The Future of Distributed Flexibility

Call for input

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Making a positive difference
for energy consumers

The Future of Distributed Flexibility

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Team:	Digitalisation and Decentralisation; Energy Systems Management and Security
Email:	flexibility@ofgem.gov.uk

We are calling for input on the future of distributed flexibility and the role of a common digital energy infrastructure to facilitate increased flexibility market liquidity. We would like views from people with an interest in energy markets, energy flexibility and energy system digitalisation. We particularly welcome responses from flexibility service providers, independent market platforms, market operators, financial services companies, technology solutions providers, consumer groups and charities. We would also welcome responses from other stakeholders and the public.

This document outlines the scope, purpose, and questions of the call for input and how you can get involved. Once the Call for Input is closed, we will consider all responses. We want to be transparent in our call for input. We will publish the non-confidential responses we receive alongside a decision on next steps on our website at ofgem.gov.uk/consultations. If you want your response – in whole or in part – to be considered confidential, please tell us in your response and explain why. Please clearly mark the parts of your response that you consider to be confidential, and if possible, put the confidential material in separate appendices to your response.

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Forewords

Akshay Kaul, Interim Executive Director, Infrastructure and Security of Supply, Ofgem

If there is one lesson to be taken from the energy crisis, it is the need to accelerate the shift away from fossil fuels to clean energy. This will help to reduce costs to consumers by breaking the link between electricity and gas prices; it will improve the security of supplies of energy; and of course, it will help to protect consumers from the dangers of unmitigated climate change.

Without reform, the electricity system, markets and grid become an obstacle, not an enabler, to net zero. It is imperative and urgent now that generation and network investment are closely planned and co-ordinated to deliver the investment needed to meet net zero targets for 2035 (a net zero clean power system) and 2050 (a net zero economy) and ensure the system can become truly smart and flexible.

This will be especially critical at distribution level where the transformation will happen on a local basis, with changes to the way people fuel their vehicles and heat their homes happening on a street by street, town by town basis and a growth of local generation of power. The changes needed to the energy system will need to empower consumers and deliver the right outcomes for all.

New innovations will give consumers more control to save money through access to better data and regularly updated prices, allowing them to harness the smart features of modern consumer goods to access cheap abundant renewable electricity when there is more wind or sun, and use their flexibility to change demand when it's still and overcast. This will mean lower bills, reduced strain on the grid, and help enable the transition to net zero.

To get the best out of our energy system, local and national arrangements for network planning need to work together to optimise the system as a whole. Network planning at both levels needs to take full account of the potential for flexibility. And electricity network services on the ground needs to be delivered effectively and consistently whether you're in Greenwich or Glencoe.

We don't have all the answers yet. Work is already underway to establish the Future System Operator. The ESO published the first edition of a holistic network design for the transmission system last summer, focusing on the offshore wind target for 2030. We followed this up with a decision on accelerating strategic transmission investment based on this holistic plan. We also made a decision that the Electricity System Operator should prepare a strategic plan for the electricity transmission system to deliver net zero targets for 2035 and 2050. The consultations and calls for input being launched today begin to put some more essential pieces in place – the regulation of distribution system operation and the evolution of flexibility markets. Work in other areas of system and network regulation such as future price controls, connections policy and network charging will follow, but always with the same foundational mission: how to accelerate the shift to a net zero energy system at the least overall cost to consumers, in line with long-range whole system plans. This task is now vital and urgent. There is not a moment to lose.

Laura Sandys CBE

Non-Executive Director SGN, Highview Power, Ohme & Energy System Catapult

Chair of the UK Government's Energy Digitalisation Taskforce

We are in the foothills of a very exciting, dynamic, and interactive energy system. Moving from a small number of players to 100 million actions and actors on the system; each generating, consuming, storing, and flexing "just in time". This requires a very different approach to how we unlock these distributed assets and create opportunities for actors to participate effectively in markets while ensuring that the interactions of these assets and markets do not destabilise the system itself.

The prerequisite for digitalising our energy system has been clearly established and crucial steps are now being taken with the Digital Spine and Asset Registration platform. This is very good news. However, we must add to these public interest assets with additional open, democratic, digital tools to deliver us the functionality we need in this new energy system.

Everyone now recognises flexibility as a fundamental part of our energy system going forward. With 20-30 GW of flexibility required by 2035, we swiftly need to put in place the common digital energy infrastructure which can unlock this crucial component of the system. How do we create a coherent, open, and national platform to deliver our flexibility requirements at national, local and substation level while ensuring that actions on one part of the system don't cancel out actions undertaken by another player?

I really commend many of the market developments and platforms that have emerged over the last few years from networks and operators to help unlock flexibility. However, as we described in the Digitalisation Taskforce, we are currently creating a tower of Babel where actions and value will be contradictory and potentially unstable for the system.

It is therefore right that Ofgem are developing new approaches to unlock flexibility. Approaches which put stable system coordination and universal access at the heart of proposals. The vision they articulate would interact with the Digital Spine and Asset Register, providing a thin layer of common standards, visibility, and market coordination. It would offer a transparent, true value, and competitive platform for flexibility markets. As with thin and highly contained platforms that exist in other markets, Ofgem's proposals should also stimulate and promote a wide range of new innovative companies and solutions that can develop exciting propositions for customers.

The UK can be at the forefront of developing crucial digital tools that enable flexibility. Just consider the prize – by 2035 the number of EVs will be equivalent to 3 nuclear power stations! Their inherent flexibility can support our transition to Net Zero, but only if we have the right tools in place.

Contents

The Future of Distributed Flexibility 1

Executive Summary 8

Introduction 10

1 The imperative, potential, and challenges of flexibility 14

1.1 Distributed flexibility is not optional 14
1.2 Two simplified scenarios 17
1.3 What are CER services worth? 18
1.4 Distributed flexibility's recent history 21
1.5 The strategic challenges 24
1.6 The emerging market failures 27

2 An approach pivot: The case for change 30

2.1 Ofgem's role 30
2.2 Conclusion: a case for a common digital vision for flexibility 31
2.3 Ongoing innovation and change 36

3 What that future could look like 38

3.1 Archetype 1: Business as usual 38
3.2 Archetype 2: Thin 39
3.3 Archetype 3: Medium 41
3.4 Archetype 4: Thick 43
3.5 Archetypes and core functions 46
3.6 Assessment of archetypes 47

4 Delivery considerations 48

4.1 Delivering a common digital energy infrastructure 48
4.2 A new-build common digital energy infrastructure, or an extension of an existing asset? 52
4.3 The possible role of the Future System Operator 52
4.4 Financing a common digital energy infrastructure 53

5 Conclusion and taking forward the future of distributed flexibility ..54

6 Appendices 55

6.1 Appendix 1: Responding to this call for input 56
6.2 Appendix 2: Privacy notice on call for input 61
6.3 Appendix 3: Glossary 63
6.4 Appendix 4: Call for Input questions 66

Executive Summary

What does the future of distributed flexibility look like? How will we get there? This document is designed to stimulate discussion on these critical questions.

This document begins by asserting the imperative and potential of unlocking distributed flexibility. For a net zero energy system with high renewables penetration and increasing electrification of heat and transport, flexibility is not optional, it is essential. Without flexibility, electric vehicles and heat pumps are added as parasitic loads and all consumers will pay higher costs for additional generation and network infrastructure. Flexibility is hugely valuable: the challenge is how we effectively convey that value to distributed flexibility assets.

Currently, issues around market access and coordination are preventing distributed flexibility from fully offering and receiving their system value. This is especially true for Consumer Energy Resources (CER) like electric vehicles and heat pumps, a key component of distributed flexibility. We need a flex-centric system; to get there, we propose a strategic approach focused on addressing the challenges CER face and unlocking CER flexibility as a route to advancing *all* distributed flexibility.

The document reviews the journey that distributed flexibility has been and is going on in Great Britain. It is not clear that a coherent ecosystem which enables CER flexibility will emerge organically or on a timescale which keeps pace with CER uptake. We believe that the pockets of excellence of distributed flexibility now need to converge, 'joining the dots' to deliver distributed flexibility at scale.

Through engagement with stakeholders, we identified multiple strategic challenges which are collectively preventing distributed flexibility at scale. These strategic challenges are felt everyday by flexibility market participants as symptoms of four key underlying market failures: imperfect information, limited oligopsony market coordination, a structural lack of trust, and market-specific issues.

To mitigate market failures and deliver Ofgem's duty to protect consumers, we propose that a common end vision for distributed flexibility is needed: a common digital energy infrastructure. This would drive certainty and support the delivery of enablers able aiming for a common destination. The common digital energy infrastructure would address three of the market failures by delivering information provision, market coordination of operations and actions, and trust and governance. The fourth market failure, market-specific issues, such as minimum capacity volumes, require specific enabling work not delivered by a common digital energy infrastructure.

The document explores three archetypes for a common digital energy infrastructure alongside a business-as-usual counterfactual, in order to initiate industry discussions and seek views. The three example archetypes are points on a spectrum: a 'thin', 'medium' or 'thick' infrastructure.

The thin archetype is a directory which lists market operators and flexibility providers. The medium archetype is an exchange platform which hosts multiple markets to facilitate and coordinate market participation and operation. The thick archetype is a central platform which contains multiple markets, undertaking every step of their process and co-optimising across them. An initial assessment of the desirability and feasibility of the archetypes is presented.

The document finally outlines preliminary considerations for delivery of a common digital energy infrastructure. We set out initial non-exhaustive thoughts on institutional roles and financing approaches, and give thought to whether a common digital energy infrastructure should be new-build or an extension of existing systems, and whether there is a natural fit with the role of the Future System Operator (FSO).

A supplementary technical annex is also published alongside this document. This includes non-exhaustive information to assist readers structure further analysis.

This Call for Input is deliberately strategic, in order to stimulate discussion across industry and create a call to collective action. We are seeking feedback and a mandate to develop this vision with industry, so we can all deliver the flex-centric energy system we need.

Introduction

Since 2020, energy has been cheaper to produce from renewables than from fossil fuels for the vast majority of the global population.[1] The economic tipping point for green energy has been met and passed; what is needed now are policies to remove structural barriers limiting the further penetration of renewables and low carbon technologies. One of the biggest challenges remaining is making our energy system – and particularly demand – flexible enough to accommodate more renewable electricity.

To meet net zero, our energy system needs to be flexible: a high penetration of renewables naturally means abundant, cheap electricity when the sun shines and the wind blows, and equally, periods of overcast and still weather mean less renewable energy is available. Today, more expensive, and higher carbon (often gas), generation needs to step in.

Consumers must be at the heart of the future energy system. The steady electrification of transport and heating means our demand is going to rise. Even today, despite macro-economic uncertainty, we own increasing numbers of the (electrical) things with user interfaces that people would describe as "their way to get from A to B", "how they heat their home" or "keep their food fresh".

From an energy system perspective, these electric vehicles, heat pumps and modern white goods are consumer energy resources (CER)[2]: smart connected assets capable of delivering a flexible energy system. A flexible system should not change how we use our devices – but it should mean we intelligently use power in different ways at different times and in different locations.

This *flexibility* is the key tool we need to modify electricity demand and generation patterns to accommodate clean electricity. If demand can be flexible, we can make better use of our renewables, accommodate more of their output, and (by reducing – and eventually eliminating - our reliance on gas on still days) help secure our energy supplies.

CER could be invaluable for the energy system: offering distributed flexibility to balance energy demand and generation and helping keep energy affordable. Through a robust framework for sharing informed consent about asset control, individuals and businesses

[1] Based on new build generation, covering two thirds of the global population. Scale-up of Solar and Wind Puts Existing Coal, Gas at Risk (2020); BloombergNEF; https://about.bnef.com/blog/scale-up-of-solar-and-wind-puts-existing-coal-gas-at-risk//. Wider analysis of global energy transition available from RMI: The Energy Transition Narrative - RMI

[2] The behaviour of a very large number of individually tiny assets owned by consumers is just one of several types of energy system flexibility. All are needed.

could use their CER to be paid for the flexibility they provide, and to keep their bills down. Inversely, if 'parasitic' and not engaged in being flexible, CER will exacerbate demand and generation uncertainty, introduce new kinds of grid integration challenges (such as power quality issues), and require us to collectively pay for early and potentially unnecessary network reinforcement and generation capacity overbuild.

The key question is how consumers (and specifically the companies that aggregate their assets) know where and when it is a "good" or "bad" location or time to use electricity. Energy markets are the best indicator of what distributed assets (including CER) should be doing where and when. We need to remove barriers to entry, ensuring that all distributed assets can access these markets and are aware of the value-streams available.

We can identify that energy markets have a very localised issues and that market outcomes must be coherent. For example, an EV charge point in the Midlands might be behind a distribution network constraint while another in Wales is not. If the charge points only follow the outcome of one market (i.e., that there is lots of renewable electricity coming in from the North Sea), then both the chargers in the Midlands and Wales would start charging. One's behaviour would be welcome. The other would be problematic. Geographically and temporally specific markets therefore must be deconflicted, ideally by a neutral third party.

