing the data in a central database.

5.28 NUAR, the National Underground Asset Register set up by the Geospatial Commission has developed a central database to access data via data licences.

Collaboration and stakeholder engagement

5.29 In terms of the different data sharing initiatives that are emerging set out in 4.16 to 4.21 which represent only a selection of current data sharing initiatives not the entire landscape, there is a lack of collaboration in aligning the development of these initiatives. At the working group sessions, participants commented on how the current proliferation of initiatives appeared disjointed and there is a need for a portfolio perspective to ensure alignment in technical development and from a governance perspective.

5.30 One participant recommended mapping current data sharing mechanisms and conducting a gap analysis to identify and prioritise gaps. The development of many data sharing initiatives risks the increased proliferation of alternative approaches to data sharing which are not interoperable.

5.31 It is therefore essential that there is coordination across these data sharing initiatives to draw together emerging lessons learnt and best practice. It is important that there are different data sharing initiatives ongoing at the same time to explore and test different approaches, but it is essential that key learnings are incorporated into the development of a data sharing infrastructure.

5.32 It is therefore necessary to ensure that as part of a data sharing infrastructure there is a mechanism for enabling coordination and capturing those lessons learnt. Enabling collaboration through extensive stakeholder engagement is part of that solution.

5.33 In the working group sessions, some participants highlighted the need for greater collaboration between the networks and the Virtual Energy System being developed by National Grid ESO to more deeply involve the networks in the development of the Virtual Energy System. It was also made clear that there are existing channels for collaboration such as through the Energy Networks Association (ENA) Data and Digitalisation Steering Group (DDSG) which can be used to facilitate greater collaboration.

5.34 It is a common occurrence that innovation projects which have a requirement for stakeholder engagement, do not enable enough stakeholder engagement to satisfy all parties. A team can believe they are undertaking extensive stakeholder engagement whereas in reality they need to do even more, to fully reach all relevant stakeholders.

5.35 Stakeholder engagement is a time-consuming process, as is technical development, and it is as critical as technical development, to ensuring the success of data sharing initiatives. The development of a data sharing infrastructure needs to incorporate a significant amount of stakeholder engagement, along the lines of the stakeholder panels proposed in the Zuhlke report[28] on governance.

Governance

5.36 One of the reasons a data sharing infrastructure does not exist in the energy sector is because there is no institution authorised or capable to develop that infrastructure and so we have seen these different initiatives emerging which are not currently joined up sufficiently. Governance is needed to establish clear roles and responsibilities in developing a data sharing infrastructure.

5.37 Participants in the working group sessions articulated a preference for Ofgem to take ownership of a data sharing infrastructure and to lead stakeholder engagement. For example, participants representing gas networks noted that participation in the wider digitalisation conversation can be more challenging for gas networks as the focus is typically on the electricity side.

5.38 This strengthens the case for Ofgem's role in balancing interests across the sector. Participants also noted the culture change required to adopt new technical processes through wider digitalisation and data sharing and looked to Ofgem to promote engagement across the industry on this point.

5.39 In the development of the data sharing infrastructure, working group participants emphasised the need for technical and business representations from all organisations to reach consensus and that this would require an entity to facilitate and coordinate engagement to align common practice. Some participants expressed a preference for an independent body to govern the development of the data sharing infrastructure.

5.40 Representatives at the ENA Data and Digitalisation Steering Group (DDSG) provided support to the idea of a Task Group driving forward the development of

[28] Moving to Action: Digitalising our Net Zero Energy Future (383apps.com)

a data sharing infrastructure in the first instance whilst the necessary governance arrangements are put in place, for example, the setting up of an independent digitalisation body. When asked whether industry would want to lead such a Task Group, the answer was a clear no, recommending that it would be appropriate for Ofgem to lead such a Task Group and play the role of convening and coordinating across the energy sector, ensuring engagement across all sectors within energy.

5.41 Ofgem, DESNZ and the FSO are not individually the appropriate organisation to develop the data sharing infrastructure alone. They need to work together and with industry to put the data sharing infrastructure in place. There is strong evidence across the energy industry to suggest that Ofgem should play a leading role in setting up the data sharing infrastructure.

5.42 A data sharing infrastructure is required for all sectors across the economy so that we can share data in a seamless and secure way across the economy, not just the energy sector. A huge part of getting to net zero is in understanding the linkages between energy and transport, the built environment, manufacturing, water, communications etc. Climate change is a cross sector systemic problem. Governance is required to ensure that data can be shared across all sectors of the economy.

5.43 However, given the net zero imperative, there is a strong argument to place energy at the front and centre of an emerging data sharing infrastructure. Therefore, governance options should focus on prioritising energy sector data sharing so that blueprints and lessons learnt in energy can be transferred to other sectors.

Skills

5.44 There is a lack of digital skills across Ofgem and industry. This is no different to any other sector of the economy, but due to the net zero imperative needs to be addressed urgently as it is holding the energy sector back from realising the full benefits of data and digitalisation. In the working group sessions, participants explained how the networks have had to invest in digital skills to follow Data Best Practice and to develop Digitalisation Action and Strategy Plans.

5.45 This has created new digital roles in the industry. In the working group sessions, participants suggested that a key challenge is how to raise capabilities and develop relevant skills across the sector. Participants suggested and supported a

review to consider the baseline capabilities of Ofgem and the networks and to identify the appropriate tools and frameworks required. Participants also noted the potential impact of skills and training on cultural change and the extent of cultural change needed to embrace digitalisation.

