Sustainable Energy Futures Ltd

Delivered by
Innovate UK and EPSRC

Enabling Decentralised Energy Innovation

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An independent report by Sustainable Energy Futures Ltd, commissioned by Innovate UK

Foreword

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Challenge Director
Prospering from the Energy Revolution challenge programme
Innovate UK

We live, work and travel in regions, cites, towns and communities. Yet our energy infrastructure remains very centralised – sending energy one way, from bulk supply points to the networks' edges where we live and work.

The case is building for other, complementary approaches, which take a more place-based perspective. Decentralised, often renewable power generation is growing fast as costs fall, with assets embedded in the communities that use the energy. Local heat and transport are on a path to electrification, with major implications for local and national grids. And technologies for managing and sharing energy supply and demand are improving all the time.

What if we could bring together energy supply, storage and use within cities and towns, enabled by the latest technologies? Could we balance supply and demand locally or regionally, create efficiencies, save carbon and costs, and establish entirely new ways of living with energy?

To look at these questions, in 2018 UKRI established the Prospering from the Energy Revolution challenge programme.

Delivered by Innovate UK, the £104m programme explores and develops approaches to smart local energy systems. It has invested in over 80 projects around the UK, most of them now complete or nearly complete. They range in scale from neighbourhoods to whole city-regions.

From these projects, there is growing evidence of the potential benefits of integrated place-based approaches. They could bring cheaper energy for consumers, build local prosperity, accelerate the journey to net zero through progress in towns and regions around the country, and mitigate the massive costs of reinforcing energy networks that will otherwise be needed.

But we have also learnt that there are many barriers in the way of large-scale roll-out of decentralised energy systems, including questions of regulation and governance.

That is why, as part of our programme, we have commissioned this important piece of work from Sustainable Energy Futures Ltd.

Decentralised energy will be an inherent part of our future energy system, and we have to consider how we can integrate and harness its value via energy system and market change programmes as we move to net zero.

I believe this work will make an invaluable contribution to the way we think about energy, and to the UK's urgent drive to decarbonise our energy system in a way that works for all.

The role of decentralised energy in net zero

1. **Decentralised energy is an increasingly important component of the UK and global energy system.**

   According to National Grid[1] decentralised generation will account for up to 30% of total electricity generation capacity by 2030. In addition, the Climate Change Committee suggest we will need to deploy over 12 million electric vehicles and EVs and 5.5 million heat pumps to meet the 6th Carbon Budget[2].

2. **There are economic benefits to smart decentralised energy systems.**

   Analysis by the EnergyREV research consortium indicates that that smart local energy systems (SLES) could save £1.7bn of total system costs annually[3].

3. **Decentralised energy is crucial to future energy system resilience.**

   The BEIS and Ofgem Smart Systems and Flexibility plan estimates that around 30 GW of low carbon flexibility will be required to support the energy system by 2030[4]. National Grid estimates that around 100 GW of demand side flexbility will be required by 2050[5]. This includes decentralised energy assets and approaches, including demand-side response from homes and businesses.

4. **Place-based approaches to the net-zero transition can unlock wider benefits.**

   PwC estimate that a place-based approach to the energy transition could unlock £108bn of savings on consumer bills for an investment of £58bn[6].

5. **There is a global opportunity for the UK to demonstrate the deployment, integration, and business models for decentralised energy.**

   According to the International Energy Agency, investment in clean energy will rise to $4 trillion annually, driven by decentralised electricity generation and decarbonisation of transport and buildings[7].

1 *National Grid Future Energy Scenarios 2022: www.nationalgrideso.com/future-energy/future-energy-scenarios*
2 *Climate Change Committee 6th Carbon Budget: www.theccc.org.uk/publication/sixth-carbon-budget/*
3 *EnergyREV report: www.energyrev.org.uk/outputs/insights-and-tools/benefits-of-flexibility-of-smart-local-energy-systems-in-supporting-national-decarbonisation/*
4 *BEIS and Ofgem Smart Systems and Flexibility Plan 2021: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1003778/smart-systems-and-flexibility-plan-2021.pdf*
5 *www.nationalgrideso.com/future-energy/future-energy-scenarios/flexibility*
6 *PWC report for IUK: www.ukri.org/wp-content/uploads/2022/03/IUK-090322-AcceleratingNetZeroDelivery-UnlockingBenefitsClimateActionUKCityRegions.pdf*
7 *IEA World Energy Outlook 2022: https://iea.blob.core.windows.net/assets/830fe099-5530-48f2-a7c1-11f35d510983/WorldEnergyOutlook2022.pdf*

Executive summary

Decentralised energy (DE) is energy based at or near the energy user and has a crucial role to play in the delivery of a decarbonised, smart, flexible, energy future. However, decentralised energy business models face barriers to delivering benefits and value to citizens, consumers, local communities and the wider energy system.

This report, commissioned by Innovate UK, reviews the barriers and potential solutions that will enable decentralised energy to play a full role in decarbonisation, innovation, and delivering positive outcomes for citizens and communities.

Our review of the evidence on decentralised energy business models, barriers, and solutions shows that all decentralised energy business models face barriers. These barriers fall into five main themes:

1. **Limitations in realising the value of decentralised energy** - Decentralised energy has significant value to local and national energy systems, as well as wider priorities, but is prevented from discovering and fully realising it.
2. **Market rules and governance** - The current regime for licensing energy suppliers and the self-governance of industry codes and technical standards stifles decentralised energy from realising its potential.
3. **Limitations in innovation support processes** - Innovation processes are not sufficiently flexible or integrated.
4. **Limited attention on the demand side** - Energy efficiency and demand-side approaches have been undervalued in the UK for decades and are inherently local and aligned with decentralised energy resources.
5. **Regulatory uncertainty and lack of multi-level coordination** - There is a national lack of vision and a holistic plan for the future zero-carbon energy system, particularly on the role of decentralised energy.