These are not new ideas. Distributed flexibility has been a key industry focus for years. Since 2016, specific attention has been given to creating market mechanisms to support distributed flexibility, and we have learnt a lot. Many working groups, innovation projects and pilots have sought to test and trial specific parts of a smart and flexible energy system. As a result, GB is considered one of the leading nations in enabling flexibility. However, we know we have a long way to go.

Ofgem has seen CER participation in energy markets struggle, with challenges around market access and coordination. High transaction costs, barriers to market entry, the limited value of individual services, limited access to information, and a lack of coordination persist. Whilst pockets of excellence exist, with hugely valuable knowledge and experience, we still hear comments such as "[flexibility markets] *couldn't have been designed to be more difficult; it's horrendous"* (senior executive at an aggregator). At the same time, we're starting to see the pace of CER uptake – like EV sales – outstrip the energy system's ability to accommodate them.

We believe one of the reasons distributed flexibility markets have struggled is because we have attempted to integrate CER into legacy market designs, appending new requirements and services. We propose that what we need instead is a deliberate,

flexibility-centric energy industry. We need energy markets and their infrastructure to become smart and digitalised, just like the CER that can provide distributed flexibility.

Ofgem have a role to protect all consumers. This is a case in point. We could continue our current trajectory, creating discrete projects, enablers and pockets of excellence and hope they eventually coalesce into a coordinated, well-designed energy system sufficiently quickly that we meet net zero, and don't incur all the costs of parasitic CER.

Alternately, we could take a different approach. We believe that for CER to be helpful energy system assets, we need a coherent, ambitious, and practical vision for distributed flexibility to participate across many different energy markets. When agreed, we can accelerate projects, enablers, and knowledge around that vision.

The focus of this paper is therefore how we get from pockets of excellence to a system-wide distributed flexibility transformation.

We need to 'join the dots' across the many markets in which CER could add value, from managing the balance of supply and demand of electricity, to supporting local energy grids, to helping operate the energy system.

In addition to reflecting on existing distributed flexibility market enablers, we need to learn from other 'many-to-many' marketplaces and reflect on what our industry might be missing. We are no longer convinced that *just* ensuring the enablers would deliver distributed flexibility at scale. As such, in this paper we present a case for a common digital energy infrastructure able to unlock flexibility in multiple markets by facilitating information provision, market access and coordination, and effective trust and governance structures. We aim to ensure that any common solution promotes, not restricts competition, that it unlocks innovation and makes market entry simpler and with less friction and cost.

This call for input marks the start of a change in policy approach for distributed flexibility. The document takes a different approach to many, in that it aims to look at the issue first and open up broad discussion, rather than dividing the issue up based on who may eventually solve it. The document offers a strategic analysis of the current position and a bold vision of what the future could look like. To begin the conversation on a strategic reorientation, it deliberately presents overarching analysis and arguments, setting direction and tone. It does not prematurely delve into detailed examinations of technology types or implementation schedules but, rest assured, these important areas will be discussed at the appropriate time.

The overarching analysis presented is built on several months of extensive industry engagement and qualitative and quantitative analysis. This exploratory work covered many areas in more detail than we will present in this document. The purpose of this call

for input is to initiate discussion, seek feedback and return a mandate to develop the details of this work with industry.

The document first reflects on the imperative for distributed flexibility and takes a critical-realist review of the strengths and weaknesses of distributed flexibility today. It sets out our case for change to enable distributed flexibility at scale, and the requirement for a common digital energy infrastructure. It then offers three archetypes that would fulfil our future vision, compared against a business-as-usual archetype. We conclude with early considerations on delivery.

The document requires your feedback and engagement. We need your views, insight, and support to accelerate distributed flexibility.

If you are not familiar with Ofgem calls for input and associated concepts, more details on how to engage are given in Appendix 1.

1 The imperative, potential, and challenges of flexibility

Section summary

To reach net zero, distributed flexibility is not optional. This section will explore the value of this service and the opportunity cost (i.e., the consequence of distributed flexibility not working).

We will then briefly explain distributed flexibility's recent history and reflect on the structural (strategic) and experiential (tactical) challenges limiting distributed flexibility at scale today. Please note that this work focuses on the long-term trajectory and major obstacles, rather than granular challenges.

We hypothesise that if allowed to continue the current trajectory, distributed flexibility at scale will be stymied by market failures.

We conclude that we need to dramatically accelerate the delivery of distributed flexibility to meet our ambitious net zero goals.

This section will set the reader up to identify the overarching need for a coherent, proactive policy around a common digital energy infrastructure to underpin and enable distributed flexibility.

Questions:

1. ***What do you think distributed flexibility could contribute to the energy system?***
2. ***Will a focus on CER flexibility also help enable other forms of flexibility, especially distributed flexibility?***

1.1 Distributed flexibility is not optional

The UK is rightly proud of its ambition to meet net zero. In 2019, the UK became the first major economy to pass laws that we will meet net zero by 2050.[3] This global leadership was met with acclaim and gave clear direction on our climate ambitions.

[3] Climate Change Act 2008; UK GOV; Climate Change Act 2008 (legislation.gov.uk)

To meet net zero, we need to continue to increase the penetration of variable renewables in our energy mix. Variable renewables, by their nature, produce cheap and abundant energy when and where the wind blows and the sun shines; but when the wind isn't blowing and the sun isn't shining, they don't.

At the same time, the electrification of heat, transport, and other energy-intensive consumer goods create increasingly variable demand patterns. Variable generation and demand patterns are a challenge for energy networks and systems built for predictable behaviour and volumes of energy being transported.

Flexibility then, is needed to account for high variable renewable penetrations and electrification of demand; put very simply, flexibility is the ability to shift in time or location the consumption or generation of energy, to meet system and network physical requirements. The more demand can be varied in time or location, the more variable renewable energy our system can successfully accommodate without additional network, generation, or storage assets.[4]

Flexibility could deliver savings of £3.2-4.7bn/year by 2030 (c.f. thermal generation): 25-60% through reduced low carbon generation investment; 25-40% through cheaper reserve services; and 10-20% through reduced distribution network reinforcement[5]; and up to £10bn/year in system cost reduction in 2050.[6] Modelling by the Carbon Trust and Imperial College London showed that deploying demand side flexibility, could save around £5bn per annum in 2050.[7]

[4] As new energy system assets come online and power system requirements evolve, so too should our definition of Flexibility. At its most essential, Flexibility can be defined as the ability for a smart, grid-connected asset to modulate its operation in response to an external signal. The external signal reflects the needs of a particular energy system actor or market and defines the specific flexibility service that is being sought. There are a wide range of existing and theoretical flexibility services that could be provided by CER and DERs, as seen in table 1. All of these should be considered as potential uses for flexibility going forward.

[5] Roadmap For Flexibility Services to 2030; Poyry and Imperial College London; ROADMAP FOR FLEXIBILITY SERVICES TO 2030 (theccc.org.uk)

[6] 2012 prices; Smart Systems and Flexibility Plan 2021, Electricity System Flexibility Modelling Annex; UK GOV; Smart systems and flexibility plan 2021: Appendix I - Electricity system flexibility modelling (publishing.service.gov.uk)

[7] Page 106 of Flexibility in Great Britain 2021; Carbon Trust and Imperial College London; Key findings - Flexibility in Great Britain - The Carbon Trust

Focusing on CER first, in order to unlock all distributed flexibility (including DERs)

Distributed flexibility comes from both CER and DER:

- CER are (residential) consumer-owned assets, and their primary purpose is to provide a non-energy system service e.g., heating a home or transportation; but they can also control their operation to provide energy system services. They are generally smaller in kW/kWh size and connected to the LV distribution network at the consumer premises. CERs can include generation, storage and demand assets, with the most common examples being EV charging (including V2G), heat pumps, HVAC, white goods, small-scale batteries and rooftop solar or wind.[8]
- DER are business owned assets, and their primary purpose can be to provide energy system services or to provide business services. They are generally larger in kW/kWh and can be connected at any voltage level on the distribution network. DERs can be generation, storage and demand assets, examples include medium sized solar farms, wind farms or batteries, commercial EV fleet charging, and industrial and commercial demand-side response from equipment or buildings.

To unlock the benefits of all distributed flexibility, this call for input focuses first on CER; knowing that by proxy this also advances DER participation.

CER must be aggregated to provide flexibility with meaningful impact. This aggregation necessitates that operation will be both data rich and probabilistic in nature. Conversely, DER are larger, may offer direct control, and are likely more able to enter markets and provide value in the near term, either because they were built as commercial energy assets, or because they have greater price elasticity than consumers.

Tackling the CER-specific flexibility challenges has the immediate consequence of resolving DER-specific challenges simultaneously. Conversely, addressing only the DER-specific challenges would leave significant CER flexibility excluded.

Although CERs are not purchased for energy system purposes, they are 'energy smart', in that they are capable of communicating with external parties and controlling their own operation.[9,10] There will be many CER in the GB system: The Climate Change Committee

[8] The term CER uses a consumer and flex-centric view to define energy system assets; Death to DER?; Energy Consumers Australia; Death to DER? Why we need to change the language we use for the energy transition (energyconsumersaustralia.com.au)
[9] Energy Smart Appliances Programme; BSI; Energy smart appliance programme - a flexible and low CO2 energy system | BSI (bsigroup.com)
[10] The Electric Vehicles (Smart Charge Points) Regulations 2021; UK GOV; The Electric Vehicles (Smart Charge Points) Regulations 2021 (legislation.gov.uk)

predict 5.6m EVs on the road in 2025, 15.9m in 2030, and 27.6m in 2035; the figures for total new heat pumps fitted in buildings over the same period are 1m, 5.3m, and 11.6m.[11]

CER may not be like a traditional generator or DER, but this should not be a barrier to their engagement. They may be geographically dispersed (in line with population) and heterogenous (in terms of asset type and specification). CER bids will be nuanced in terms of their ability to perform certain energy system services based on asset locations, technical specifications or with certain pre-conditions attached (such as a state of charge, or number of permitted discharge cycles). However, there are companies able to successfully aggregate fleets and optimise consumer outcomes today.[12]

Engaging effectively with CER, their owners and aggregators represents a significant technical – and critically cultural – change to the energy system architecture. Distributed flexibility ensures efforts to balance our national grid that are overtly consumer-focused, directly creating an energy efficient and energy conscious culture for consumers and transferring value to participants of all sizes.

1.2 Two simplified scenarios

CER *could* be new 'parasitic' energy system loads, creating a need for additional generation assets and additional low voltage network to support their requirements; these increases system costs which consumers ultimately pay. Consumers with CER would benefit from their services while consumers without CER would both not benefit from the asset *and* still bear a share of this additional cost (a cross subsidy).

Or, instead of being parasitic load, CER *could* be valuable energy system assets, capable of providing distributed flexibility to optimise our country's energy security in a future with high volumes of variable renewables. CER owners would be remunerated for the services their assets provide, and the consequential savings would be enjoyed by all consumers.

Arguably, at present there are relatively few CER that are capable of services and contracted into energy markets. However, when there are 20+ million CER in the system, their collective performance will be extremely significant. We cannot wait until

[11] 2022 Progress Report to Parliament; CCC; 2022 Progress Report to Parliament - Climate Change Committee (theccc.org.uk)
[12] Optimise Prime; UKPN; UK Power Networks Innovation - Optimise Prime

that time to create and implement the infrastructure that will allow us to harness their potential.

1.3 What are CER services worth?

CER have many of requisite technology characteristics to make them capable of participating in a wide variety of energy market services. However, they are not currently doing so.

The value of distributed flexibility is always relative to the alternatives. If considering the distant future (planning timeframes), there are numerous counterfactual options which offer good value, such as building out additional network or generation, for example. The value of flexibility is commensurately low.

In the medium term (scheduling timeframes) the number of alternative options falls, and the value of distributed flexibility rises. As we get closer to real time (operational timeframes), the alternatives to distributed flexibility fall away and the relative value of distributed flexibility increases dramatically. CER flexibility, therefore, should dramatically increase short-term market liquidity.

Different energy markets procure different specific short-term products and services, each with alternatives. At the highest level, these are energy balancing (shifting load over time), alleviating network congestion (shifting load locations and/or time) and system operability (providing technical support services). CER have the characteristics to do all these things.