5.46 CDBB found that the skills required to develop a National Digital Twin[29] fall under both digital ("hard technical skills") and business ("soft non-technical skills"). A combination of technical and people-related skills is essential to getting the most of data and digitalisation and this mix is best found in diverse teams.

5.47 This refers to development of a data sharing infrastructure as a socio-technical programme. It is not wholly technical in nature and needs to address stakeholder engagement and cultural change. Much literature[30][31] has emerged in this space, to support the concept of data sharing as socio-technical rather than purely technical.

5.48 Ofgem has a strong capability in the small data and digitalisation team. This team needs more resources to assess and guide compliance with DBP and to collaborate with DESNZ and a Digitalisation Orchestrator in developing a data sharing infrastructure. The culture of data and digitalisation needs to pervade across an organisation as part of digital transformation. Ofgem needs to digitally transform itself and skill up all staff at all levels, with basic digital literacy and understanding. In this way Ofgem can lead and support digital transformation across the energy industry.

The role of the Future System Operator (FSO)

5.49 Participants in the working group sessions expressed uncertainty over the future role of the FSO and caution with regard to overburdening the FSO in its early days. Some participants indicated that it would be appropriate for the FSO to play a central role in developing, managing and maintaining common resources under a data sharing infrastructure as the FSO will have a central role in planning and in the use of data. Participants suggested that DNOs would need to support the FSO

[29] Skills and Capability - DT Hub Community (digitaltwinhub.co.uk)
[30] The Gemini Papers - DT Hub Community (digitaltwinhub.co.uk)
[31] Socio-technical networks of infrastructure management: Network concepts and motifs for studying digitalization, decentralization, and integrated management - ScienceDirect

to improve understanding at the local level. Participants recognised the need to build capabilities within the FSO over time.

5.50 The FSO will have the power to request information from licensees in the same way that Ofgem can. This, and its central planning and coordinating role, puts the FSO at the heart of a data sharing infrastructure. It is difficult to see how the FSO can do its job without seamless and secure data sharing enabled through a data sharing infrastructure. Therefore, once set up and ready to take on this role, the FSO must be a part of that data sharing infrastructure developing and maintaining it, for the whole the energy industry from a public interest perspective.

Licence conditions

5.51 In the working group sessions, participants acknowledged the possibility for Ofgem to mandate adoption of a data sharing infrastructure through licence conditions, based on the data best practice precedent.

5.52 Ofgem has the opportunity in possible future price controls e.g., RIIO 3 GT, GD, ET and ED to incentivise adoption and use of an energy data sharing infrastructure, in the same way that Ofgem has put Data Best Practice into licence conditions.

5.53 Whilst networks are at different stages of their digital journeys, the time it will take to develop a first version data sharing infrastructure is estimated at 3-5 years. This means that all networks should plan for adoption within 5 years. Participants in the working group sessions acknowledged the key driver as net zero and the need to accelerate the pace of adoption.

The role of steering groups

5.54 During the interview process, consultees emphasised the need to have open discussions with Ofgem without fear of repercussions or penalties to better inform Ofgem.

5.55 In the working group sessions, participants referred to the collaborative spirit of the ENA Data and Digitalisation Steering Group (DDSG) as enabling a way of facilitating collaboration across the networks and Ofgem and as a channel for providing input to Ofgem.

What does a digitally enabled future look like for Ofgem?

5.56 As set out in the data sharing vision, in the future people working at Ofgem and FSO will have the information they need to make decisions which advance our path towards net zero for the benefit of all customers. Automation will also mean that some of this data is provided automatically without requiring human prompts. However, as we make the most of digital technologies we should not lose sight of the human in the loop.

5.57 Data and new technologies are tools to help us make better decisions. Discussions between regulator and regulated can often be combative in nature and miss an opportunity for collaboration. Informal working groups can aid collaboration where clear goals are set and all participants are clear that these groups do not present opportunities for regulatory capture.

5.58 In order to avoid situations where both the industry and the regulator suffer the consequences of public outrage such as in the Combined Sewer Overflow (CSO) matter in the water industry, Ofgem should consider carefully how to promote these collaborative discussions to get into the heart of looming problems across the sector without enabling regulatory capture.

5.59 Greater access to high quality data will reduce the prospect of such incidences arising which damage public confidence in both regulator and industry, but in addition to that more informed data and evidence driven view, Ofgem must find a way to keep the human in the loop.

6. Recommendations

A roadmap to an energy data sharing infrastructure by 2028

6.1 Based on stakeholder engagement and evidence gathering this report makes the following recommendations to Ofgem. A data sharing infrastructure is essential to support data sharing across energy industry to enable accelerated lowest true cost path to net zero. The consultant's recommendations are as follows:

1. **Ofgem to invest in additional data and digitalisation skills and capability.** (start Q4 2023, complete end 2025 – 2 year programme)
2. **Ofgem to set out a vision for data sharing across energy system and to publish a call for input or consultation for developing the data sharing infrastructure (DSI) for energy** (including trust, prepare, share functions) and governance options, (Q1 2024) leading to:
3. **Ofgem to work with DESNZ to set up energy digitalisation body (Energy Digitalisation Orchestrator)** based on evidence from digital spine study and response to forthcoming industry consultation (start Q3 24, set up Q2 27, needs extra funding). Energy Digitalisation Orchestrator is the ideally the energy arm of a national level cross sector Digitalisation Orchestrator. The Energy Digitalisation Orchestrator is responsible for overseeing the development of the DSI to a point when it can hand over operations and maintenance to FSO. Its purpose is to set direction and be accountable for the delivery and adoption of DSI. Orchestrator procures delivery of later phases of DSI.
4. Prior to formal set up of Orchestrator, **Ofgem lead an Energy Data Sharing Infrastructure Task Group** of energy sector representatives (with a secretariat staffed with secondees). (Q1 2024 needs extra funding) Its function is to oversee set up of DSI working with industry. The prospect of the Task Group becoming the Energy Digitalisation Orchestrator strengthens the Task Group's credibility to set direction for the DSI. The Energy Data Sharing Infrastructure Task Group oversee and procure delivery of first phases of DSI.
5. **Ofgem appoint FSO as the authority (energy data sharing infrastructure operator)** to maintain and develop the data sharing infrastructure for the energy sector working closely with the Energy Digitalisation Orchestrator:

a. Prior to FSO taking on this role, Ofgem through Energy Data Sharing Infrastructure Task Group leads in supporting ESO convene engagement across industry in co-creating data sharing infrastructure (start Q1 2024)

b. FSO to convene engagement across industry in co-creating data sharing infrastructure (2024-2028)

c. Ofgem to set obligations for FSO deliver data sharing infrastructure working closely with the Digitalisation Orchestrator by 2028 (start Q1 2024, V1 by Q1 2026, V2 by Q1 2028)

d. Ofgem to set network licence conditions (for all licensees) to enable rapid adoption of data sharing infrastructure. Ofgem should set a soft requirement to comply by 2026 for all licensees (with incentives) and a hard requirement to comply for all licensees by 2028 (with incentives and penalties) for gas and electricity transmission in RIIO GT3 and ET3, for gas distribution in RIIO GD3 and for electricity distribution in RIIO ED3.

i. Mandate 1) participation in Trust Framework (Trust) 2) adoption and use of data standardisation mechanism (Prepare) 3) adoption and use of data sharing mechanism (Share)

ii. Ofgem to incentivise and foster steering groups to cover specific topics as part of wider governance landscape eg Data and Digitalisation Steering Group (DDSG).

e. Ofgem D&D team and FSO set up coordination mechanism for use cases where they request same data – "report it once and count it once" (by 2026) as both have powers to request information

6. **Ofgem to offer incentives eg designate a strategic area of SIF to develop connected digital twins in energy (for all vectors) and connect across energy system using data sharing infrastructure** and/or connect with other sectors eg transport, water, communications, manufacturing, health (round 4 2024).

Implementing these Recommendations

6.2 **Recommendation 1: Ofgem to invest in additional data and digitalisation skills and capability.** In order to be a digital regulator Ofgem must invest further in data and digitalisation skills and capability. This resource can build

upon current foundations by applying Data Best Practice internally, and developing a regime for assessing licensees' progress with DBP which is aligned to regulatory incentives. This entails meaningful measures of digital maturity which assess progress in digitisation and digitalisation. For example, so that licensees know where their assets are and understand the quality of that data and can use it in business planning processes, knowing how reliable it is.

6.3 Investing in data and digitalisation skills and capacity should be front and centre to Ofgem's future approach to regulation. This includes providing additional resources to the data and digitalisation team and it also includes skilling up all staff who work with data across the organisation. As the industry has and must continue to invest in data and digitalisation capability to meet net zero targets, so too must Ofgem.

6.4 In order to attract talent with data and digitalisation skills, Ofgem needs to develop a talent acquisition strategy which could focus on two aspects: 1) the level of Ofgem Director salaries[32] relative to Ofcom Director salaries[33] and investigate how to redress the balance and 2) investing in sending staff on the appropriate training and Masters level courses. **(start Q4 2023, complete end 2025 – 2 year programme)**

6.5 **Recommendation 2: Ofgem to set out vision for data sharing across energy system and to publish a call for input or consultation for developing the data sharing infrastructure (DSI) for energy in Spring 2024.** The consultation should set out for the functions of a data sharing infrastructure including data standardisation mechanism, trust framework and data sharing mechanism and should set out options for governance. **(Q1 2024)**

6.6 **Recommendation 3: Ofgem to work with DESNZ to set up cross sector digitalisation body (Digitalisation Orchestrator) based on evidence from digital spine study and response to forthcoming industry consultation.** (start Q3 2024, set up by Q2 2027 – to allow 3 years for legislative change, needs extra funding). The Energy Digitalisation Orchestrator is responsible for overseeing the development of the DSI to a point when it can hand over

[32] Ofgem Annual Report and Accounts 2021-22
[33] Senior salary disclosure – 2022 (ofcom.org.uk)

operations and maintenance to FSO. Its purpose is to set direction and be accountable for the delivery and adoption of DSI.

6.7 Once operational, the Energy Digitalisation Orchestrator procures delivery of later phases of DSI. The Energy Digitalisation Orchestrator would ideally be the energy arm of a national level cross sector Digitalisation Orchestrator which would oversee the development of data sharing infrastructure blueprints to enable interoperability across all sectors of the economy, based on the approach of the National Digital Twin Programme.

6.8 It is suggested that Ofgem lead the energy sector in pioneering a data sharing infrastructure which is interoperable with other sectors of the economy, given the energy sector's prominence in achieving net zero and the interdependence of other sectors on energy.