Together these barriers either prevent or create friction for decentralised energy business models. We have identified a set of priority solutions that could overcome these barriers (summarised in Figure 1). These solutions fall into four main categories: **Reviews** to gather evidence; creating specific and holistic energy system **strategies/visions**; essential **enablers**; and **reforms** to energy system roles, responsibilities, and markets.

Our analysis and discussions in the workshops held as part of this study also revealed that these solutions alone are insufficient. We have also identified cross-cutting issues that pervade decision-making in energy and will affect the outcomes of any measures to enable decentralised energy. These cross-cutting issues are important because they affect both how decisions are taken and cause constraints on solutions. We have identified six cross-cutting issues:

- A centralised mindset;
- A lack of definition and agency for decentralised energy assets and actors;
- A lack of cross scale coordination and clear roles;
- A lack of risk-based approaches to managing change;
- An outdated and uncoordinated approach to resilience;
- Limited recognition of the diverse values of decentralised energy.

In conclusion, one solution stands out from this review: **a clear, holistic, and inclusive vision for the future energy system**. This vision would set out the principles for future reforms and address the cross-cutting barriers that pervade decision-making in energy. It would accommodate the economic and wider benefits of decentralised energy and the needs, preferences and values of citizens, communities, and consumers. It would clarify and assign the roles and responsibilities of energy system institutions and actors at all scales, ensure data is open and accessible, and allow innovative business models to emerge whilst protecting customers. It would also ensure that all supply and demand-side assets are treated equally and can play a full role in future system operation.

Figure 1: Summary of priority solutions.

A clear, holistic and inclusive vision for decarbonising the energy system

	REVIEW	STRATEGY	ENABLERS	REFORMS
Barrier 1 Realising value of decentralised energy	Review benefits and impacts of dynamic pricing on DSO operations Develop common methodologies for assessing local co-benefits	Clarity and responsibility and role of DNO/DSO in delivering decentralised energy FSO whole systems and local costing role		Implement REMA reforms and assess the impact on DE Demand-side reform in energy markets Clarify role, rights and access for energy communities
Barrier 2 Market rules and governance		**CREATE AN OVERARCHING STRATEGY AND VISION FOR ENERGY SYSTEM DECARBONISATION**	Deliver half-hourly settlement	Implement meter splitting Implement retail market reform
Barrier 3 Innovation support			Implement energy digitalisation taskforce recommentations	Create energy innovation zones
Barrier 4 Demand-side	Baselining and common methods for DSR/efficiency	Strategy for the future of the gas grid (including a hydrogen grid)		Establishment of a new body to manage infrastructure decommissioning
Barrier 5 Vision and scale	Review progress of the DSO transition Review of local markets (access, value streams, interactions)	Revise strategy and policy statement for Ofgem clarity on local and net zero	Require local or regional energy plans and integrate with network business planning	Implement heat network regulation and zoning Regulate waste heat (cross-regulation)

Introduction

Innovate UK commissioned this analysis and report in response to emerging evidence from the Prospering from the Energy Revolution (PfER) programme. This evidence showed that governance arrangements do not currently allow distributed energy to play a full role in decarbonisation, innovation or delivering positive outcomes for citizens and communities and the businesses that service them. Existing policy, regulation and governance structures do not recognise the role and value of decentralised energy, particularly at the grid edge and on the demand side. Innovate UK had four objectives for the analysis:

1. Identify possible roles and architecture of a net zero energy system and market with a focus on distributed energy, particularly from a grid edge, citizen perspective.
2. To understand how the current policy, regulation and governance arrangements act as a barrier to distributed, smart energy systems.
3. To assess how governance arrangements could be changed to better enable decentralised energy roles and business models whilst ensuring citizens, customers and consumers are protected.
4. Identify change proposals that are modular, interoperable, scalable and regulated appropriate to the level of risk posed.

Our approach to meeting these objectives is summarised in Figure 2. The detailed methodology can be found in the companion report, Enabling Decentralised Energy Innovation: Analysis and Methodology at www.energyfuture.uk/research.

The structure of this report follows our methodology. For brevity we have combined sections 3 and 4.

Section 1 describes our analysis of 14 PfER projects in terms of their objectives, actors and business models. We present seven business model archetypes as units of analysis for the rest of the report.

Section 2 summarises our literature review and crowdsourcing exercise of barriers to decentralised energy business models. We present five themes of barriers and multiple sub-barriers that affect decentralised energy business models.

Section 3 summarises our review and analysis of solutions to the barriers to decentralised energy innovation. We present a framework and prioritisation of solutions based on two stakeholder workshops. We also identify cross-cutting issues that must be addressed to enable decentralised energy innovation.