Alternatives to flex over time

Time

	Planning **timescales** *(Services which are alternatives to procuring flexibility)*	Availability **timescales** *(Flexibility services provided ahead of operations)*	Operations **timescales** *(Flexibility services provided close to real-time)*	
			Pre- t=0	Post- t=0
Energy balancing	**Contracts for Difference** • *Generators enter long-term contracts with Government and get paid a flat (indexed) rate*	**Capacity Market** • *Government procures pre-agreed flexibility, years in advance, to respond to system stress events* **Wholesale day-ahead/intra-day** • *Wholesale trading of generated electricity, day-ahead or intra-day* **Time of use tariffs** • *Supplier driven variable tariffs used for half-hourly settlement* **Local P2P** • *Trials only, enables producers and consumers to trade electricity directly* **Tx Locational marginal pricing** • *Possible modification of wholesale trading, with price dependent on location*	**Balancing mechanism** • *System operator procures flexibility close-to-real-time to manage energy imbalance (can also support constraint management)* **Tx frequency services** Dynamic Moderation • *System operator accesses flexibility to slowly correct small frequency deviations* Dynamic Regulation • *System operator access flexibility to provide rapid response to frequency deviations* Reserve services • *System operator accesses flexibility to manage energy imbalance at various timescales*	**Tx frequency services** Dynamic Containment • *System operator accesses flexibility post-fault to bring system back into balance* Reserve services • *System operator accesses flexibility to manage energy imbalance at various timescales*
Network constraints	**Dx flexible connections/active network management** • *Customer connections where curtailment is part of the terms of connection* **Dx reinforcement deferral** • *Conventional reinforcement where flexibility is non-economic solution*	**Local P2P**[13] • *Trials only, enables producers and consumers to trade capacity directly* **DNO flexibility products** Sustain • *System operator procures pre-agreed flexibility to prevent the network going beyond its firm capacity*	**Tx thermal services** Constraint Management Pathfinders • *System operator accessing flexibility to resolve constraints and reduce balancing costs*	**DNO flexibility products** Dynamic • *System operator accesses flexibility following network abnormality* Restore • *System operator accesses flexibility to support increased load restoration*

[13] Peer to Peer flexibility trades; Scottish and Southern Electricity Networks; Peer to Peer capacity trades | SSEN Transition (ssen-transition.com)

	Dx smart network assets • *Upgraded physical infrastructure using new solid-state technology*	Secure (scheduled) • *System operator procures the ability to access pre-agreed flexibility based on real-time conditions* **Tx Locational marginal pricing** • *Possible modification of wholesale trading, with price dependent on location*	**Tx Demand Flexibility Service** • *System operator reducing peak demand via supplier/aggregator procured flexibility (can also support energy balancing)* **DNO flexibility products** Secure (dispatched) • *System operator accesses pre-agreed flexibility based on real-time conditions*	
Operability services **(power quality, voltage, stability etc.)**	**Grid Code** • *Mandated capability features for connections to assist system stability*		**Tx/Dx voltage services** Tx – Voltage Pathfinders Dx – Trials only i.e. Q-Flex[14] • *System operator accesses flexibility to regulate network voltages* **Tx/Dx stability services** Tx – Stability Pathfinders Dx – Trials only i.e., RaaS • *System operator access flexibility to mitigate short-circuit levels and inertia*	**Tx/Dx restoration services** Tx – Distributed Restart Dx – Trials only i.e. RaaS [15] • *System operator accesses flexibility to restore power following a black-out* ***Future Dx power quality services*** • *System operator procures flexibility to tackle grid losses and improve supply quality*

Table 1: The range of local and system-wide (frequency) services distributed flexibility could theoretically provide over timescales from planning to real-time, for both transmission (Tx) and distribution (Dx) networks.[16,17]

[14] Q-Flex; Electricity Networks Association; Q-Flex | ENA Innovation Portal (energynetworks.org)
[15] Resilience as a Service; Electricity Networks Association; Resilience as a Service | ENA Innovation Portal (energynetworks.org)
[16] The two opposing wedges at the top of the table indicate that as you move closer to real time alternatives to flexibility, such as building generation or reinforcing the network, become less and less available. Correspondingly, as the alternatives fall away, the value of flexibility increases as you move closer to real time. Note: Table is not exhaustive and specific services are dependent on asset technical capabilities.
[17] Additionally, non-financial signals such as a sufficiently granular carbon intensity signal could also be used to provide a flexibility service.

To ensure consumer choice, CER should be able to choose to participate in both individual and stacked markets relative to consumers' risk appetites.[18] The consumers or their commercial representatives (i.e. aggregators) should be aware of the values, options and liabilities and help their customers make proactive choices.

For consumers and aggregators to choose, all markets must be open and information symmetrically available. Certain specific markets are open to CER today. A few markets are even stacked or coordinated. However, there is no current ambition nor institutional mandate to bring markets together and open them systematically to the participation of CER. Both consumers and their commercial representatives suffer from this lack of information provision, market coordination of operations and access, trust, and governance.

Logically, any attempt at coordination also needs to accommodate changing future system operation requirements, market designs[19] and changing or new product specifications.

1.4 Distributed flexibility's recent history

The distributed flexibility industry has only emerged in the last 10 years with the emergence of smart CER devices alongside increasing renewables penetration.

Progress can be tracked using the design thinking methodology show in Figure 1.

[18] Market "stacking" is the practice of optimising the overall revenue stream by entering multiple markets to access multiple revenue streams, where market rules permit this activity. In some cases that will involve stacking in the same time period by providing multiple services simultaneously; in other cases, it will be based on moving between revenue streams in different time periods to take advantage of opportunities at different times of day.
[19] Such as the Review of Energy Market Arrangements (REMA): Review of electricity market arrangements - GOV.UK (www.gov.uk) and the Demand Flexibility Service (DFS): Demand Flexibility Service | National Grid ESO

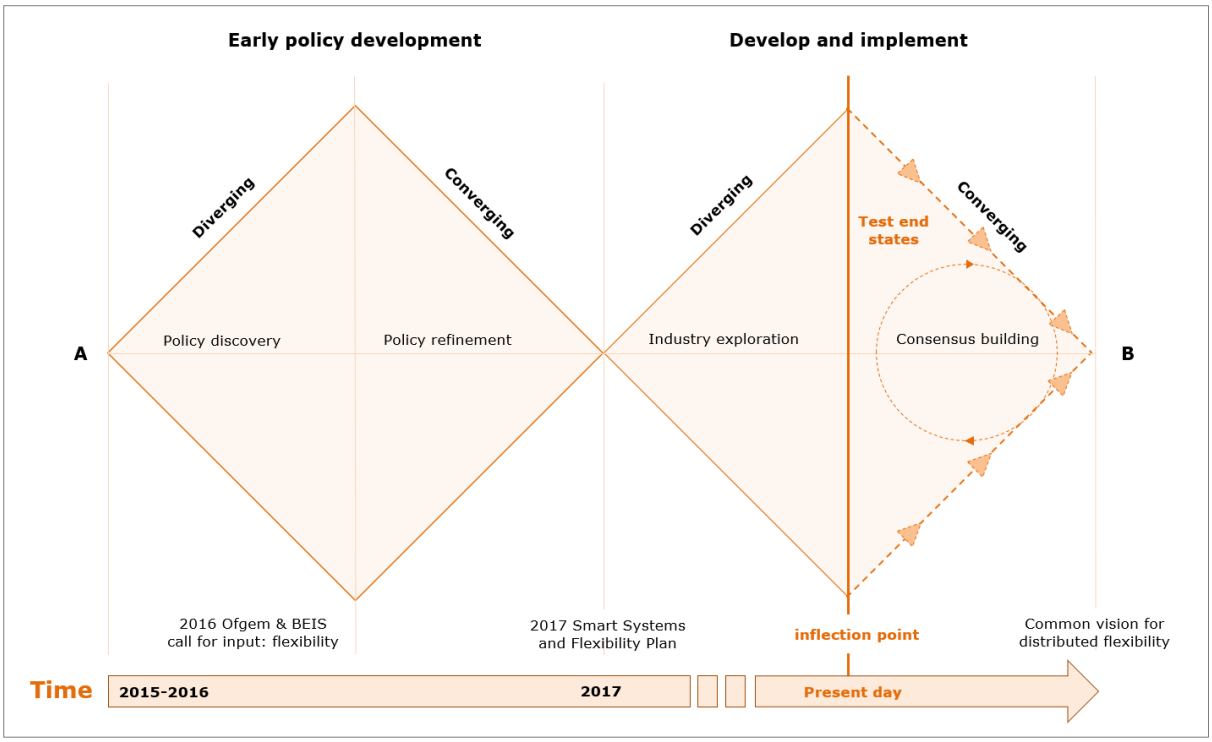


Figure 1. 'Design thinking double diamond' timeline of flexibility policy and industry delivery since 2015.[20]

In 2015, Ofgem and BEIS established the need for a policy on flexibility (around Point A). Early policy questions were outlined in the 2016 Call for Evidence on flexibility,[21] resulting in vast **divergent** input and ideas across industry. Ofgem and BEIS took a deliberately **convergent** decision to seek ongoing industry development, with the seminal Upgrading our Energy Systems: Smart Systems and Flexibility Plan[22] outlining role and responsibilities for industry, government and the regulator (the touch point of the two diamonds).

From 2017, the intent was to move to industry delivery at scale. A period of **divergent** delivery was established, with multiple new working groups initiated, as exemplified by

[20] The design thinking double diamond is inspired by Dan Nessler's blog on design thinking, which references the Design Council's Double Diamond; How to apply a design thinking, HCD, UX or any creative process from scratch; Dan Nessler; How to apply a design thinking, HCD, UX or any creative process from scratch — Revised & New Version | by Dan Nessler | UX Collective (uxdesign.cc)
[21] Published in 2016; Smart, Flexible Energy System – a call for evidence; UK GOV; Smart, Flexible Energy System - a call for evidence | Ofgem
[22] Published in 2017; Upgrading our Energy System – smart systems and flexibility plan; UK GOV; Upgrading our Energy System – smart systems and flexibility plan | Ofgem

the ENA's Open Networks project (2017-present).[23] In 2021, an update to the Smart Systems and Flexibility Plan was published,[24] providing information on the current trajectory and affirming the need for delivery at pace.

Significant innovation budgets were created and delivered, resulting in a robust range of projects and a burgeoning flexibility knowledge economy. Ofgem alone has directly supported over 60 projects at a total spend of greater than £171m on innovation projects related to flexibility,[25] with projected benefits cases in the multi-billions. Considering innovation activities to date, there is now saturation in many areas, the opportunities to make further progress are now in improving coordination across markets and joining together existing innovations (driving for Point B).

We are now in the enviable position of enormous accumulated knowledge and an engaged industry.[26,27] However, we recognise a near saturation of projects, challenges of knowledge dissemination and pickup beyond project initiators, resulting in limited conversion of innovation to business as usual. Arguably, as an industry we are now knowledge rich but implementation poor. Critically this conversion rate is being outstripped by the pace of CER deployment.[28]

Some progress has been made through working groups, and GB is recognised as world leading on flexibility.[29] Our DNOs, for example, have created new standardised procurement processes for flexibility services.[30] However, this has taken over five years to reach, with regular and enduring feedback from industry,[31] government and Ofgem[32] that there remain significant issues around the pace of delivery; the often limited DNO-ESO coordination; high friction in market entry, burdensome processes, and lack of user-

[23] Published in 2022; Five Years ON; Open Networks; Open Networks: Five Years ON – Energy Networks Association (ENA)
[24] Transitioning to a net zero energy system: smart systems and flexibility plan 2021; Transitioning to a net zero energy system: smart systems and flexibility plan 2021 - GOV.UK (www.gov.uk)
[25] Estimate of ESO and DNO innovation funding spend since 2012, using ENA portal key word search for flexibility and manually filtering.
[26] The Strategic innovation fund (SIF) highlights the knowledge from innovation to date: Consultation on SIF Governance Document | Ofgem
[27] Smarter Networks Portal; ENA; ENA Innovation Portal (energynetworks.org)
[28] 2022 Progress Report to Parliament; CCC; 2022 Progress Report to Parliament - Climate Change Committee (theccc.org.uk)
[29] 2022 Market Monitor for Demand Side Flexibility; LCP Delta 2022 Market Monitor for Demand Side Flexibility - LCP Delta (delta-ee.com)
[30] DNOs have developed approaches to tendering and selecting flex service providers. These are procurement processes and should not be confused with markets.
[31] 2022 Flexibility Consultation Wrapper Document; Open Networks; ON22-PRJ-2022 Flexibility Consultation Wrapper Document (energynetworks.org)
[32] 2019; Open letter to the ENA Open Networks project; Ofgem/BEIS; Open letter to the ENA Open Networks project from Ofgem and BEIS | Ofgem

centric design. Unfortunately, we are now seeing some Flexibility Service Providers exit from DNO-led flexibility markets based on these challenges.

Integration challenges were echoed in the late 2022 publications of consultation documents by NGED[33] and UKPN[34] which independently sought input on the changes needed to improve access to DNO flexibility markets and coordinate with ESO markets. Whilst both documents outlined similar priorities for development and industry pain points, they differ considerably in their proposed approach. There is not currently a clear process to reconcile these differences, integrate with other key actors, and actually deliver the increased flexibility market liquidity that is sought.

We now reaching an **inflection point** where we need pull together and **converge** our vast accumulated knowledge on flexibility and focus on ensuring we join up markets to reach a coordinated end-state. To deliver for consumer, we must now ensure CER are useful system contributors. We recognise that the pace of change needs to increase. We believe industry needs to coalesce around a common vision for the future to accelerate and reinvigorate distributed flexibility.

To build confidence, we must be clear eyed about the strategic barriers we currently face and the market failures these engender.

1.5 The strategic challenges

In direct engagements with Ofgem, stakeholders have raised their observations and critical challenges across industry for the delivery of distributed flexibility at scale, including the need for incumbents to embrace change. We have analysed these observations and summarised the overarching strategic level challenges which are collectively restricting the potential of distributed flexibility. More granular challenges such as operational metering and baselining, amongst others, are covered under market failures below.