6.9 The formal set up of an Energy Digitalisation Orchestrator may require legislative change. It is recommended that this is an important step, even though it takes time, and will give the interim solution set out in recommendation 4 more credence.

6.10 **Recommendation 4: Set up of Energy Data Sharing Infrastructure Task Group led by Ofgem and enabling collaboration with industry.** It is recommended that prior to formal set up of the Energy Digitalisation Orchestrator, Ofgem lead an Energy Data Sharing Infrastructure Task Group of energy sector representatives to oversee the set up of the data sharing infrastructure.

6.11 Following the energy data sharing infrastructure consultation, if there is evidence of sector wide support, Ofgem should lead this Task Group and should be responsible for the funding allocated to developing the energy data sharing infrastructure.

6.12 It is important that funding is allocated both to the development of the data sharing infrastructure to develop the functions of the data standardisation mechanism, trust framework and data sharing mechanism and also to ensuring adoption.

6.13 In this way, Ofgem should designate a Data Sharing Infrastructure Fund (DSIF). Ofgem's role in leading this Task Group is critical in ensuring it's success in setting up the data sharing infrastructure. Ofgem should have both the mandate

and the funding to progress with an energy data sharing infrastructure, without both it will not succeed in making the progress needed.

6.14 Ofgem should provide a small secretariat function of full-time staff dedicated to the set of the data sharing infrastructure. These staff could be seconded from Ofgem, DESNZ and licensees, funded through the DSIF. This Task Group should include representatives from: DESNZ, FSO, network licensees eg drawn from the ENA Data and Digitalisation Steering Group, wider energy sector non-licensed entities and consumer organisations.

6.15 Members of the ENA Data and Digitalisation Steering Group suggested that the Task Group could be supported by data and digitalisation experts on a consultancy basis. It is recommended that options be consulted on during the Data sharing infrastructure consultation.

6.16 This report recommends that the Task Group needs: 1) Funding 2) Mandate 3) Collaboration. The Task Group must set out a culture of working collaboratively across industry from day 1. The prospect of the Task Group becoming the Energy Digitalisation Orchestrator strengthens the Task Group's credibility to set direction for the DSI. The Energy Data Sharing Infrastructure Task Group oversee and procure delivery of first phases of DSI. **(Q1 2024 needs funding)**

Figure 9

Task Groups need mandate, funding and engagement to be effective:

Progress has been slow in setting up a data sharing infrastructure across all sectors because it is a complex sociotechnical mission and no one organisation has had the mandate and funding to do this. In 2017 Data for the public good recommended the development of a data sharing infrastructure (called a Digital Framework for Infrastructure Data) and the set up of a Digital Framework Task Group. But the Digital Framework Task Group made up of a strong set of relevant stakeholders did not have funding or mandate to develop the data sharing infrastructure. Through the Centre for Digital Built Britain supported by BEIS and Innovate UK, the Digital Framework Task Group laid the foundations for the development of data sharing infrastructure through its work for example of the Pathway to an Information Management Framework[34] and resources such as the Digital Twin toolkit[35]. Task Groups are very effective at gaining engagement and input but to have enduring impact they need funding and mandate.

[34] The pathway towards an Information Management Framework - Public Resources - DT Hub Community (digitaltwinhub.co.uk)
[35] About the Digital Twin Toolkit project - DT Hub Community (digitaltwinhub.co.uk)

6.17 Members of the DDSG also highlighted the need for collaboration across industry to drive the data sharing infrastructure forward. ESO has focused on efforts on stakeholder engagement to build support for the Virtual Energy System, which is presented as a form of a data sharing mechanism, but during the course of this study, it was clear that this initiative does not have the full support or awareness of the energy industry.

6.18 Stakeholder engagement is a key requirement to developing a functioning data sharing infrastructure. Ofgem's leadership is crucial in engendering a culture of collaboration across this Task Group. Targeted Stakeholder engagement enables collaboration across those parties. It is vital that the Task Group is a diverse reflection of both the energy industry and consumer needs. It will be important to set out a clear terms of reference and for members to be appointed on the clear understanding of the time commitment involved and for that to be factored into their day job.

6.19 **Recommendation 5: Ofgem to appoint FSO as the authority (Energy data sharing infrastructure operator) to maintain and develop the data sharing infrastructure for the energy sector working closely with the Energy Digitalisation Orchestrator.** Once set up the data sharing infrastructure will need to be maintained and developed as use cases and technology evolve. Consultation with the DDSG confirmed industry support for this role for the FSO. The FSO is expected to be a new organisation in 2024.

6.20 Consultation undertaken during this study suggests that this presents an opportunity to put an obligation regarding the data sharing infrastructure on the FSO, also with regard to the power to request information from licensees. However both internally Ofgem and the industry have suggested that many responsibilities are expected to be delivered by the FSO in its infancy. Given that the FSO will need to be a data-driven organisation, in order to plan and manage the energy system, it will need a data sharing infrastructure and therefore it is appropriate that the FSO should take a leading role in ensuring it's delivery and adoption.

a. Prior to FSO taking on this role, Ofgem through Energy Data Sharing Infrastructure Task Group leads in supporting ESO convene engagement across industry in co-creating data sharing infrastructure (start Q4 2023-