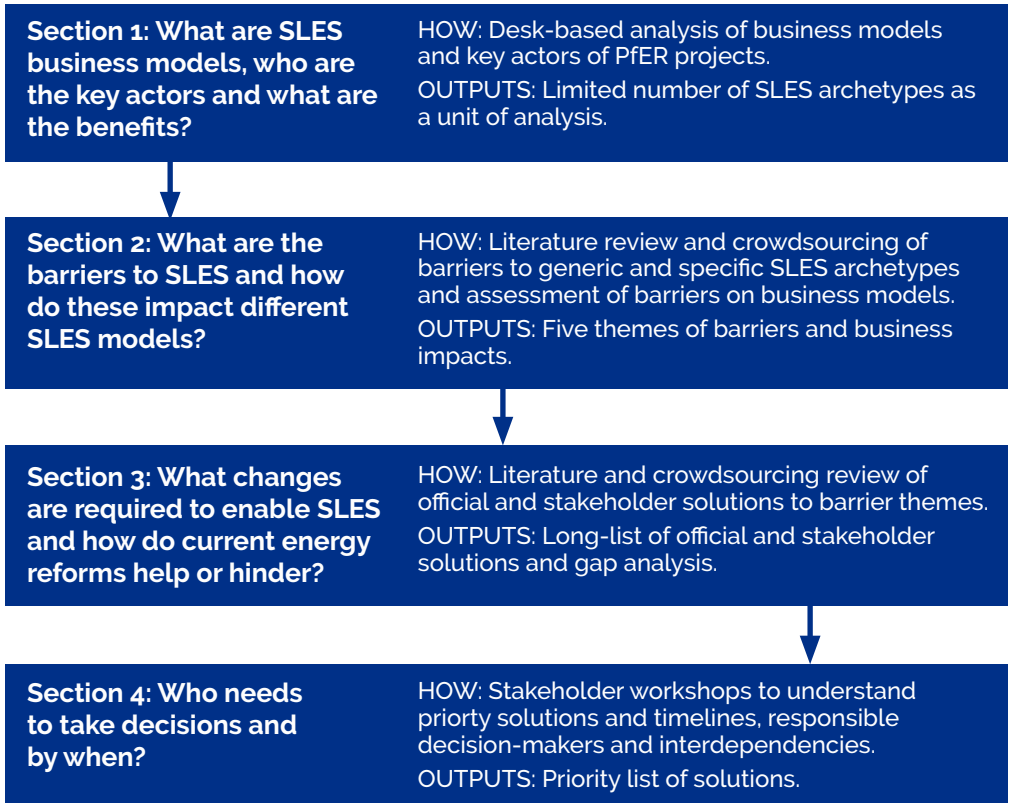

Figure 2: Summary of methodology and outputs of report.

Section 1

What are decentralised energy business models, who are the key actors and what are the benefits?

This section explores the customers, objectives, purpose, actors, and configuration of decentralised energy business models[8].

We have analysed the Prospering from the Energy Revolution (PfER) demonstration and detailed design projects[9] and present four representative business model archetypes (BMAs)[10]. These four BMAs are supplemented by three additional BMAs derived from the wider literature, and together these seven BMAs form units of analysis for subsequent sections of this report.

BMAs are a helpful way to study decentralised energy businesses. They make visible the relationships, the technologies and interactions with policy and regulation. This is important as these aspects co-evolve, for example, customer behaviours and preferences will affect how a business develops its proposition.

8 Business models describe the nature of value delivered to customers, how organisations and networks create value and the means of capturing revenues from that value [REF].
9 Read more about the projects here: www.ukri.org/wp-content/uploads/2022/01/UKRI-250122-SmartLocalEnergySystemsEnergyRevolutionTakesShape.pdf
10 Business model archetypes describe the relationships between customers and actors and how energy, value and services circulate.

Decentralised energy business model archetypes

Virtual Power Plant

Short description: Optimising assets behind a virtual meter to achieve energy system objectives.

Example PfER projects: ReFLEX Orkney & Liverpool Multi-Vector Energy Exchange

The Virtual Power Plant (VPP) creates a virtual meter behind which all the local energy assets can interact. The objectives of the VPP and how it derives value include enabling trading and sharing energy locally, resolving local constraints and maximising self-consumption of local renewables. The interface with the wider energy system is via a virtual meter, which will essentially be importing or exporting electricity half-hourly. Depending on objectives, the VPP might provide wider energy system services, such as flexibility and balancing and ancillary services locally and nationally.

There are common features in the different VPPs. There is some form of optimisation and local trading platform 'inside' the VPP. This platform enables assets to trade electricity and moderate demand within the VPP. There is also an interface with the wider energy system, which some projects call a "virtual energy company" (VEC). This is responsible for trading electricity with the wider system, often through a licensed supplier.

For a customer to be part of a VPP, they would need to sign up and register the assets that they wish to make available to the VPP (for example, a home battery system). This might include signing some form of agreement that stipulates when and how customer assets can be used, particularly if any automation is involved. The benefit to involvement will depend on the VPP objectives and could include lower bills, greater utilisation of local energy resources and additional revenue from flexibility services. Depending on how the VPP is configured, it could be either the VEC or the customer's usual energy supplier who is responsible for billing and wider regulatory compliance.

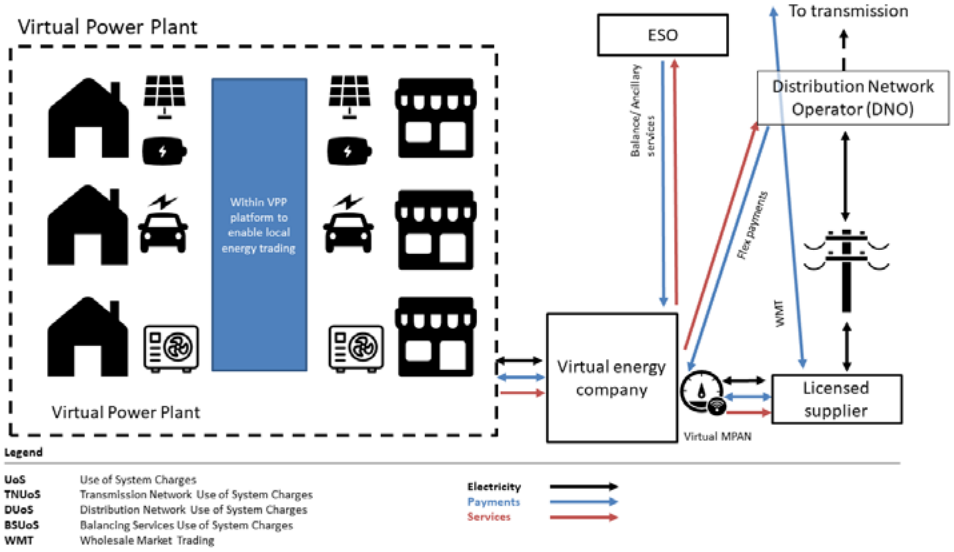

Figure 3: Virtual Power Plant BMA.

Decentralised energy business model archetypes

Private network

Short description: Creating a private electricity or heat network to deliver energy services to users.

Example PfER projects: Energy Superhub Oxford (ESO), Peterborough Integrated Renewables Infrastructure (PIRI), Project REMeDY, GreenSCIES2 & Milford Haven: Energy Kingdom

There are examples of private networks that deliver heat or electricity, or both. The principles of the business models are similar. They aim to build a private energy network to deliver energy services to customers (and possibly the wider energy system). The customers of the network pay the private network operator for both the energy they consume and for the cost of maintaining the network.