Across these challenges, coordination often comes up as an issue. Where coordination is required and suggested, we specifically highlight that this must be in accordance with competition law and must not result in anti-competitive behaviour. Moreover,

[33] Evolution of Distribution Flexibility Services; National Grid Electricity Distribution; A4 simple report 1-col no divider Nov 2019 (nationalgrid.co.uk)
[34] Consultation: A step change in local flexibility; UK Power Networks; Consultation-A-step-change-in-local-flexibility-Final-1.pdf (ukpowernetworks.co.uk)

coordination should enable greater liquidity and competition across markets and participants.

1. A lack of common infrastructure, governance, and trust

Current buyers of distributed flexibility are oligopsonies,[35] with limited incentive to coordinate market design with other buyers if their market works for them, nor create user-centric experiences for sellers.

2. Each buyer to their own

Buyers have generally sought exclusivity over resources (as evidenced by contractual prohibition of generators behind distribution constraint managed zones participating in National Grid ESO managed markets), irrespective of the best outcome for either the consumer or the system. If the markets are not coordinated or at a minimum, linked, it is impossible for Buyer A to see what Buyer B has contracted and vice versa. (We are aware this begets a broader policy and regulatory question about our industry and the nature of how institutions share information).

3. No buyer incentive in coordination

There is little clear direction nor consistent incentive for buyer to coordinate multiple markets. A plausible incentive of greater market liquidity through coordination is overridden by structural incentives and design to maximise certainty in existing siloed markets at the expense of common markets. This effectively functions as a tragedy of the commons for market coordination. As a result, all parties seek flexibility, yet none fulfil a central role. Ofgem's parallel Consultation on the Future of Local Energy Institutions and Governance also explores this critical function.[36]

4. Skills and competencies

We are all a product of our histories. DNOs are good at building, operating, and maintaining network assets. This has long been their business model. Developing dynamic new markets that engage millions of CER is not a DNO core competency. Ofgem's parallel Consultation on the Future of Local Energy Institutions and Governance proposes changes to market coordination.[37] National Grid ESO, similarly, is accustomed

[35] An oligopsonistic market is a market in which a small number of dominant buyers hold a majority of the market share.
[36] Future of Local Energy Institutions and Governance, Ofgem Consultation (1st March 2023)
[37] Ibid.

to markets for larger assets and has struggled to incorporate and transfer risk to numerous small assets at scale.

5. Too big, too hard, too risky

Our industry operates a risk-based paradigm, as is appropriate for the provision of a critical good. No one buy-side party has the appetite nor mechanism to cover the risk of a change of approach. Equally no sell-side actor can cover the traditional liabilities born of this paradigm. This warrants a public interest discussion. Further, system and network operators often prefer to build or contract their own organisation's specific tools and technologies, rather than rely on others. This is borne out in approaches to innovation and a lack of willingness to share common digital infrastructure.

6. Perspective

Network and system operators have a centralised mindset.[38] Flexibility is all too often regarded as an 'add-on' to the existing system; able to periodically provide a helpful service, but not something to design *for*.[39]

7. Legacy industry and stakeholder community

The nature of an asset-based legacy industry means that it experiences socio-cultural, as well as technical, resistance to change. Flexibility brings together previously isolated sectors (such as DER, original equipment manufacturers, software companies, networks), to create complex interdependencies in service provision. Socio-cultural hurdles include the need to re-establish a common language and modern toolset. Further, knowledge from wider industries should be embraced to learn from relevant experience, for example in telecommunications and finance.

8. Investment certainty

Expert commentators have highlighted their inhibitions on investing in digitalisation and distributed flexibility as it is perceived as being overdue for a clear vision on where it is going, and when.

9. CER financing

Today, purchasing CER generally requires substantial up-front capital or good credit ratings. This generally results only affluent consumers being able to purchase CER and

[38] Report highlighted a centralised mindset as a critical barrier; Enabling Decentralised Energy Innovation; Sustainable Energy Futures; Research | Sustainable Energy Futures
[39] Report p 61 highlights the evolving nature of consumer complaints as EVs integrate with energy system; Charging the Future: Drivers for Success 2035; EV Energy Taskforce; EV Energy Taskforce: Drivers for Success 2035 | Reports | Electric Vehicle Energy Taskforce

benefit from their flexibility revenues. It also means that only those affluent consumers can benefit from the value of flexibility, and those without smart CER are unable to receive the value of flexibility. The UK financial services industry's expertise could be brought to bear on securitising CER and lowering financing costs, based on historic asset performance and potential flexibility revenues. With the right enabling environment and provision of market data, financial innovation could develop new securitised asset classes to improve access to CER financing for more consumers.

1.6 The emerging market failures

The overarching strategic challenges outlined above are felt by stakeholders everyday as individual pain points in the flexibility journey. Here we present these more granular pain points as symptoms resulting from what we identify as four underlying market failures.

Market failure 1: imperfect information and information asymmetries

Inefficient decision-making stems from an inability to see the whole picture. Trust is further eroded when that picture cannot be described. Value is being lost for both individual organisations and the overall system. This is seen in pain points caused by lack of information:

- Buyers do not have sufficient visibility of all sell-side options, so cannot meet the cost and reliability objectives of their market efficiently.
- Sellers similarly do not have sufficient visibility of all buy-side options, so cannot efficiently maximise the value of their asset across multiple markets.
- Consumers are not aware of the fact their CER can be valuable to the power system – and conversely that their 'parasitic' assets are increasing the costs of the system for others
- Sellers, and importantly regulators, do not have access to digestible historic and current market data on buyer decisions in all markets, which erodes trust.
- Investors cannot build accurate and optimised business cases for market entry without access to a wide range of historic market data.
- Finally, regulators cannot effectively alleviate harms without adequate visibility of current and historic market data.

Market failure 2: oligopsony market coordination of operations and access

Limited coordination across these siloed markets dominated by a few large buyers is causing inefficient system (and market) operation overall. This includes coordinating

procurement and dispatch operations and coordinated access to markets. Specific pain points include:

- A lack of product standardisation even among the limited number of markets, which makes it difficult for sellers to compare products and make efficient decisions to maximise asset value across multiple markets.[40]
- A lack of operational coordination across products, which leads to inefficient or insecure system operation by buyers, who lack primacy rules for conflict identification and subsequent notification/resolution proposal.
- Reduced liquidity and competition as fewer sellers operate in any given market
- A lack of harmonised access to markets and common processes which creates such a 'transactional' burden for sellers that they simply never enter the market at all, which reduces liquidity and competition further.

Market failure 3: a structural lack of trust [41]

Without transparency, sellers don't believe that markets are being operated impartially. This undermines their motivation to participate, reducing liquidity and competition. The specific pain points here are:

- Lack of clear governance and/or oversight of flexibility markets
- Lack of independent dispute resolution mechanism, which is needed for common processes with multiple oligopsony buyers
- Desire for transparency and evidence to justify operational choices and value for money

Market failure 4: contextual, market-specific issues

The fourth market failure is a catchall of specific barriers to entry. This publication does not cover these individually in detail, but they are addressed as enabling work which needs to be accelerated.

These include market participants observations that various specific entry requirements prohibit either assets or actors, which reduces competition. These include:

[40] A key focus of 2023 Open Networks work programme; Strategic Roadmap for Flexibility (2023); Open Networks; ena-open-networks-strategic-roadmap-for-flexibility-(2023).pdf (energynetworks.org)

[41] A lack of trust may also stem from a lack of independent market governance, i.e. a neutral party overseeing operations to ensure they are fair. Such issues of roles and responsibilities are addressed in the consultation on the Future of local energy institutions and governance, and so will not be covered in depth here.

- Burdensome legal requirements, such as bespoke or complex contracting terms requiring specific legal expertise or high liability levels requiring substantial financial reserves.
- Burdensome or limiting technical requirements for smaller or digital assets, such as minimum participation volumes or specific operational metering requirements.

This section has presented the critical importance of distributed flexibility, highlighted its potential and the existing limitations. This knowledge prepares the reader to appreciate opportunity for change.

We next present a case for fundamental acceleration towards a common digital energy infrastructure able to underpin and enable distributed flexibility and help ensure the delivery of our net zero goals.

2 An approach pivot: The case for change

Section summary

This section explains Ofgem's clear view that there is a case for a new strategic vision for flexibility, based on a common digital energy infrastructure. We explain the requirement for an end-state vision to meet the challenges in section one, and why a solution would be digital by design. We then outline the outcomes we'd expect based on desirability, feasibility, and the ability to support DER uptake. We use the common functions of information provision, market coordination of operations and access, and trust and governance to describe desirable outcomes.

Questions:

3. ***Is there a 'case for change' and a need for a common vision for distributed flexibility?***
4. ***What is your vision for how to accelerate the delivery of accessible, coordinated and trusted markets for distributed flexibility?***
5. ***Will certainty of an end vision help accelerate enabling work and make it cohesive?***
6. ***When should a common digital energy infrastructure be in place? And therefore, when should development begin?***

Recap on the need for distributed flexibility

We are now operating under a time-bound imperative to enable distributed flexibility at scale. We have iterated and innovated many aspects of the technologies, platforms, commercial models, and actors' roles. We are information rich but implementation poor. At the same time, we recognise there are both structural (strategic) and everyday (tactical) challenges which are current barriers to the delivery of distributed flexibility at scale.

2.1 Ofgem's role

As Ofgem, regulator of gas and electricity markets, our job is to ensure markets are driving the right overall outcomes for consumers. We believe that there are regulatory market issues, and a case for Ofgem to examine how these can best be managed in the

interests of consumers. We recognise these are emerging market failures that will likely be exacerbated over time as the number of DER in the country increase and our energy markets become more complicated.

We do not think a consistent, low-friction environment for decentralised flexibility will emerge either organically or in time. Each individual actor (buyer) is only incentivised to improve their respective monopsony. They either do not have the functional and legal ability, legitimacy, or appetite to become the pre-eminent facilitator. Time is also critical: an organic solution might take 5-10 years to develop. At that pace, there is a real risk that the underlying CER and DER are not encouraged to be systematically 'useful' and we risk net zero power system delivery. In a similar fashion to the recent smart charging decision, there is a clear role for the regulator create a consistent and enabling policy environment.[42]

As regulator, we occupy a pro-consumer position in which we observe the many trials and projects but also the lack of scale implementation.[43] We see both missed opportunities for consumers (DER owners in particular) and the risk of consumer harm (in the form of higher transition costs and missing net zero legal targets). We therefore believe we have a duty in the interests of protecting consumers from poor market outcomes. This means, amongst other activities, protecting market participants from such things as bad market participant investments, surge pricing or a possible lack of physical and digital interoperability. Ofgem are well placed to monitor and oversee the development and implementation of distributed flexibility.

2.2 Conclusion: a case for a common digital vision for flexibility

The magnitude of the challenges faced, plus the scope of the potential upside for all consumers (and energy system actors), leads us to believe there is a case for a public interest intervention. The nature of the problem (many heterogenous CER across the country's six distribution networks and seventeen current markets – with more to come) suggests that a single common solution would remove the most friction by delivering the

[42] Government's recent EV Smart Charging Action plan also outlined Ofgem's role to review and seek to remove barriers to markets and create a consistent enabling environment: Electric vehicle smart charging action plan - GOV.UK (www.gov.uk)

[43] In 2022, Climate Change Committee in it's progress update report, highlighted the need for clear policies to drive change, in addition to overarching climate ambitions. This same argument applies in our desire for a common, deliverable vision for distributed flexibility. 2022 Progress Report to Parliament - Climate Change Committee (theccc.org.uk)

maximum information, coordination, and trust. The solution must offer all actors a single source of truth, be independent and accountable.

There will be millions of CERs; hundreds of buy- and sell-side actors; millions of connection points; a dozen (or more) market products and all operating at increasing speed. These will also all change over time. We need this common solution to be future facing and utilise modern technologies. Furthermore, the solution must be user-centric, accessible, and data-rich. We therefore believe any solution ***must*** be inherently digital.

This case for a common digital solution aligns with aims of the Energy Digitalisation Strategy and builds on the evidence gathered by the Energy Data Taskforce and the Energy Digitalisation Taskforce.[44,45,46]

What needs to change?

The next stage of distributed flexibility delivery requires a common vision to manage strategic and structural issues.

Our proposed vision is simple: that CER should be actively engaged in all GB energy markets via a common digital energy infrastructure, assisted by a wide variety of enabling market changes and standards that would enable their active participation. This would represent a sea change for many of the existing rules and frameworks.

The change requires the implementation of trusted, well-governed institutions and infrastructures to support distributed flexibility. These would be based on neutrality, transparency and clear accountability and responsibility. Trust is required to ensure functional markets, and as well as transparency, independence, and accountability, it would provide clear route to recourse and independent dispute resolution for common processes.