24). The ESO Virtual Energy System team are laying the foundations for a data sharing mechanism blueprint which can either be adopted by industry or replicated. The Energy Data Sharing Infrastructure Task Group need to ensure that this work is taken forward as part of the data sharing mechanism and that best practice emerging at the national level is applied to the energy sector. The Task Group working with ESO need to examine how to build upon the Virtual Energy System and through industry support and expert input turn it into a data sharing mechanism that will work for industry.

b. FSO, once set up, working as part of the Task Group to convene engagement across industry in co-creating data sharing infrastructure (2024-2028)

c. Ofgem to set obligations for FSO to deliver data sharing infrastructure working closely with the Energy Digitalisation Orchestrator by 2028 (start Q1 2024, V1 by Q1 2026, V2 by Q1 2028). It is noted that the data sharing infrastructure will evolve over time as use cases and technology change and therefore there will be evolving versions, V1, V2, V3 etc.

d. Ofgem to set network licence conditions (for all licensees) to enable rapid adoption of data sharing infrastructure. Ofgem should set a soft requirement to comply by 2026 for all licensees (with incentives) and a hard requirement to comply for all licensees by 2028 (with incentives and penalties) for gas and electricity transmission in RIIO GT3 and ET3, for gas distribution in RIIO GD3 and for electricity distribution in RIIO ED3.

  i. Mandate 1) adoption and use of data standardisation mechanism 2) participation in Trust Framework 3) adoption and use of data sharing mechanism.

  ii. Ofgem to incentivise and foster steering groups to cover specific topics as part of wider governance landscape eg DDSG. During the interviews and workshops carried out as part of this study, consultees emphasised the importance of discussion in an open and collaborative manner. Formal discussions between regulator and licensees can neglect important aspects of industry operations. Creating a more informal space, where open conversations can be had to discuss what's working and what's not working well can

enable parties to work towards resolution without fear of repercussions along the way. Building trust amongst parties to share insight on problems is crucial to enabling collaboration.

e. Ofgem and FSO to set up a coordination mechanism for use cases where they request same data – "report it once and count it once" (by 2026) as both have powers to request information. This should be enabled through a data sharing mechanism (eg a regulatory and FSO reporting smart cache) and should be a specific use case in the development of the data sharing mechanism.

6.21 **Recommendation 6: Ofgem to offer incentives eg designate a strategic area of SIF to develop connected digital twins in energy** (for all vectors) and connect across energy system using data sharing infrastructure and/or connect with other sectors eg transport, water, communications, manufacturing and health etc.

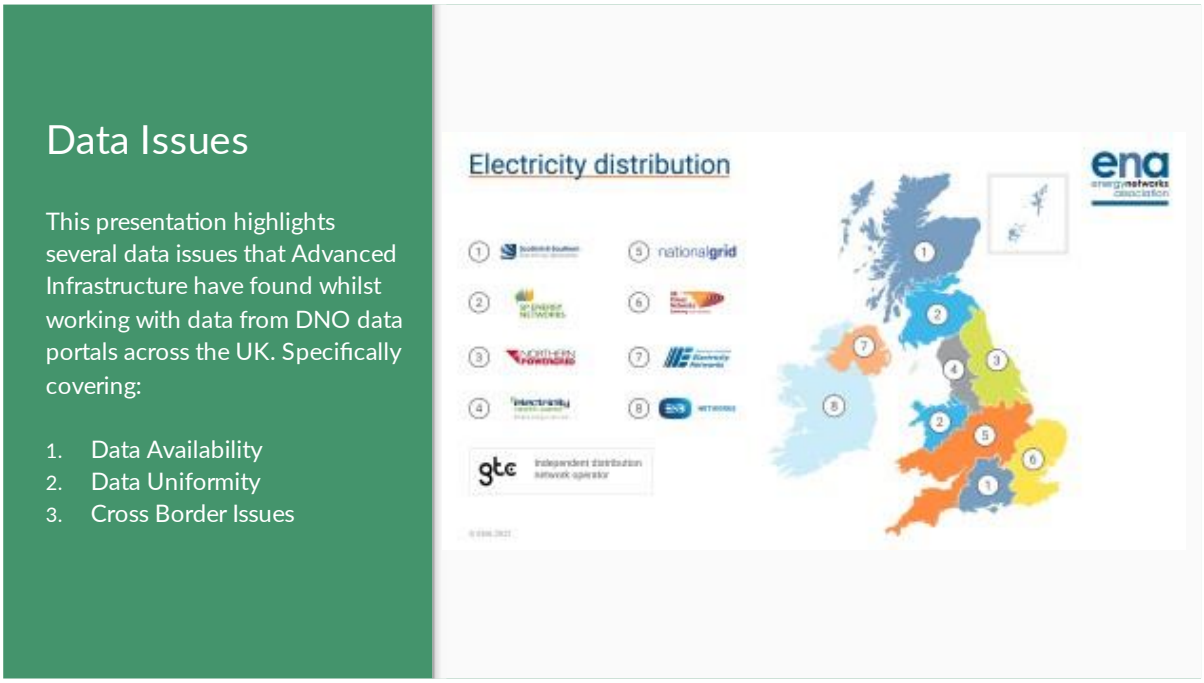
6.22 Inclusion of a data sharing infrastructure testing challenge as part of round 4 of SIF launching in mid-2024 would align well with the development of a data sharing infrastructure over the period 2025-2028, prior to the hard licence obligation in 2028 to adopt the data sharing infrastructure. Networks will need the opportunity to test the emerging data sharing infrastructure to ensure that it is being developed in a user-friendly way and that it is robust.