For a private wire electricity network, there are similarities with the VPP archetype. It will require some form of energy company to operate the network, optimise the energy assets and demand, bill customers and interface with the wider energy system. For a private heat network, if it is just heat being generated and supplied to end customers, then the heat network operator will be responsible for operating the network, optimising the energy assets and demand and billing network customers.

There is usually a smart platform at the centre of the private network responsible for optimising the connected assets and customer demand. This might include utilising waste heat sources, operating heat assets (like heat pumps), heat networks, heat stores, electricity networks, electricity generation assets (local renewables and behind-the-meter assets in homes), local battery storage and assets such as EVs and chargers. The platform could also enable the trading of energy between users of the network (for example, a home selling its excess PV to other users).

From a customer perspective, depending on the nature of the private network, customers may need to be recruited (e.g., to recruit enough customers to make a heat network economically viable), or they might come with the network (e.g., if the network is the only source of heat or electricity in a place). In an electricity network, if the customer has energy assets that could contribute, they will need similar agreements to those described in the VPP. In all cases, the private network company will be responsible for pricing and billing for energy services, collecting the use of system charges and dealing with customers.

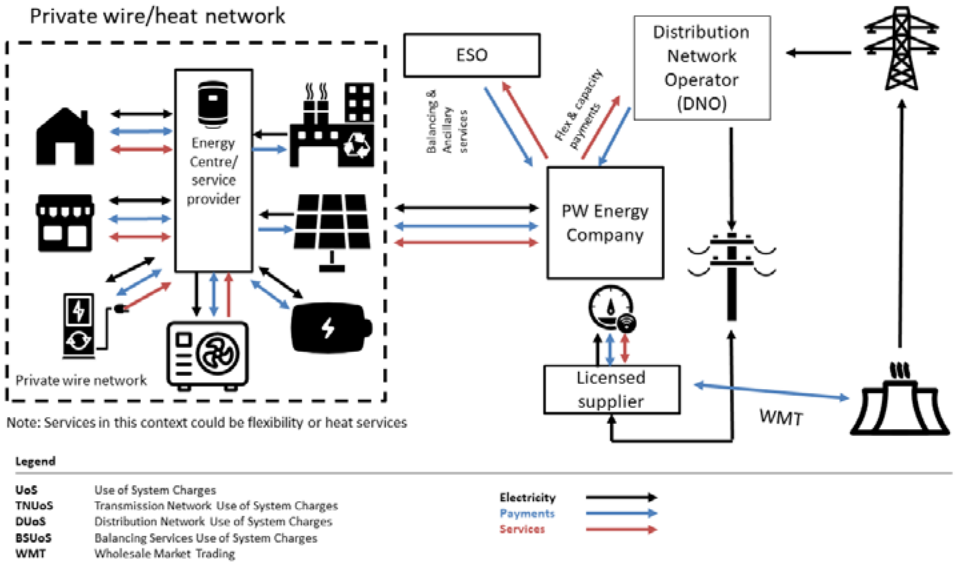

Figure 4: Private network BMA.

Decentralised energy business model archetypes

Flex-enabled business models

Short description: Working with local users and assets to address local network constraints and enable more local renewables.

Example PfER projects: Local Energy Oxfordshire (LEO), Greater Manchester Local Energy Market, Project GIRONA

This family of business model archetypes is focused on unlocking flexibility from various local assets to solve local (and national) energy system issues. Often the driver is local grid constraints acting as a barrier to local renewable electricity generation deployment.

Ownership of local energy assets is mixed (for example, behind-the-meter assets in homes and businesses, as well as standalone grid assets, like solar farms). Consequently, the business models either focus on unlocking multiple different routes to market or on specific use cases. For example, in Project LEO, the Low Carbon Hub attempts to unlock flexibility from all local sources through playing the role of the Local Energy Market (LEM) Platform. It works through different intermediaries – energy suppliers for homes and small businesses and aggregators for other assets – or directly with some local assets, creating a pool of local flexibility.

The Rose Hill Primary School in Oxford, part of Project LEO.

From a customer perspective, particularly homes and small businesses, they would be recruited by the LEM platform. This would include clarity on how their assets will be used, the value/reward available and any permissions required (such as automating asset dispatch). Depending on the nature of the contracts and agreements, the LEM platform would either automatically trigger assets or pass the signal through to asset owners to do so. The LEM platform is responsible for finding opportunities to sell and deliver flexibility services and ensuring customers are billed accurately. In return, it will charge a transaction fee for delivering the services.

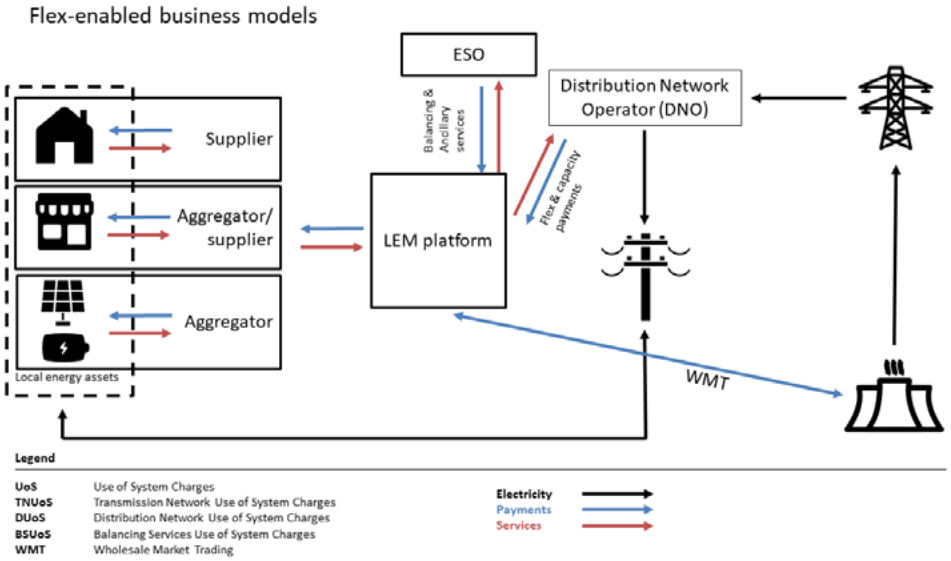

Figure 5: Flex-enabled business models archetype.