The outcomes (or key indicators) of this vision bearing fruit include:

[44] Digitalising our energy system for net zero: strategy and action plan; BEIS, Ofgem, Innovate UK; Digitalising our energy system for net zero: strategy and action plan - GOV.UK (www.gov.uk)
[45] Energy Data Taskforce: A Strategy for a Modern Digitalised Energy System; Energy Data Taskforce | A Modern Digitalised Energy System (catapult.org.uk)
[46] Energy Digitalisation Taskforce: Delivering a Digitalised Energy System; Delivering a Digitalised Energy System - Energy Systems Catapult

- The number of CER actively participating in energy markets, with progress indicators outlined in the BEIS updated Smart System and Flexibility Plan monitoring framework[47]
- The true value of their contributions to our system being assigned
- The degree of trust energy system buyers place in services delivered by CER
- Improvements in operational security and coordination resulting from CER being actively engaged (leading to reductions in balancing, for example)
- Financial services innovation leading to increased deployment of CER

We believe there are two key elements to our vision. The first part (a common digital energy infrastructure) is a new idea and forms the bulk of this paper. The second part, 'enablers', including market changes and standards, are predominantly covered in other areas of work across government and industry.

Part 1: A common digital energy infrastructure

A new common digital energy infrastructure would be responsible for reducing friction. The common digital energy infrastructure has been proposed explicitly to enable distributed flexibility, while supporting all markets and enabling all types of flexible assets. We propose industry seek consensus behind a common end-state for flexibility, able to directly address market failures 1, 2 and 3 examined in Section one above. This common infrastructure would help ensure:

- Information provision: Information transparency is critical to inform market development.
- Market coordination of operations and access: Common access to and operational coordination across energy markets for flexible assets is required to unlock the system and consumer value of flexibility
- Trust and governance: Suitable arrangements are required for any market to function effectively.

Critically, we must bring together markets and market participants to erode market silos, increase liquidity, surface opportunities, and improve decision making. Competing digital infrastructures would be self-defeating.

[47] Smart systems and flexibility plan monitoring framework; BEIS; Smart systems and flexibility plan 2021: Appendix II - Smart systems and flexibility plan monitoring framework (publishing.service.gov.uk)

We believe that a common digital energy infrastructure will likely require the following functions to unlock CER flexibility. These are subject to further discussion in section three against a series of archetypes:

- the digital registration of actors, assets and markets;
- ensuring the visibility of assets, consent and positions;
- enabling price discovery and liquidity across all markets;
- delivering a digital contracting regime;
- surfacing inter-market conflicts;
- independent dispute resolution for common processes; and,
- creating a rich data environment to assist settlement and meta-data analysis.

Collectively, this common digital energy infrastructure solution will ensure effective, efficient decision making and allow distributed flexibility to scale and deliver rapidly, irrespective the specific markets involved.

This paper will proceed to explore four archetypes: one BAU (do nothing new, proceed at current pace); and then three points along a spectrum of solutions from a 'thin' directory list that makes markets discoverable, through a 'medium' exchange-type mechanism that makes markets visible and able to coordinate to a 'thick' computational engine that solves for a cross-market outcome.

How the physical energy network is operated might vary from country to country, but digital technologies can be deployed and redeployed across multiple geographies. The core software, hardware and networking approaches can and should be designed to enable scalable deployment globally. This will likely require the use of international data standards and communication protocols.

This approach provides efficiencies and value for money in the development phase, re-deploying technology where possible, and presents business opportunities for international expansion. Additionally, it is more compatible with the multinational companies deploying CERs and providing aggregation and virtual power plant technologies, who will want to interface with a common digital energy infrastructure both here and overseas. Taking this globally-minded approach presents opportunities for the UK to not just ensure we can work with international partners and share knowledge, but to welcome multi-nationals working in other geographies and jurisdictions, and to the UK's leadership position on flexibility.

Part 2: Accelerating enablers

We hope a specific, overarching vision will reinvigorate the change processes around enablers of distributed flexibility already identified elsewhere, including the Smart Systems and Flexibility Plan.

Enablers are required across any common digital energy infrastructure and, in particular, can contribute to addressing the challenges in market failure 4 (Section one).

For clarity, by enablers we mean the specific deliverable improvements that will contribute to distributed flexibility markets, but that a common digital energy infrastructure will *not* deliver in and of itself, but which are nonetheless critical.

Flexibility at scale requires enablers. We believe a common vision is critical to accelerate the delivery and value-add of these enablers, which are individually diverse and under multiple jurisdictions.[48] This would help drive consistency and create a cohesive outcome across enablers, ensuring Ofgem, Government and industry are able to accelerate delivery towards a common goal.

Change will accelerate because of certainty of vision and outcome. Code modifications, license changes, and a hundred other micro activities that require industry consensus will benefit from reduced resource requirements and increased motivation.

This document will not dive into where the individual enablers are delivered and the roles and responsibilities for different parties, but we see the need for accelerated and cohesive development across them all.[49]

For the readers reference, the most common enablers that require consistent development and implementation include, but are not limited to:

- Low voltage network visibility
- Network constraint data
- DER asset visibility, communications connectivity, and operational metering
- Consumer consent
- Baselining
- Reform of existing markets (i.e. levelling the playing field for CER and associated organisations)

[48] The numerous baselining methodologies across GB energy markets represent a clear example of this challenge. A common vision would accelerate cohesion, bringing together the multiple working groups and resource behind a common destination.
[49] The Smart Systems and Flexibility Plan 2021 provides clarity on specific enablers and progress, Transitioning to a net zero energy system: smart systems and flexibility plan 2021 - GOV.UK (www.gov.uk)

- Future market arrangements and rules determining what actors may buy or sell in future markets (i.e. REMA and other market reforms)
- Market-wide half hourly settlement
- Data standards and sharing expectations[50]
- Standardised market products
- Market stacking and primacy rules
- Standardised contracts and pre-qualification processes[51]

2.3 Ongoing innovation and change

We also recognise there are many live initiatives in this space, but this fact should not be a barrier to a common, long-term, and transformative vision for change. Indeed, if industry had an agreed long-term trajectory, current and future innovation projects could bear more specific fruit and integrate more cohesively, accelerating progress.

Active innovation projects should also not delay Government and Ofgem addressing complex, structural policy challenges. Outputs and knowledge from innovation projects and trials will continue to inform and support action on both a common digital energy infrastructure and enablers.

Certain historical and current innovation-led digital outputs and products could be integrated as parts of a common digital energy infrastructure. These include, but are not limited to, the projects that have demonstrated the feasibility of flexibility at all scales, the projects that have explored the role and function of secondary markets, the projects that have created data standards and data concepts for the energy industry, the current work on a digital spine and automated asset registration and the many local area energy system or 'smart local energy system' projects.

Our proposed long-term vision draws on the knowledge, relationships, and recommendations from these projects already. If we receive a mandate for change through this call for input, we will look to learn from their delivery and implementation pathways.

[50] Data sharing expectations are addressed in ongoing work on Data Best Practice, which will be publishing a further consultation shortly. Call for Input for Data Best Practice | Ofgem
[51] Some enablers (data standards, standardised market products, market stacking and primacy rules, and standardised contracts and pre-qualification processes) are covered in the consultation on Future of local energy institutions and governance, which considers appropriate roles for the delivery of these activities.

Other innovation projects may coordinate or liaise with a common digital energy infrastructure, and still more may remain entirely separate.

3 What that future could look like

Section summary

This section introduces four visions, or archetypes, for the future digital infrastructure to support distributed flexibility: the counterfactual 'business as usual' archetype, and three common digital energy infrastructure archetypes.

We explain what each archetype does and evaluate how each would deliver the three critical functions of information provision, market coordination of operations and access, and trust and governance. Finally, we give a summary assessment of the archetypes against their desirability and feasibility.

Questions:

7. ***What should a common digital energy infrastructure look like, and why? Please consider the archetypes or develop your own proposition.***
8. ***What is your view on the desirability and feasibility of the archetypes or your own alternative proposition?***

The following four visions, or archetypes, can be understood as being on a spectrum with varying degrees of both intervention and technical functionality. They are designed to help establish a framework for understanding what the future vision for distributed flexibility could look like but are neither mutually exclusive nor exhaustive.

3.1 Archetype 1: Business as usual

This is the counterfactual archetype, against which all others are compared. It is what would evolve organically from the current approach if no strategic intervention occurred. It's assumed end-state, based on the current trajectory, is one of multiple individual markets with piecemeal improvements to certain processes to accommodate distributed flexibility.

BAU assumes that markets lack any consistent means of coordination. This means Flexibility Service Providers must engage individually with each market, which creates high friction. If one market position affects another market's outcome, those markets may coordinate bilaterally (if at all), or if the Flexibility Service Providers has sufficient visibility, they may be able to take some coordination action. Elsewhere, there is a lack

of transparency across most market participants and positions. Liquidity and price discovery are expected to be low. Some level of standardised data exchange and communications is expected to emerge; however, this may not be comprehensive in scope or swiftly implemented.

Pockets of excellence are expected, with improvements in market access and delivery for distributed flexibility, but these actions are themselves siloed, and lack a coherent vision.

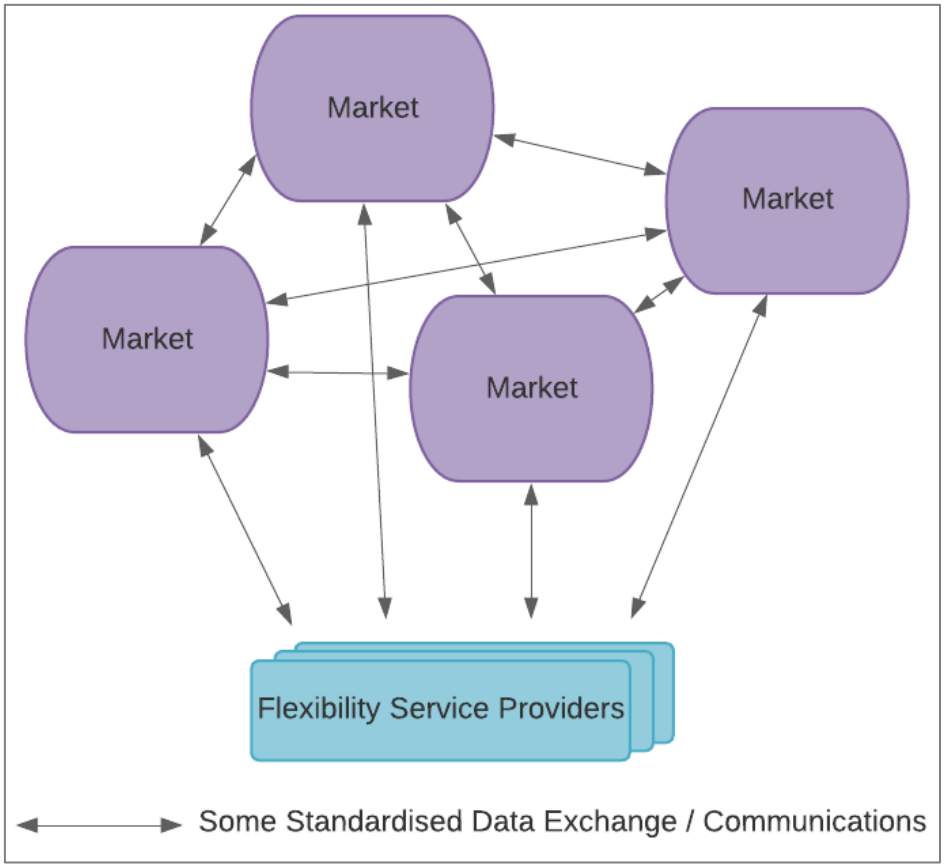


Figure 2: Diagram depicting market participant interactions for 'Business as Usual' archetype

3.2 Archetype 2: Thin

This archetype is the most minimal intervention. It is based on the concept of a *directory* that would assist market buyers and sellers of distributed flexibility to understand the landscape of markets and assets available. Access to the directory is open, and common communication standards are established between all market participants.

The directory approach is *thin* because there is no common point of access to join markets, nor is there an established or governed coordination mechanism between markets. This effectively means that markets and participants are 'blind' to one another, unless they take specific action to establish bilateral data sharing agreements.

Communication is bilateral, and there is little to no transparency of market activity, even where there are dependencies across markets such as notification of conflicts between market positions.

Common data standards and communications protocols are required i.e., open, standardised APIs. These would be agreed and developed by industry.

The directory approach requires a small piece of common digital energy infrastructure, *the directory* itself, and for all actors to agree and deploy standardised interfaces in their systems.