6.23 Implementing these recommendations as a package will set Ofgem and industry on the road to seamless and secure sharing of data supporting regulatory reporting and an accelerated lowest true cost path to net zero. Engendering a culture of collaboration and change is essential to the net zero mission. The responsibility to deliver rests with all and it is up to Ofgem to lead this collaboration.

Appendix 1 : Evidence

Evidence from Advanced Infrastructure Technology Limited

A1.1 During a meeting held with Advanced Infrastructure Technology Limited, a representative presented examples where data from the DNO is in different formats and means different things. As a result, the data team at Advanced Infrastructure Technology Limited have to spend a considerable amount of time cleaning the data ready for use.



Data Availability

Data that is made available by DNOs in their open data portal is not uniform.

The data that is made available, as well as the dataset names and combinations of how the data is shared is different across DNOs.

Yes (Green) = Data Available
Yes(Purple) = Data newly available
NA -= Data not available

Data Field	WPD/NGED	UKPN	SSEN	ENW	NPG	SPEN
Grid Supply Points: >132kV						
Identification and IDs / Substation Code	Yes	Yes	Yes	Yes	Yes	Yes
Location (Coordinates)	Yes	Yes	Yes	Yes	Yes	Yes
Rated apparent power	Yes	Yes	Yes	Yes	Yes	Yes
Voltage Level above and below	Yes	Yes	Yes	Yes	NA	Yes
Substation connectivity	Yes	Yes	Yes	Yes	Yes	Yes
Connedted generation	Yes	NA	Yes	Yes	Yes	Yes
Switch rating (maximum current)	NA	NA	NA	NA	NA	NA
Loading	Yes	Yes	Yes	Yes	NA	Yes
Extra High Voltage Line						
Line impedance	Yes	Yes	NA	Yes	NA	Yes
Line geometry	Yes	Yes	NA	Yes	NA	Yes
Switch rating (maximum current)	NA	Yes	NA	Yes	NA	NA
Bulk Supply Points: 132kV/33kV						
Identification and IDs / Substation Code	Yes	Yes	Yes	Yes	Yes	Yes
Location (Coordinates)	Yes	Yes	Yes	Yes	Yes	Yes
Rated apparent power	Yes	Yes	Yes	Yes	Yes	NA
Voltage Level above and below	Yes	Yes	Yes	Yes	NA	NA
Substation connectivity	Yes	Yes	Yes	Yes	Yes	Yes
Connected generation	Yes	Yes	Yes	Yes	Yes	Yes
Switch rating (maximum current)	NA	NA	NA	NA	NA	NA
Loading	Yes	Yes	Yes	Yes	Yes	NA
High Voltage Line						
Line impedance	Yes	Yes	NA	Yes	NA	NA
Line geometry	Yes	Yes	NA	Yes	NA	NA
Switch rating (maximum current)	NA	Yes	NA	Yes	NA	NA

Data Availability

These tables provide a survey of some standard datasets, and the coverage of this data across the 6 DNOs covering Great Britain.

The data that is available is slowly becoming more aligned, although there are still significant gaps across the spectrum.

Data Field	WPD/NGED	UKPN	SSEN	ENW	NPG	SPEN
Primary substations: 33kV/11kV						
Identification and IDs / Substation Code	Yes	Yes	Yes	Yes	Yes	Yes
Location (Coordinates)	Yes	Yes	Yes	Yes	Yes	Yes
Rated apparent power	Yes	Yes	Yes	Yes	Yes	Yes
Voltage Level above and below	Yes	Yes	Yes	Yes	NA	Yes
Substation connectivity	Yes	Yes	Yes	Yes	Yes	Yes
Connected generation	Yes	Yes	Yes	Yes	Yes	Yes
Switch rating (maximum current)	NA	NA	NA	NA	NA	NA
Loading	Yes	Yes	Yes	Yes	Yes	Yes
Medium Voltage Line						
Line impedance	Yes	Yes	NA	Yes	NA	Yes
Line geometry	Yes	Yes	NA	Yes	NA	Yes
Switch rating (maximum current)	NA	Yes	Yes	NA	NA	NA
Distribution substations: 11kV/400V						
Identification and IDs / Substation Code	Yes	Yes	Yes	Yes	Yes	NA
Location (Coordinates)	Yes	Yes	Yes	Yes	Yes	NA
Rated apparent power	Yes	Yes	Yes	Yes	Yes	NA
Voltage Level above and below	Yes	Yes	NA	Yes	NA	NA
Embedded & Microgeneration	Yes	Yes	NA	Yes	Yes	NA
Substation connectivity	Yes	Yes	Yes	Yes	NA	NA
Switch rating (maximum current)	NA	NA	NA	NA	NA	NA
Loading	Yes	NA	Yes	Yes	NA	NA
Low Voltage Line						
Line impedance	NA	NA	NA	NA	NA	NA
Line geometry	NA	Yes	NA	NA	NA	NA
Switch rating (maximum current)	NA	NA	NA	Yes	NA	NA
Feeder cables	NA	NA	NA	NA	NA	NA

Data Availability

The data that is presented within the datasets is not uniform, even in two datasets which are given the same name or covering the same topic.