Decentralised energy business model archetypes

Smart local energy system marketplace + optimisation BMA

Short description: Creating the conditions for new smart local energy systems to emerge.

Example PfER projects: Zero Carbon Rugeley, West Midlands RESO & Rewire-NW

This archetype seeks to create the conditions for a myriad of decentralised energy business models to emerge. Often driven by a local authority, it undertakes activities such as energy planning, engagement with local citizens and actors, investment, and asset coordination. They also feature the introduction of some organisations or platforms responsible for optimising the local energy system and maximising value by trading with local and national energy markets. In some ways, this is creating a local energy innovation and investment zone from which decentralised energy business models can emerge.

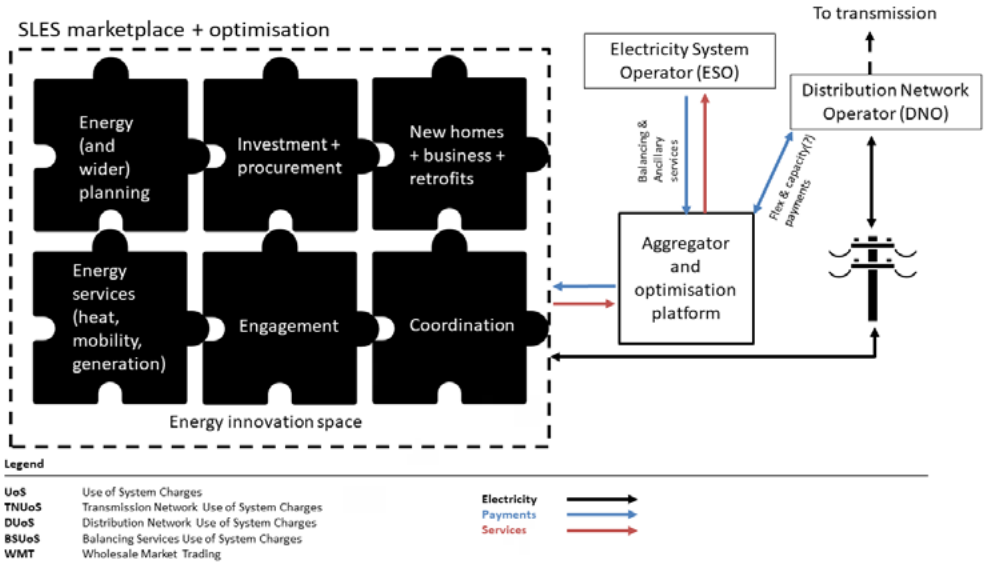

Figure 6: SLES marketplace and optimisation BMA.

The West Midlands RESO project is planning Coventry's low carbon future.

Additional BMAs for analysis

The four BMA clusters arising from our analysis of the PfER projects do not necessarily represent the full range of decentralised energy business models operating in the UK. To address this, we undertook a rapid literature review[11] to find additional business models to consider in our analysis. The literature review revealed three additional business model archetypes, summarised in the table below.

Business model archetype	Brief description
Peer-to-peer energy	P2P business models use third-party digital platforms to enable prosumers to securely trade energy with each other with minimal involvement from suppliers. We have used the UK model developed in the PROSEU[12] project to illustrate the approach. Several of the PfER projects discuss P2P energy, but is unclear whether any have been successful in demonstrating the model.
Energy Service Company (ESCo)	Energy service business models sell energy services such as reliable electricity, hot water, and stable room temperatures rather than selling a specific technology or energy commodity. Consequently, ESCos shift responsibility for the performance of the building into long-term contracts between the ESCo and the household/business. We included a specific ESCo archetype because such models focus on energy efficiency approaches.
E-Mobility service provider	We included E-Mobility service provider because it specifically deals with transport. The emergence of transport electrification across public and private vehicle fleets is an opportunity to link with local energy systems.

11 Search terms "local energy AND business model" and "decentralised energy AND business model" in Google Scholar.

12 PROSEU (https://proseu.eu/) is an EU-funded research project, bringing together 11 project partners from seven European countries. It aims to enable the mainstreaming of the renewable energy 'prosumer' phenomenon into the European Energy Union. Prosumers are active energy users who both produce and consume energy from renewable sources.

Section 2

What are the barriers to decentralised energy and how do these impact different decentralised energy business models?

This section explores the barriers to decentralised energy (DE) and related customer propositions. The analysis is based on a literature review, interviews with key stakeholders and a crowdsourcing exercise. The methodology is detailed in the full analysis and methodology report at www.energyfuture.uk/research. We have also assessed how the barriers affect the seven decentralised energy business model archetypes.

The barriers to decentralised energy exist in the context of significant changes taking place in the GB energy system. Considerable action is already taking place by the Government, Ofgem and others to develop a smart and more flexible energy system.

This includes a shift towards increased network access rights at the distribution level, the development of market-wide half-hourly settlement by 2025, commitment to developing a Future System Operator, ongoing transition from distribution network operator (DNO) to distribution system operator (DSO), the work streams identified within the Smart Systems and Flexibility Plan, as well as numerous other consultations and reforms (see Section 3 for the major ones).

Nevertheless, our analysis made clear that considerable barriers to decentralised energy business models still exist.

Themes of barriers to decentralised energy

The barriers identified are structured around five key themes with several sub-topics within these overarching challenge areas. These comprise:

1. Limitations in realising value from SLES
2. Market rules and governance
3. Limitation in innovation support processes
4. Lack of attention on the demand-side
5. Regulatory uncertainty and lack of multi-level coordination

We briefly describe the themes of barriers and associated sub-barriers in Table 1. In addition to these overarching themes, there are complex interlinkages between many of the barriers. For example, limitations in data visibility and access partly drive difficulties in value stacking across markets, and a focus on the supplier hub model limits opportunities to integrate energy efficiency into value propositions. For many projects, it is the combination of multiple barriers which is limiting business model viability and scalability.