Running through a market chronology for distributed flexibility using a directory approach:

- Both buyers and sellers would need to be familiar with the directory and ensure their systems and processes are compliant with the programming interfaces
- During market **exploration**, sellers would need to navigate individually to any appropriate market for which they meet the entry criteria
- For **registration**, buyers would need to complete due diligence on the sellers and their assets individually, contracting would be market-specific (potentially bespoke arrangements)
- During the **competition** step, trading would take place bilaterally in each market, overseen by the buyer
- For **availability** and **dispatch**, updates and instructions would be communicated directly between the buyer and the seller. Buyers and sellers would have no idea whether there were market conflicts until real time operational disfunction (unless the buyers were aware their markets had dependencies and had coordinated bilaterally)
- When undertaking **verification** on market outcomes, this would be a bilateral process, with no conduit for market data
- **Settlement** would also take place bilaterally per each markets' own rules
- There would be limited dispute resolution needed since there are no common coordination processes; any dispute resolution would only cover issues with directory services

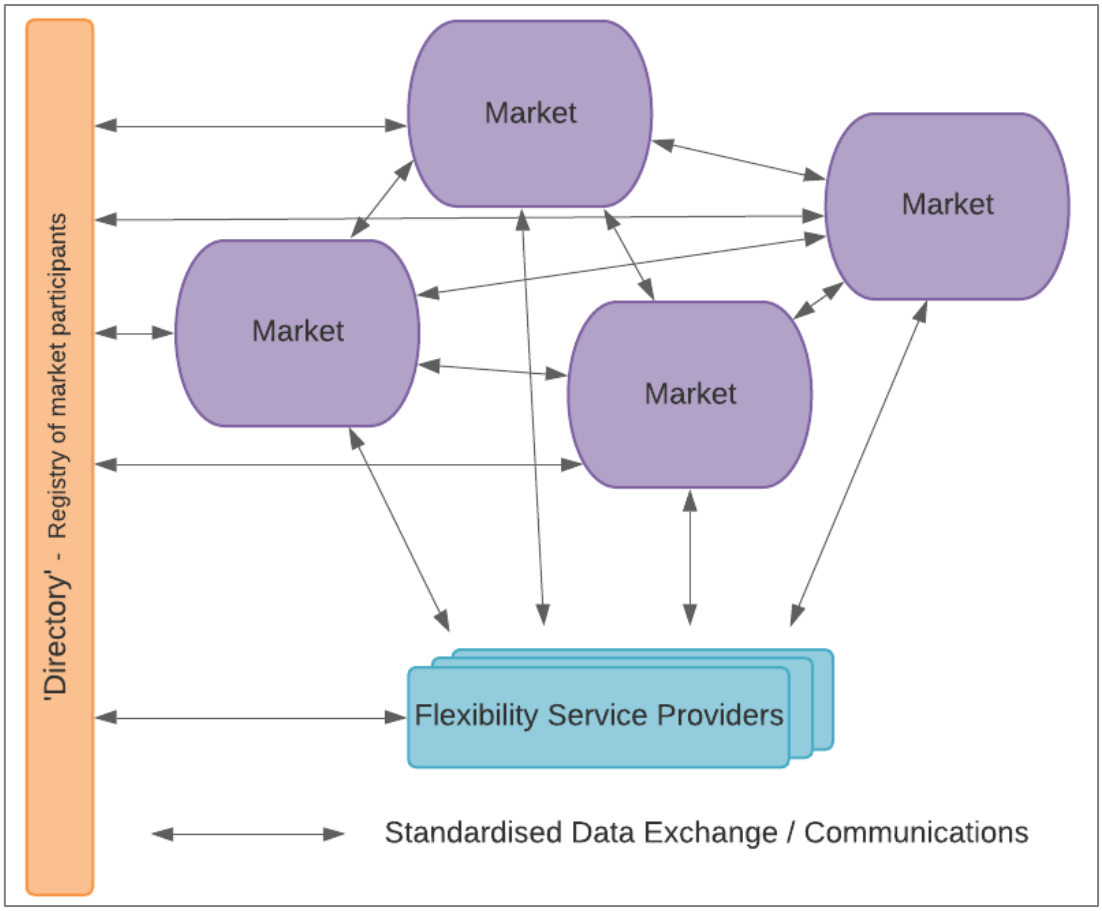


Figure 3: Diagram depicting market participant interactions for 'Thin' archetype.

3.3 Archetype 3: Medium

This archetype most closely resembles an 'exchange'; a singular and scalable digital location where multiple markets are visible and coordinated under a known governance framework, yet continue to retain their own market designs, platforms, and systems. Individual markets could be ported onto an exchange over time.

An exchange would provide a single source of truth for its energy markets, giving a common point of access, digitising contracting mechanisms, reducing friction, and increasing visibility across markets for buyers and sellers. This should significantly increase price discovery and liquidity.

An exchange would allow buyers, including independent market operators and system operators, to procure, dispatch, and settle, but they would do so in a transparent and coordinated environment. This would make the processes easier and more efficient.

Running through a market chronology for distributed flexibility using an exchange:

- During market **exploration**, sellers want to understand the nature of the market, their likely returns and historic trends. Buyers, when creating a market, want to know what assets can meet their product requirements – and if appropriate, the likely prices paid and historical performance. An exchange would provide a structured, open single-source-of-truth to supply data to meet these use cases.
- For **registration**, sellers need to qualify against requirements and register their assets. Simultaneously, buyers wish to evaluate the ability of CER and aggregators to meet their requirements. An exchange provides common prequalification and visibility functionality, which reduces friction and repetitive, burdensome processes. An exchange can pre-agree standardised contract terms and conditions, reducing the requirement for bilateral due diligence. Visibility of side-by-side variations in registration acts as a check on discrepancies.
- An exchange allows existing processes for market **competition** and asset **availability** and **dispatch** to take place 'off exchange', reflecting markets' unique operations and existing digital infrastructures. An exchange would host all ex-post data for subsequent transparent presentation.
- Additionally, a coordinating exchange has a critical role in flagging conflicts, at competition or dispatch stage, across markets for buyers and sellers to remedy offline, based on transparent market positions and actions.
- Finally, **verification** and **settlement** are again areas where existing systems and processes perform well. At this point, the role of an exchange would again be to host all ex-post data present it centrally in a transparent way. This feeds back into the first step of the process, as this data supports market exploration.
- The trusted governance would provide independent dispute resolution for any issues with common processes provided by the exchange

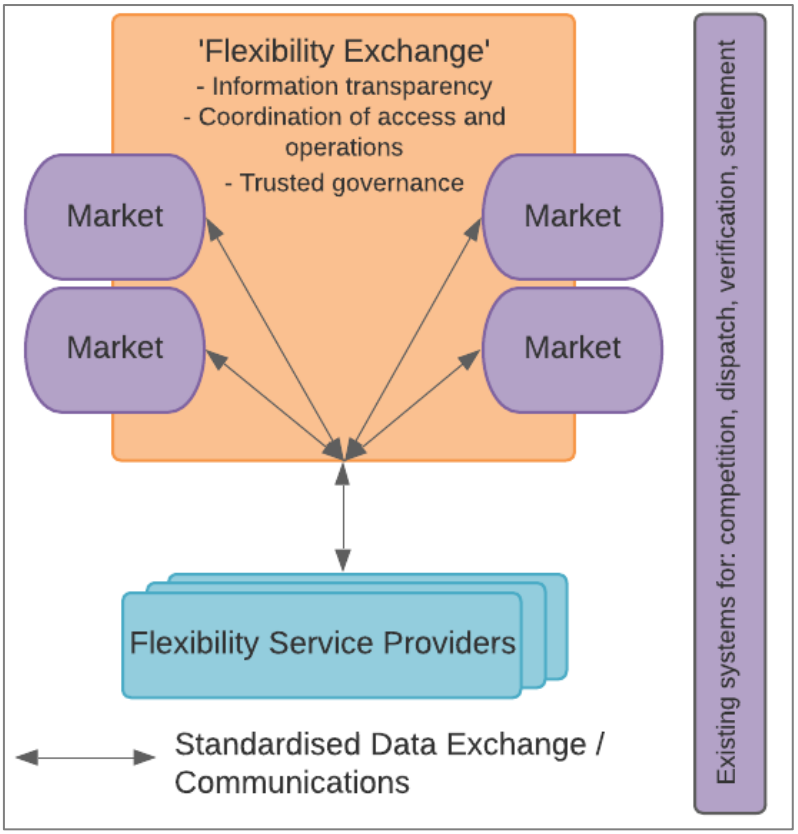


Figure 4: Diagram depicting market participant interactions for 'Medium' archetype.

3.4 Archetype 4: Thick

This archetype is a central platform for the end-to-end delivery of distributed flexibility. The central platform encompasses all activities from exploration to settlement across all markets.

Doing all processes centrally allows full optimisation across all markets at all voltage levels, but it is unlikely to leave any service provision with existing systems. Since all interactions happen on the central platform, it can present all information centrally, providing increased liquidity and competition. Computationally, the central platform would 'solve' for the best[52] outcome for each CER.

Running through a market chronology for distributed flexibility using a central platform:

[52] The "best" outcome would depend on the algorithm's parameters: it could be carbon, security of supply, lowest overall cost, consumer outcome, etc. or a hierarchy of these.

- Market **exploration** is easy as a central platform provides a structured, open single-source-of-truth for the data needed, the same as the medium exchange archetype.
- For **registration**, flexibility providers and market operators would register their assets and markets, then follow common participation processes which reduce friction, the same as the medium exchange archetype, with the same benefit of increasing market alignment.
- The platform would administer the market **competition** process. Crucially, because it is clearing all markets, it can co-optimise across them all for whole system operation.
- The platform would then also receive **availability** updates and issue **dispatch** instructions.
- The central platform would be coordinating across markets, to give notification of conflicts and seek to optimally resolve these through providing a preferred dispatch option.
- Finally, the central platform would complete **verification** and **settlement**.
- The trusted governance would provide independent dispute resolution for any issues with common processes provided by the central platform.

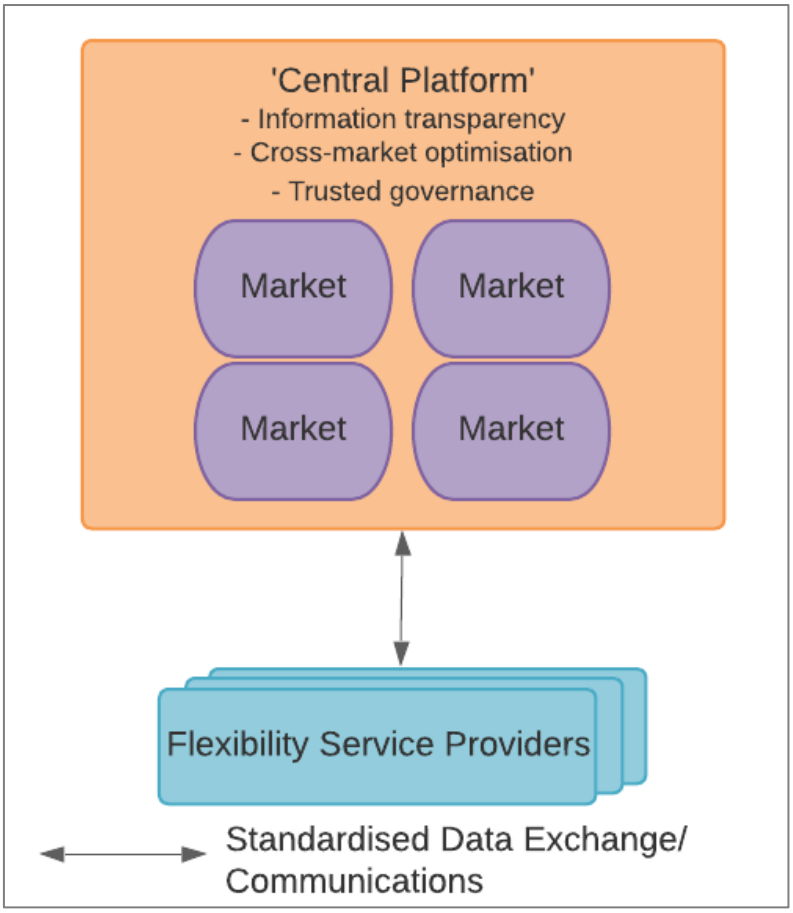


Figure 5: Diagram depicting market participant interactions for 'Thick' archetype

3.5 Archetypes and core functions

	BaU – let distributed flexibility continue without intervention	**Thin – a directory of protocols & standards**	**Medium – an exchange**	**Thick – a central platform**
Information provision: services that enable greater visibility of market rules, product data and asset performance as well as external information, where appropriate.	**Very limited** – bilateral interactions don't give transparency	**Limited** – register of markets and assets available improves visibility, but bilateral interactions don't give transparency	**Good** – single source of truth for market and asset data, including historic performance and basic analytics	**Good** – same as medium
Market coordination of operations and access: services that aim to improve operational efficiency and streamline various stages of the procurement processes.	**Limited** – multiple bilateral market interactions must be set up, no common access point/process	**Limited** – multiple bilateral market interactions must be set up, no common access point/process	**Good** – central coordination services to notify of bid/dispatch conflicts, also common access point/process for some aspects	**Very good** – full co-optimisation across all markets and common access point/process for all aspects
Trust and governance: services that enable transparency in decision making and governance, fostering trust in the marketplace.	**Very limited –** no common governance role, limited decision-making transparency	**Limited** – no substantial common governance role but register monitored for accuracy, limited decision-making transparency	**Good** – governance of common platform services, disputes and change management, improved decision-making transparency	**Very good** (depending on entity) – full central governance of all aspects, full decision-making transparency

Table 2: Assessment the four archetypes against the delivery of the three critical functions, as related to market failures 1-3, that the common digital energy infrastructure must perform.