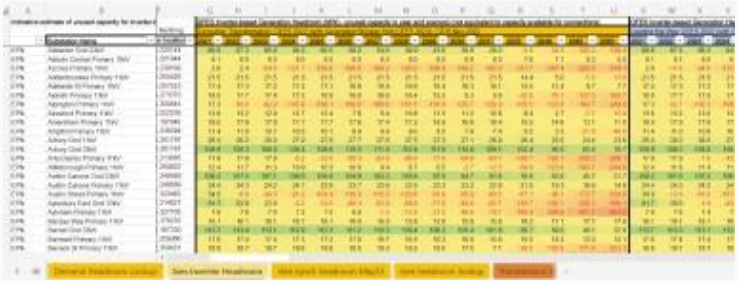
These slides cover the specific example of generation headroom.

For Generation Headroom there is not a common format for presenting the datasets and DNOs are presenting different datasets as well. For example, UKPN presents this datasets in two different categories including:

1. Inverter-based generation units
2. Synchronous generation units

Some DNOs present a less detailed dataset.

The following picture are samples of datasets for UKPN and NPG generation headroom.



Data Availability

The data that is presented within the datasets is not uniform, even in two datasets which are given the same name or covering the same topic.

These slides cover the specific example of generation headroom.

There are also significant differences in the source of the data.

Some DNOs present data based on current information, whilst others only present the headroom of substations for DFES scenarios and make it more difficult to access current data.

The following picture are samples of datasets for UKPN and NPG generation headroom.

Data Uniformity

The datasets that are shared, even when they are covering the same data, are often in different formats and do not align. This makes working across the UK difficult.

Some examples of this are shared in the tables across the next two slides.

This means a huge amount of time must be spent on aligning and cleaning the data.

DNO	Data	Filetype
Electricity North West	1. Primary-BSP with locations 2. BSP-GSP with locations 3. GSP locations	1. Xlsx 2. Xlsx 3. Kml (Google maps)
National Grid Electricity Distribution (Former Western Power Distribution)	1. Primary-BSP with polygons 2. BSP-GSP with polygons 3. GSP polygons	1. .gpkg(ESRI) 2. .gpkg(ESRI) 3. .gpkg(ESRI)
Northern PowerGrid	1. Heatmap 2. Locations	1. xlsx 2. xlsx
Scottish and Southern Electricity Networks	1. Heatmap 2. Availability Map	1. Xlsx 2. xlsx
UK Power Networks	1. LTDS Circuits 2. Locations	1. Xlsx. 2. geojson
SP Energy Networks	1. Connections with location	1. Json file with location

Data Uniformity

This lack of uniformity is true even across datasets that are shared by all DNOs and that should follow a common reporting format, for example the Embedded Capacity Register.

This means a huge amount of time must be spent on aligning and cleaning the data.

SSEN and NPG are share multiple datasets for ECR including:

1. Generation assets are included where the Registered Capacity is greater than or equal to 1MW.
2. Sites providing Demand Side Response (DSR) are included where the contracted capacity is greater than or equal to 1MW.

However, other DNOs share different data, such as assets above and below 1 MW, but without separating Demand Side Response, making cross-DNO formatting difficult.

Data Uniformity

Within data shared by the same DNO, there are still discrepancies that lead to data issues, including alignment of assets across multiple datasets and the identifiers used for these assets.

This means a huge amount of time must be spent on aligning and cleaning the data.

In this example, NPG present two datasets which include substation lists, however, the number of Primary Substations in these two datasets is different:

1. In the Heat map dataset, the total number of Primary Substations for Yorkshire and Northeast regions is 535.
2. In the substations list, the total number of Primary Substations is 780.

Data Uniformity

Within data shared by the same DNO, there are still discrepancies that lead to data issues, including alignment of assets across multiple datasets and the identifiers used for these assets.

This means a huge amount of time must be spent on aligning and cleaning the data.

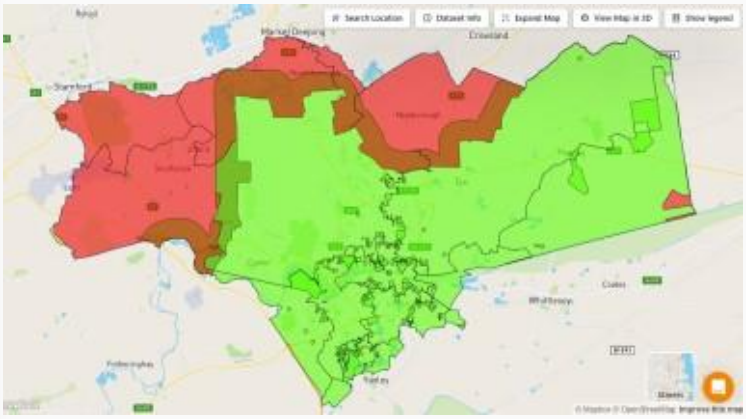
Continued.

DNO Border Issues

These differences in format, datasets and what data is in which dataset makes it very difficult to work on the border of DNO regions.

For example, Peterborough Primary Substations Supply Area border which is included in both WPD and UKPN.

Making this data visible and usable for the end user requires significant cleaning and analysis.