These complex interlinkages between barriers are recognised in theme five which highlights the challenges stemming from a lack of systemic oversight of market and regulatory reforms from the Government and Ofgem.

How do the barriers affect the business model archetypes?

The effect of the barriers on decentralised energy business models depends on how business models are configured. To test this, we analysed the seven BMAs we identified in Section 1 against the five themes of barriers. Table 2 summarises the findings – the detail of this analysis is in the separate analysis and methodology document available at www.energyfuture.uk/research.

The analysis demonstrates that all the BMAs are affected by a range of barriers. For the most part, the impact is a soft-stop/frictional-type effect. Often it is the combination of multiple 'soft-stops' that in aggregate prevent the viability of BMAs.

Many barriers impacted on a wider range of BMAs. For example, sub-barrier 1.1 on challenges in revenue stacking affects all the BMAs. This is because all the BMAs can create value in multiple markets, but there are issues with (multiple-) market access, especially for behind-the-meter assets, such as home batteries.

There are also specific 'hard-stops' that prevent some BMAs from realising their ambitions. As an example, peer-to-peer energy is difficult because the single supplier model makes it difficult for multiple peers to trade energy with one another as they may all be with different suppliers (sub-barrier 2.1).

Table 1: Themes of barriers and sub-barriers to decentralised energy.

Barrier theme and description	Sub-barrier and short description
Theme 1: Limitations in realising value from distributed energy Distributed energy resources (DER) are an increasingly important part of the energy system. Significant barriers remain to such local energy resources realising their potential energy system value. It is difficult, if not impossible, to trade and settle energy locally in local energy markets. DERs are also restricted in their ability to deliver flexibility services locally (because the markets are nascent) and nationally (because there is limited visibility and interoperability between national balancing and ancillary services markets). Recent changes to the residual and forward-looking charges for electricity networks have reduced the business case for existing DER. However, they have also reduced the cost of connecting new assets. The cost of electricity is also artificially high compared to gas because of how levies are distributed. These factors have the effect of creating hard barriers and frictions that restrict distributed energy resources from realising their potential value to the wider energy system. In addition, there are a range of co-benefits from local energy that cannot be recognised by decision-makers, despite being important locally.	**1.1 Challenges in revenue stacking and the need for market liquidity** Decentralised energy resources have value to local and national energy systems. It is currently hard to stack up valuable services and retain the value locally. **1.2 Complex routes to market** Flexibility markets are largely designed for large portfolios of distributed assets or large distributed energy resources. This can exclude or cause friction for smaller assets. The rules of market participation can be exclusive and are often complex. **1.3 Local settlement** It is difficult, if not impossible, to trade and settle energy locally in local energy markets. **1.4 Non-financial value and co-benefits** The value of flexibility services and decentralised energy is often considered only in financial terms, and environmental and social benefits are overlooked **1.5 Targeted Charging Review** Ofgem's decision to recover network residual costs via fixed charges and reduce embedded benefits has negatively impacted the business case for decentralised energy assets. **1.6 Flexible connections and principles of access** It is currently very difficult to change connection agreements to accommodate flexibility. In addition, Active Network Management blocks the value of time-based capacity optimisation and capacity trading. **1.7 Imbalanced levies between gas and electricity** The lack of policy costs on gas has a significant impact on the viability of energy efficiency and heat decarbonisation approaches.

Barrier theme and description	Sub-barrier and short description
Theme 2: Market rules and governance The current regime for licensing energy suppliers and the self-governance of industry codes and technical standards stifles decentralised energy from realising its potential. To undertake any (at scale) energy generation, energy supply and energy network activities (including, in the future, heat networks) a licence is required from Ofgem. These licences are complex, prescriptive, rigid, and were not designed with a highly decentralised energy system in mind. Consequently, innovative, or non-traditional energy activities, such as local energy approaches, struggle to fit in the framework and often cannot deliver the services they aspire to. In many cases, local energy approaches need to work with a licensed supplier, which restricts the customers they can reach and adds transaction costs to their proposition. Whilst there is an exemption regime for generation and supply, the Government is currently reviewing this to reduce distortions. Change to licences and codes is slow, complicated and incremental.	**2.1 Outdated principles and supplier hub** The supplier hub model is widely accepted as a barrier to decentralised energy business models due to complexity and high entry costs for non-traditional and smaller suppliers. **2.2 Multiple suppliers** The single supplier model is a blocker for business models that rely on transactions from multiple parties at a single meter point. **2.3 Derogations and exemptions** Existing regimes for derogations and license exemptions are not seen as operating effectively. **2.4 Non-energy licensing and regulatory barriers** The licensing regimes in other sectors can present a barrier to some SLES models. For example, FCA regulations require a credit licence for financing energy assets. **2.5 Complex and fragmented industry codes** Industry codes and the code governance process have been widely criticised as fragmented, reactive and overly complex.