3.6 Assessment of archetypes

		BaU – let distributed flexibility continue without intervention	Thin – a directory of protocols & standards	Medium – an exchange	Thick – a central platform
Desirability	**Providing 3 functions**	**Very limited –** existing markets and bilateral interactions with limited provision of functions	**Limited** – some improved visibility, but limited coordinated access or operations and limited role for governance	**Good** – single source of truth for information, services for market coordination and single point of access, governance for common services	**Good –** single source of truth for information and single point of operation and governance for all markets
	User-centric design	**Very limited** – high friction user experience finding and accessing individual markets separately	**Very limited** – users have visibility of each other, but still need to access on an individual basis	**Good** – sellers can easily access multiple markets; buyers can easily coordinate across markets	**Good** – fully streamlines all steps for sellers and optimises market operation for buyers
	Net-new functionality	**N/A** – counterfactual	**Very limited** – provision of new common register	**Good** – provides multiple new functions, and does not duplicate existing functions	**Limited** – provides substantial new functionality but also overlaps existing functions
Feasibility	**Time and cost to deliver**	**N/A –** counterfactual	**Good –** new infrastructure is small, simple, and discrete from existing operations, minimising time/cost to deliver	**Limited** – new infrastructure is sizable with some complex aspects, so will take moderate time/cost to deliver	**Very limited** – new infrastructure is substantial with significant complexity, so will be significant time/cost to deliver
	Low external dependency	**N/A** – counterfactual	**Limited** – would benefit from external initiatives, but could deliver functionality without them completing	**Limited** – would benefit from external initiatives, but could deliver functionality without them completing	**Very limited** – reliant on external initiatives e.g., could not deliver full co-optimisation without substantial LV visibility
	Adaptable and enabling innovation	**Very limited** – interventions could change the direction, but would only have slow progress state to build on	**Good** – creates a foundation of standards and protocols, and small infrastructure that could be expanded	**Good** – creates a foundation of standards and protocols, and common infrastructure that innovators can leverage	**Very limited** – creates a foundation of standards and protocols, but infrastructure is already all encompassing

Table 3: Assessment of the four archetypes against their desirability and feasibility.

4 Delivery considerations

Section summary

This section opens early discussion on the delivery approaches for a common digital energy infrastructure to help unlock distributed flexibility. We are aware of the complexity of the options and importance of the topic.

This section therefore briefly compares delivery options against required roles, notes that there are options to use existing or newly developed digital products, and touches on varying financial approaches to industry transformation.

Further work will need to be done on a delivery plan, if industry support the overarching thesis of this paper.

Questions:

9. ***Should a common digital energy infrastructure be new-build, or should it build-out from existing infrastructure?***
10. ***What are the important areas for consideration when designing institutional delivery models for a common digital energy infrastructure?***
11. ***What are the important areas for consideration when designing financial delivery models for a common digital energy infrastructure?***

For a common digital energy infrastructure to be developed, the following delivery aspects need to be considered.

4.1 Delivering a common digital energy infrastructure

The infrastructure assets for distributed flexibility do not exist at the national level, but there is significant knowledge embedded in specific innovative companies, industry actors, and non-industry technology suppliers.

In short, we need a set of principles for how a common digital energy infrastructure should be delivered. We suggest these should include trust and governance, stakeholder participation and transparency, accountability on decision making, delivery at pace, consistency of implementation, and expert input. Further work will explore whether these are exhaustive.

The physical realisation of something as important as distributed flexibility should not be simply allocated directly to an industry working group; discussion is needed on the best potential allocation of responsibilities. There are multiple options for how a common digital energy infrastructure could be delivered.

Irrespective the delivery model, there are four critical roles that must be filled:

1. Accountability
2. Ownership and responsibility
3. Input and advice
4. Technical delivery

Each of these four elements is not necessarily an independent institution. Indeed, certain institutions and actors could fulfil multiple roles. There are multiple possible delivery models, each with benefits and risks, explored through worked examples in the table below.

We provide some preliminary analysis for how this common digital energy infrastructure could be delivered, but this will require further work and your critical feedback. The below table proposes a non-exhaustive list of delivery models (with suggested details as non-exhaustive examples only), assessed against the critical elements above.

The delivery models explored below do not include the common digital energy infrastructure emerging organically as a fully commercial entity without government contract or licence. This approach is unlikely to occur given the heavily regulated nature of the energy sector and the risk of commercial capture. A purely commercial approach risks continuing the discrete uncoordinated markets we see today, as multiple competing offerings may emerge; this would undermine the key value which a single common digital energy infrastructure would provide.

	Delivery model:	**Fully Private** (single party or consortium develops)	**Mandated central entity**	**New mandated consortium** (regulated entities develop)	**Tendered and licenced**	**Code body** (multiple mandated parties collaborate)	**Government IT project**
Explanation	**Selection model**	Contracted by government	Mandated by Ofgem/ government	Mandated by Ofgem/ government	Open tender	Mandated/tendered/ contracted	Public
	Governance regime	Governed by contract	Licence regime; legislation	Possible licence; contract	Licenced	Multi-party contract; licenced; legislation	Public body report to government
	Revenue model	Profit seeking – for private entity to develop	Accepted rate of return	Unclear	Accepted rate of return	Unclear	Public budget; energy consumers
	Example	London Stock Exchange	Future System Operator	Open Banking Implementation Executive	Data Communication Company (DCC)	SEC; RECCo	NHS spine
Activity to be undertaken	**Accountability**	*Government, regulator and/or expert panel*					
	Ownership and responsibility	Single contract from Government to private entity. Operating model must be commercially viable. Must remain competitive e.g., possible to rescind contract.	Mandate a single entity, either in legislation or license.	A collective mandate across multiple entities, either in legislation or license.	Government tender to multiple parties, with role and outcomes relatively defined. Operating model must be commercially viable. Must remain competitive e.g., possible to rescind contract.	Code body is responsible for industry-wide agreement. Code body would need clear powers, which likely requires legislation.	Government retains ownership.
	Input and advice	For the private entity to determine approach. Opaque to others.	For the mandated entity to determine approach. Easier for industry to oversee.	Presumed expertise within the mandated entities.	Guidance in advance of scope being released.	Code body has some in-house expertise and can convene groups easily.	Government team recruits expertise or contracts advisors, and could convene groups.
	Technical delivery	For the private entity to determine approach.	Tender(s) for delivery.	Presumed in-house expertise, or maybe tender(s).	Presumed in-house expertise, or maybe subcontract/tender(s) at entity's discretion.	Tender(s) for delivery.	Build in-house, maybe with tendered elements.

Analysis:	**Benefits**	Efficiency – through operating as a profit driven private entity. Speed of delivery – as a single entity with authority to self-determine. Accountability – as a single responsible entity.	Simplicity – single entity with clear mandate. Institutional role – could fit with and extend existing role. Industry expertise – existing knowledge of industry operation. Accountability – oversight through regulation of single entity.	Long-term ownership – collective ownership could provide longevity though adaptability. Expertise – relevant expertise represented in consortium.	Value for money – competitive tendering should achieve the best value for money. Accountability – as a single responsible entity.	Transparency – a participatory forum with open reporting. Expertise – relevant expertise through members or working groups. Accountability – code body held to account by industry participants as part of the development process.	Direct public interest – would ensure creation of services which are in the greater public interest. Neutrality –no vested interest a single party benefiting, so will develop for the benefit of all parties.
	Risks	Corporate capture – might serve corporate interests over sector interests. Technical lock-in – would be reliant on systems of single private entity. Perverse incentives – commercial business model could influence behaviour of market participants.	Legacy risk – could cause lock-in by integration to legacy technology systems in delivery organisation Pace – track record suggests delivery timelines may be delayed. Recruitment/skills – may require significant upskilling	Pace – could be slow without driving leadership. Technocratic – decision making might not consider wider objectives. Coordination - multi-party delivery could be challenging.	Administration – would require a substantial tendering process and ongoing delivery monitoring. Technical lock-in – would be reliant on systems of single private entity.	Pace – could be slow without driving leadership and need for consensus. Split accountability – participants only contributing individual pieces could lead to lack of overall results.	Pace – track record suggests delivery timelines may be delayed. Recruitment/skills – may require significant upskilling

Table 4 outlines key delivery model options and analysis for the common digital energy infrastructure.

4.2 A new-build common digital energy infrastructure, or an extension of an existing asset?

A primary delivery question is whether a common digital energy infrastructure should be a new-build asset or an extension of existing assets.

- A new build approach allows a purpose-built design and reduces the risk of reliance on legacy technology. It has the benefit of enabling the asset (and so potentially governing institution) to be independent from day one, and enables more optionality to change the entity(s) tasked with delivery or operation in future based on a lower risk of legacy technology lock-in.
- An extension approach might more readily accommodate current institutions and build on existing technologies. Specifically, National Grid ESO's various platforms could be extended to coordinate across multiple markets. Alternatives include extending existing independent market platforms or power exchanges, or even beyond the energy sector extending existing exchanges such as e-commerce or stock exchanges into energy markets.

Either way, the solution would comprise a modern, modular technology infrastructure that would allow different elements to be built and maintained by different organisations, likely using a central code repository or common framework.

4.3 The possible role of the Future System Operator

The Future System Operator (FSO) is being designed and developed to create an expert, impartial body to enable more coordinated, strategic whole system planning. The mandate of the FSO aligns closely with the requirements of the ownership and responsibility role for a common digital energy infrastructure.

Given the ambition and scope of both the FSO and the common digital energy infrastructure, we would anticipate interest from the FSO to develop this work. Additionally, there are numerous synergies with digital products and platforms that National Grid ESO is developing currently, which could potentially extend to become a common digital energy infrastructure under the FSO. Whilst there are clear opportunities and synergies, we do not believe the FSO is the only party that could potentially fill this role, and we welcome feedback.

4.4 Financing a common digital energy infrastructure

There are inevitable capex and opex costs to a common digital energy infrastructure. Consideration needs to be given to the following factors:

The nature of common infrastructure and the role of private finance

The role of private finance presents a policy question for the independence or potential bias of a common digital energy infrastructure – especially when related to consumer-owned devices and behaviour change in a public good. This has two dynamics: data privacy, namely whether consumers trust the party to manage their data responsibly, and data use, namely what the motivating factor is for the party.

Who pays versus who benefits

We must be conscious of who is paying for a common digital energy infrastructure and where value is generated. There is a greater good argument around having a common digital energy infrastructure with socialised costs, but any party creating excessive value will need to be closely observed. Equally, we are open to alternative cost and benefit distribution proposals.

The balance of public and private risk

Different financial models, such as the regulated asset base (RAB) or contracts for difference (CfD) have been applied to large infrastructure projects seeking private finance and reflecting the degree of delivery risk. It is unclear where on the spectrum of risk transfer models a common digital energy infrastructure would sit.

Subsidisation versus profit

There are central digital infrastructures that are profit-making, like the London Stock Exchange. Similarly, there are digital infrastructures that are not-for-profit or even publicly financed. It is unclear what degree of subsidisation or profitability a common digital energy infrastructure should necessitate. This is bound up in the delivery model.

Revenue models

If the common digital energy infrastructure is commercial, consideration needs to be given to revenue models, and the risk of perverse incentives. For example, revenue based on a share of trades, or the number of trades may incentivise churn or slicing of contracts over consumer value.

5 Conclusion and taking forward the future of distributed flexibility

This document has set out a case for change in the policy and industry design and delivery to support distributed flexibility. This is a call to action and is written to stimulate discussion and ultimately accelerate a flexible energy system needed to accommodate a high penetration of variable renewable energy and CERs and meet our net zero ambitions. The analysis and vision are intended to engage readers in strategic discussion on the future of distributed flexibility and return a mandate for further work on technical, delivery and financing options.

First, this document set out a clear imperative for a flexible energy system, focussing on the role of CERs and the potential value, or opportunity cost, that these small-scale assets could bring. Strategic and tactical barriers were discussed, with analysis leading to the conclusion that a clear and compelling vision for the future of flexibility is absent. We present discussion on the case for a common digital energy infrastructure, developed in the public interest, which will allow industry to coalesce around a common vision, and thereby also accelerate the delivery of critical enablers for flexibility. We put forward some possible options for what such a common digital energy infrastructure could look like and discuss how it could be delivered.

From here, we need readers across industry to share your views and to respond to us on this call for input. Importantly, we want readers to discuss the future vision for distributed flexibility with colleagues within and across industry. To meet the ambition and challenges set out, we need a collective conversation on distributed flexibility.

We hope that this work will kick-off work to refine the vision for distributed flexibility, allowing industry to develop, iterate, and move toward a common digital energy infrastructure.

We trust this document will stimulate discussion and look forward to hearing from you.

6 Appendices

Appendix	Name of appendix
1	Responding to this call for input
2	Privacy notice on consultations
3	Glossary
4	Call for input questions

A technical annex is provided as a supplementary document.

6.1 Appendix 1: Responding to this call for input

What are we calling for input on?

We are calling for input on the future of distributed flexibility and preliminary considerations on the role of a common digital energy infrastructure. This document begins by outlining the imperative, the potential and the challenges of distributed flexibility. A critical reflection on the recent history of the sector focuses on the strategic challenges that have emerged, which we believe are latent market failures. Respondents are asked how they perceive the value of distributed flexibility and the role of consumer energy resources, as it pertains to the energy system to meet our net-zero goals.