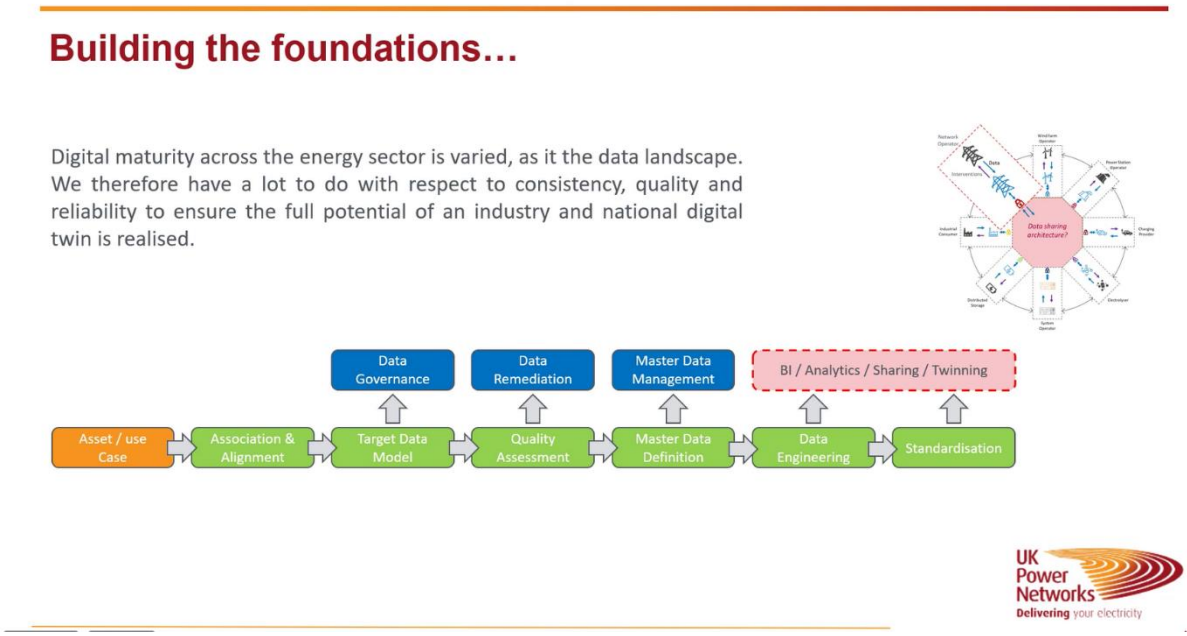
DNO Border Issues

These differences in format, datasets and what data is in which dataset makes it very difficult to work on the border of DNO regions. This is also true when comparing DNO borders to other public border datasets.

For example, these maps show the boundaries of local authorities (black lines) and DNO regions (red lines). These are two very important maps to align, however, the borders are often very skewed.

Evidence from UK Power Networks

A1.2 During the Gemini Call of 18 July 2023, UK Power Networks presented[36] on the foundational work that UK Power Networks is doing to manage its data internally to ensure that it is shareable across the industry and compatible with a National Digital Twin. This presentation makes the point that whilst networks are embarking on their own digital journeys they need to understand how they can make their approach interoperable with the approach of others and it also references the idea of a Master Architect, which could be a function of the Energy Digitalisation Orchestrator.



[36] Matt Webb of UK Power Network presents Building the foundations for digital twins - Slide decks - DT Hub Community (digitaltwinhub.co.uk)

Appendix 2 : Meetings

Meetings held during the study

A2.1 During the course of the study, meetings, interviews and workshops were held consulting the following organisations.

Organisations
Arup and Energy Systems Catapult
National Grid ESO
Zuhlke
UK Power Networks
Working Group 3: representatives from Southern Gas Networks, Arup, IBM, Northern Powergrid, Electricity North West, National Grid Electricity Transmission, Scottish Power Energy Networks, Eco-humantropolis Clean Energy Exchange Ltd, Icebreaker One, National Grid ESO, Cadent, SSEN Transmission, UK Power Networks, Joint Radio Company, National Gas, Ofgem, Energy Systems Catapult, Electralink
Icebreaker One
Department for Transport
Data Sharing Discussion Group
National Digital Twin Programme (NDTP), Department for Business and Trade
Working Group 4: representatives from Southern Gas Networks, Arup, Wales and West Utilities, Northern Powergrid, Electricity North West, National Grid Electricity Transmission, Scottish Power Energy Networks, Northern Gas, Retail Energy Code, National Grid ESO, Cadent, SSEN Transmission, UK Power Networks, BEAMA, National Gas, Ofgem, Energy Systems Catapult, SSEN Distribution
NDTP demonstration session
Working Group 5: representatives from Southern Gas Networks, Arup, Retail Energy Code, IBM, Northern Powergrid, Electricity North West, National Grid Electricity Transmission, SSEN Distribution, Smart DCC, Scottish Power Energy Networks, Northern Gas, Eco-humantropolis Clean Energy Exchange Ltd, Icebreaker One, National Grid ESO, Cadent, SSEN Transmission, UK Power Networks, National Gas, Ofgem, Energy Systems Catapult, Electralink, National Physical Laboratory, Advanced Infrastructure, BEAMA
Advanced Infrastructure Technology Ltd
NDTP and Energy Data sharing workshop 1: representatives from Arup, Energy Systems Catapult, National Grid ESO, Icebreaker One, Honest Data, National Digital Twin Programme Department for Business and Trade, Telicent, Ofgem, DESNZ
Farad AI
Thermos, CSE
ENA Digitalisation and Data Steering Group (DDSG)

Organisations
NDTP and Energy Data sharing workshop 2: representatives from Arup, Energy Systems Catapult, National Grid ESO, Icebreaker One, National Digital Twin Programme Department for Business and Trade, Telicent, Ofgem, DESNZ, UK Power Networks

A2.2 Internal meetings with Ofgem FSNR teams and Data and Digitalisation team held over the period 15 May to 31 August.