Barrier theme and description	Sub-barrier and short description
Theme 3: Limitation in innovation support processes There are several linked problems that slow innovation in decentralised energy business models. The Ofgem regulatory sandbox process, which supports energy business model innovation, is complex, time consuming, limited in scope and often does not create the conditions to test innovations at scale. Additionally, lessons are not easily shared, constraining learning in the sector. Whilst there is funding available for energy innovation the landscape is siloed and poorly coordinated. Funding rules can be prescriptive and lack flexibility to change as innovation progresses and the overall process is somewhat risk averse. Data access and sharing is also an issue for innovation. Access to network and customer data is central to energy business models and access to such data is difficult. Additionally, data from energy assets in increasingly becoming a pay-for service.	**3.1 Regulatory sandboxes not sufficient** Accessing regulatory sandbox processes is complex and time-consuming and often does not result in the sufficient ability to test innovations at scale or provide feedback to affect changes to rules. **3.2 Inflexibility in innovation funding** Innovation funding can be siloed and with limited coordination. Also, funding does not provide sufficient flexibility to change, with rigid risk management processes and a high administrative burden. **3.3 Data access and sharing** Current arrangements for data access and sharing are not sufficient. There are challenges in accessing timely and granular data from DNOs.
Theme 4: Lack of attention to demand-side measures The energy system does not see customers as people; rather, it sees them as loads on the system. Energy efficiency has been systematically underfunded and tends to be in boom-and-bust cycles or via suppliers where it jars with their business model to sell more commodities. It is hard to get paid for not demanding energy, even though it carries system benefits. Markets are skewed towards supply technologies – it is easier to get a contract as a gas or diesel power plant in most markets than a contract to reduce demand. Consequently, these markets tend to be carbon intensive. There is a lack of high-quality, trusted system advice that integrates across building fabric and other technologies – standards are required for information provision.	**4.1 Challenging to integrate energy efficiency measures into value propositions** Energy efficiency has been underfunded, and it is currently hard to realise the value of reducing energy demand. It is difficult to integrate energy efficiency measures into DER business models. **4.2 Markets skewed towards supply technologies** Demand reduction and demand-side assets are not on a level-playing field with energy supply assets. This has the effect of leaving assets 'off the table' or causing friction for demand-side assets participating in markets

Barrier theme and description	Sub-barrier and short description
Theme 5: Lack of coordination within and across scales There is a lack of holistic statement of policy support for the role of decentralised energy in net zero (for example, in the Net Zero Strategy). This has fed through into a lack of systemic analysis of risks, benefits, and barriers by the Government and Ofgem. Whilst multiple reforms are in progress, they are progressing at different rates with unclear interactions. Many reforms have unspecified decision and implementation timescales. This regulatory uncertainty is a major challenge in clarifying the value propositions and financial viability of many projects. Local energy systems suffer from a lack of local resources, capabilities, data and powers. Local authorities are seen as important in coordinating local energy and wider spatial planning but lack the formal roles and resources to do so. DNOs are also a key body and lack the incentives to better coordinate.	**5.1 Policy uncertainty and lack of systemic approach to reform** The myriad of policy reforms has created a confusing and complex landscape with the outcomes of many consultations and reforms still awaited. There is no clear overarching vision for energy system change.
	5.2 Governance gaps at the local and regional level There is no statutory role for local government in energy system change, innovators need to develop bespoke relationships and processes in each area, and there is a lack of clarity on central-local net zero interactions.
	5.2.1 No local planning and coordination role A lack of local planning and coordination, and uncertainty in roles and responsibilities at the local and regional level, are consistently identified as barriers to DE.
	5.2.2 DSO uncertainties There is a lack of a whole system view in DNOs with poor integration between DNO innovation and connections teams. There are also uncertainties in DSO transition processes, roles and responsibilities, and timescales
	5.2.3 Heat network barriers A lack of clarity on the regulatory framework and zoning for heat networks has hampered projects - although a new regulatory framework is coming.

Table 2: Summary of analysis of barriers against the seven BMAs.

Sub Barrier	BMA1 VPP	BMA 2 Private wire/HN	BMA 3 Flex enabled	BMA 4 SLES Market	BMA 5 P2P	BMA 6 ESCo	BMA 7 E-Mobility
Theme 1: Limitations in realising value from SLES							
T1.1 Challenges in revenue stacking and need for market liquidity	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop
T1.2 Ensuring flexibility marketplaces are accessible and standardised	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop
T1.3 Local settlement and Local Energy Markets (LEMs)	Hard Stop	Soft Stop	Hard Stop	Hard Stop	Hard Stop	Not Relevant	Not Relevant
T1.4 Non-financial value and co-benefits	Hard Stop	Soft Stop	Hard Stop	Hard Stop	Soft Stop	Soft Stop	Not Relevant
T1.5 TCR	Soft Stop	Green Light	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop
T1.6 Flexible connections and principles of access	Green Light	Green Light	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Not Relevant
T1.7 Imbalanced levies between gas and electricity	Soft Stop	Soft Stop	Green Light	Soft Stop	Soft Stop	Soft Stop	Soft Stop
Theme 2: Market rules and governance							
T2.1 Outdated principles and supplier hub	Soft Stop	Soft Stop	Soft Stop	Hard Stop	Hard Stop	Hard Stop	Soft Stop
T2.2 Multiple suppliers	Soft Stop	Not Relevant	Hard Stop	Soft Stop	Hard Stop	Not Relevant	Hard Stop
T2.3 Derogations and exemptions	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Not Relevant
T2.4 Non-energy licensing and regulatory barriers	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Not Relevant	Soft Stop	Soft Stop
T2.5 Codes and governance	Soft Stop	Green Light	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop

Table 2: Summary of analysis of barriers against the seven BMAs cont'd.

Sub Barrier	BMA1 VPP	BMA 2 Private wire/HN	BMA 3 Flex enabled	BMA 4 SLES Market	BMA 5 P2P	BMA 6 ESCo	BMA 7 E-Mobility
Theme 3: Limitation in innovation support processes							
T3.1 Regulatory sandboxes not sufficient	Soft Stop	Soft Stop	Soft Stop	Hard Stop	Soft Stop	Soft Stop	Soft Stop
T3.2 Inflexibility in innovation funding	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop
T3.3 Data access and sharing	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop
Theme 4: Lack of attention to demand side measures							
T4.1 Challenging to integrate energy efficiency measures into value propositions	Not Relevant	Soft Stop	Not Relevant	Soft Stop	Not Relevant	Hard Stop	Not Relevant
T4.2 Markets skewed towards supply technologies	Hard Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop
Theme 5: Lack of coordination within and across scales							
T5.1 Policy uncertainty and lack of systemic approach to reform	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop
T5.2 Governance Gaps at the local and regional level	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Not Relevant	Soft Stop	Not Relevant
T5.2.1 No local planning and coordination role	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Not Relevant	Soft Stop	Not Relevant
T5.2.2 DSO uncertainties	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop	Soft Stop
T5.2.3 Heat network barriers	Not Relevant	Soft Stop	Not Relevant	Soft Stop	Not Relevant	Soft Stop	Not Relevant

Section 3

What changes are required to enable decentralised energy and how should these be prioritised?