The second section explains Ofgem's clear view that there is a case for a new strategic vision for flexibility, based on a common digital energy infrastructure. We explain the requirement for an end-state vision to meet the challenges in section one, and why a solution would be digital by design. Respondents are asked whether they share our perspective on the case for change and need for a common vision, and what their own vision is on how to accelerate the delivery of accessible, coordinated, and trusted markets for distributed flexibility. Respondents are also asked about when the development of a common digital energy infrastructure should take place.

The subsequent section then outlines four archetypes, for a common digital energy infrastructure: the counterfactual 'business as usual' archetype, and three common digital energy infrastructure archetypes. We explain what each archetype does and evaluate how each would deliver the three critical functions of information provision, market coordination of operations and access, and trust and governance. Respondents are asked to then reflect on the archetypes presented and consider what does a desirable and feasible common digital energy infrastructure look like, and why.

The final section opens early discussion on the delivery approaches for a common digital energy infrastructure to help unlock distributed flexibility. Given the complexity of options and importance of this topic, the section briefly compares delivery options against required roles, notes that there are options to use existing or newly developed digital products, and touches on varying financial approaches to industry transformation. Respondents are asked about whether a common digital energy infrastructure should be new-build, or if it should build-out from existing activities. Respondents are also asked to consider the role of the FSO in enabling distributed flexibility, and other important areas for consideration when designing institutional and financial delivery models for a common digital energy infrastructure.

Other related publications include:

- The original joint BEIS-Ofgem policy paper 'Upgrading our energy system: smart systems and flexibility plan'[53] published in 2017
- Ofgem's position paper titled 'Distribution System Operation: our approach and regulatory priorities'[54] published in 2019
- Ofgem's Future Insights Paper 6 - Flexibility Platforms in electricity markets[55] published in 2019
- Ofgem's decision document titled 'Next steps on our reforms to the Long-Term Development Statement (LTDS) and the Key Enablers for DSO programme of work'[56] published in 2020
- The subsequent joint BEIS-Ofgem policy paper 'Transitioning to a net zero energy system: smart systems and flexibility plan 2021'[57]

Other related upcoming publications include:

- Ofgem's consultation on Data Best Practice and Digitalisation Strategy and Action Plan Guidance (March 2023)
- Ofgem's consultation on the Future of Local Energy Institutions and Governance (March 2023)

[53] [Withdrawn] Upgrading our energy system: smart systems and flexibility plan - GOV.UK (www.gov.uk)
[54] Ofgem position paper on Distribution System Operation: our approach and regulatory priorities | Ofgem
[55] Ofgem's Future Insights Paper 6 - Flexibility Platforms in electricity markets | Ofgem
[56] Next steps on our reforms to the Long Term Development Statement (LTDS) and the Key Enablers for DSO programme of work | Ofgem
[57] Transitioning to a net zero energy system: smart systems and flexibility plan 2021 - GOV.UK (www.gov.uk)

Call for Input stages

Stage 1	Stage 2	Stage 3	Stage 4
Call for Input open	Call For Input closes (awaiting decision). Deadline for responses	Responses reviewed and published	Call For Input decision/policy statement
1 March 2023	17:00, 10 May 2023	Summer 2023	Autumn 2023

How to respond

We want to hear from anyone interested in this call for input. Please send your response to flexibility@ofgem.gov.uk by 17:00 on 10 May 2023.

We've asked for your feedback in each of the questions throughout. Please respond to each one as fully as you can.

We will publish non-confidential responses on our website at www.ofgem.gov.uk/consultations.

Your response, data and confidentiality

You can ask us to keep your response, or parts of your response, confidential. We'll respect this, subject to obligations to disclose information, for example, under the Freedom of Information Act 2000, the Environmental Information Regulations 2004, statutory directions, court orders, government regulations or where you give us explicit permission to disclose. If you do want us to keep your response confidential, please clearly mark this on your response and explain why.

If you wish us to keep part of your response confidential, please clearly mark those parts of your response that you *do* wish to be kept confidential and those that you *do not* wish to be kept confidential. Please put the confidential material in a separate appendix to your response. If necessary, we'll get in touch with you to discuss which parts of the information in your response should be kept confidential, and which can be published. We might ask for reasons why.

If the information you give in your response contains personal data under the General Data Protection Regulation (Regulation (EU) 2016/679) as retained in domestic law

following the UK's withdrawal from the European Union ("UK GDPR"), the Gas and Electricity Markets Authority will be the data controller for the purposes of GDPR. Ofgem uses the information in responses in performing its statutory functions and in accordance with section 105 of the Utilities Act 2000. Please refer to our Privacy Notice on consultations, see Appendix 4.

If you wish to respond confidentially, we'll keep your response itself confidential, but we will publish the number (but not the names) of confidential responses we receive. We won't link responses to respondents if we publish a summary of responses, and we will evaluate each response on its own merits without undermining your right to confidentiality.

General feedback

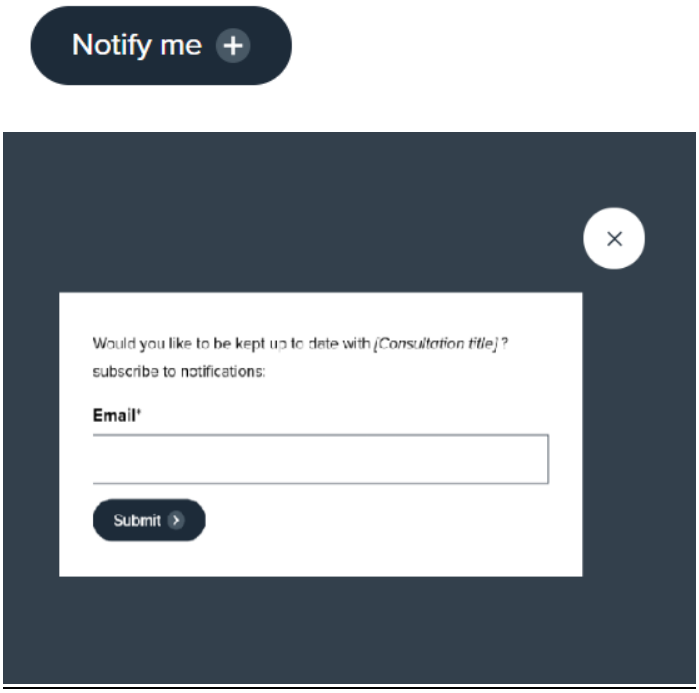
We believe that consultation is at the heart of good policy development. We welcome any comments about how we've run this consultation. We'd also like to get your answers to these questions:

1. Do you have any comments about the overall process of this consultation?
2. Do you have any comments about its tone and content?
3. Was it easy to read and understand? Or could it have been better written?
4. Were its conclusions balanced?
5. Did it make reasoned recommendations for improvement?
6. Any further comments?

Please send any general feedback comments to stakeholders@ofgem.gov.uk

How to track the progress of the consultation

You can track the progress of a consultation from upcoming to decision status using the 'notify me' function on a consultation page when published on our website.
Ofgem.gov.uk/consultations



Once subscribed to the notifications for a particular consultation, you will receive an email to notify you when it has changed status. Our consultation stages are:

Upcoming > **Open** > **Closed** (awaiting decision) > **Closed** (with decision)

6.2 Appendix 2: Privacy notice on call for input

Personal data

The following explains your rights and gives you the information you are entitled to under the General Data Protection Regulation (GDPR).

Note that this section only refers to your personal data (your name address and anything that could be used to identify you personally) not the content of your response to the consultation.

1. The identity of the controller and contact details of our Data Protection Officer

The Gas and Electricity Markets Authority is the controller, (for ease of reference, "Ofgem"). The Data Protection Officer can be contacted at dpo@ofgem.gov.uk

2. Why we are collecting your personal data

Your personal data is being collected as an essential part of the consultation process, so that we can contact you regarding your response and for statistical purposes. We may also use it to contact you about related matters.

3. Our legal basis for processing your personal data

As a public authority, the GDPR makes provision for Ofgem to process personal data as necessary for the effective performance of a task carried out in the public interest. i.e. a consultation.

4. With whom we will be sharing your personal data

The Department for Energy Security and Net Zero

5. For how long we will keep your personal data, or criteria used to determine the retention period.

Your personal data will be held for six months after the project is closed.

6. Your rights

The data we are collecting is your personal data, and you have considerable say over what happens to it. You have the right to:

- know how we use your personal data
- access your personal data
- have personal data corrected if it is inaccurate or incomplete

- ask us to delete personal data when we no longer need it
- ask us to restrict how we process your data
- get your data from us and re-use it across other services
- object to certain ways we use your data
- be safeguarded against risks where decisions based on your data are taken entirely automatically
- tell us if we can share your information with 3rd parties
- tell us your preferred frequency, content and format of our communications with you
- to lodge a complaint with the independent Information Commissioner (ICO) if you think we are not handling your data fairly or in accordance with the law. You can contact the ICO at https://ico.org.uk/, or telephone 0303 123 1113.

7. Your personal data will not be sent overseas

8. Your personal data will not be used for any automated decision making.

9. Your personal data will be stored in a secure government IT system.

10. More information For more information on how Ofgem processes your data, click on the link to our "Ofgem privacy promise".

6.3 Appendix 3: Glossary

Term	Definition
API	Application Programming Interface a standardised way for accessing a web-based software application or enabling communication between software systems.
ANM	Active Network Management is the use of DNO-owned distributed control systems to continually monitor network limits, along with systems that provide signals to DER to modify outputs in line with these limits.
Archetype	Archetype refers to the example models of how market participants could interact at different stages of flexibility service delivery. These are the Do-nothing, Thin, Medium and Thick archetypes presented in the document.
CER	CER are a collective term for consumer owned energy system assets. These can include demand, storage and generation assets include EV charging (including V2G), heat pumps, HVAC, white goods, batteries, and rooftop solar or wind. DER traditionally refer to generation and storage assets only, limiting their ability to encompass consumer energy assets. DER also assumes a requirement to integrate assets into an existing energy system, and that 'behind the meter' is a natural boundary to delimit energy systems. The term CER uses a consumer and flex-centric view to define energy system assets.
DNO	Distribution Network Operators are the regulated entities who operate the electricity distribution network across GB. There are 14 DNO licensees that are subject to RIIO price controls. These are owned by six different groups.
DSO	Distribution System Operator the entity pursuant to the operation of the Distribution System, being planning and network development, network operation and market development of the Distribution System

DER	Distributed Energy Resources are business-owned small-scale power generation or storage devices that are connected to the distribution grid, located close to where energy is consumed. Their primary purpose can be to provide energy system services or to provide business services. Examples include medium sized solar farms, wind farms or batteries, commercial EV fleet charging, and industrial and commercial DSR from equipment or buildings.
Distributed Flexibility	The ability for DERs and CERs to modulate their operation in response to an external signal (i.e. a flexibility service).
Flexibility Service	The external signal (usually reflecting a contractual right) provided to a grid-connected asset's control system for a specified duration of time.
Flexibility Market	Flexibility Market refers to the arena of Flexibility Service procurement processes across various MOs within GB. This includes DNO local flexibility markets, ESO Frequency and Ancillary services, Balancing Mechanism, Wholesale Market, Capacity Market, P2P services (i.e. PPAs) etc.
FSP	Flexibility Service Provider is an umbrella term to cover the contracting party who takes delivery and other contractual risks when selling flexibility services, such as asset owners, asset operators and aggregators.
MO	Market Operator is a collective term for system operators, product owners, buyers of flexibility services.
Market Failure	Market failures refer to a situation where a market, in the absence of intervention, fails to allocate resources efficiently.
Market participants	Market participants are the Users, FSPs and MOs that all interact with each other in the Flexibility Market
Primacy rules	Primacy rules refer to the decision framework for coordinating MOs access to different assets, which electrically impact on each other.

Product	Product refers to the specific commercial and service requirements that a MO requires of a contracted FSP. Examples include Sustain for a DSO or Dynamic Containment for the ESO.
Smart	The ability of a device to respond in real time to communication signals, using digital technologies, to deliver a service.
Stacking rules	Stacking rules refer to the decision framework for coordinating MOs access to the same assets.
User	User refers to asset owners, asset operators, aggregators, market operators and other Third Parties who exchange data using a common digital energy infrastructure.

6.4 Appendix 4: Call for Input questions

Section 1

1. *What do you think distributed flexibility could contribute to the energy system?*
2. *Will a focus on CER flexibility also help enable other forms of flexibility, especially distributed flexibility?*

Section 2

3. *Is there a 'case for change' and a need for a common vision for distributed flexibility?*
4. *What is your vision for how to accelerate the delivery of accessible, coordinated and trusted markets for distributed flexibility?*
5. *Will certainty of an end vision help accelerate enabling work and make it cohesive?*
6. *When should a common digital energy infrastructure be in place? And therefore, when should development begin?*

Section 3

7. *What should a common energy digital infrastructure look like, and why? Please consider the archetypes or develop your own proposition.*
8. *What is your view on the desirability and feasibility of the archetypes or your own alternative proposition?*

Section 4

9. *Should a common digital energy infrastructure be new-build, or should it build-out from existing infrastructure?*
10. *What are the important areas for consideration when designing institutional delivery models for a common digital energy infrastructure?*
11. *What are the important areas for consideration when designing financial delivery models for a common digital energy infrastructure?*