This section focuses on the range of possible solutions to barriers and narrows these down to a set of priority solutions.

To do this, we reviewed existing literature, then tested and validated our findings with the wider energy community through a crowdsourcing exercise. We prioritised solutions and identified interdependencies in two workshops with energy system experts.

The full methodology is described in detail in the analysis and methodology companion document to this report, available at www.energyfuture.uk/research.

Our analysis distinguishes between official solutions and solutions proposed by stakeholders. The distinction is that official solutions can be implemented by the organisations (such as governments and Ofgem) proposing them. Several of the solutions were contained in five key official documents from HMG[13], BEIS[14,15], Ofgem[16], and the Energy Networks Association[17] (ENA).

Stakeholder proposals were derived from a literature review, interviews with PfER projects and crowdsourcing with the wider distributed energy stakeholder community.

13 *HMG Net Zero Strategy: Build Back Greener. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1033990/net-zero-strategy-beis.pdf*
14 *BEIS Energy Security Bill overarching factsheet. 2022. www.gov.uk/government/publications/energy-security-bill-factsheets/energy-security-bill-overarching-factsheet*
15 *BEIS Review of Electricity Market Arrangements Consultation Document. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1098100/review-electricity-market-arrangements.pdf*
16 *BEIS Delivering a smart and secure electricity system: consultation on interoperability and cyber security of energy smart appliances and remote load control. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1088796/smart-secure-energy-system-consultation.pdf*
17 *ENA Open Networks Programme. www.energynetworks.org/creating-tomorrows-networks/open-networks/*

The range and themes of solutions

The analysis in this report has identified a range of possible solutions to address the varied and systemic barriers to distributed energy playing its full role in decarbonised, cost-effective and equitable energy systems. The analysis presented here focuses on the solutions prioritised by stakeholders. The detail of our analysis and the full range of official and stakeholder solutions to the five barrier themes is in the analysis and methodology report. Our analysis of the full range of solutions revealed several notable themes:

- Most barriers have one or more official solutions in progress or potential solutions proposed by stakeholders. However, there are few decisions that individually fully resolve any of the key barriers to decentralised energy. Comprehensive solutions packages are lacking for all barrier themes, indicating a lack of strategic or holistic strategy for decentralised energy.
- Official solutions tend to be national in formulation and only occasionally consider local or decentralised aspects. The BEIS Review of Electricity Market Arrangements (REMA)[18] is an example of this, where most reforms proposed are national in nature, except for local ancillary markets. Approaches to address local and national coordination appear to have reservations ceding power to local decision-makers. It is unclear what the official position on local energy is, particularly its role in the energy transition. Wider stakeholder solutions appear more consumer-centred than official solutions.
- Many of the proposed official solutions are in the consultation phase or are subject to other uncertainties (such as the uncertainty over when the Energy Security Bill, or subsequent formulations, will pass through Parliament). This results in considerable ambiguity over which solutions will be implemented.
- There is wide support for ongoing developments in relation to heat network regulation and zoning, code management reform, sandbox review and consumer protection in flexibility services. In many instances, stakeholders are proposing that reforms go further than current plans.

Partners and funders in the ReFLEX Orkney project.

- There is a lack of attention to the demand and retail side. There are gaps in retail market reform as well as, for example, in creating space for (local) business model innovation. There are also gaps in valuing demand-side energy in the same way as the supply side.
- The Energy Networks Association Open Networks Programme (ENA ONP)[19] is working across at least three of the barrier themes. However, there was limited discussion on the programme by wider stakeholders in their proposed solutions. This could indicate a lack of awareness or engagement between wider stakeholders and the ONP.
- There is a stakeholder emphasis on the need for a strategic position on the role of distributed energy and the creation of institutional structures to support this e.g., a dialogue process between innovators and government or the regulator, local governance reform, and a framework for decentralised energy co-benefits.

18 www.gov.uk/government/consultations/review-of-electricity-market-arrangements
19 www.energynetworks.org/creating-tomorrows-networks/open-networks/

Priority solutions

Categories of solutions

In this section, we identify the priority solutions to enable decentralised energy innovation. These priority solutions are derived from a long list of potential solutions we identified in our literature review (see methodology report). We ran two workshops with expert stakeholders to reduce this long list of solutions to narrower set of priorities. We summarise these priority decisions in Tables 3-6.

These priority decisions fall into four categories: reviews, strategies/visions, enablers, and reforms. There is an implicit scheduling of these categories of actions as policy development tends to progress from review (for example, a call for evidence) through strategy (for example, The Net Zero Strategy), to actions such as putting in place enablers (for example, the recommendations of the Energy Digitalisation Taskforce) and large-scale reforms (such as the reforms from the Electricity Market Review). Our definition of these four categories is:

- **Reviews:** This category focusing on addressing a knowledge or evidence gap to inform a future decision. These include reviews of roles and incentives (e.g., the DNO/DSO transition), the impact of ongoing decisions (e.g., impact of reforms on local energy markets) and the development of critical evidence bases (e.g., co-benefits and baseline data for DSR).
- **Strategy/Vision:** These solutions represent public strategies/visions that set a clear direction of travel for the energy sector. These included specific strategies (such as strategy for the future of the gas grid) and an overarching strategy/vision for the whole energy sector.
- **Enablers:** These solutions put in place essential elements that enable infrastructure and actors to deliver decentralised energy innovation, for example, implementing the full range of recommendations from the Energy Digitalisation Taskforce.
- **Reforms:** These are specific decisions that will reform roles, responsibilities, and markets in the energy system to enable decentralised energy innovation. There are several reform types, including specific decisions (e.g., multiple suppliers at a single meter point), market reforms (e.g., REMA and retail market reform), and new regulations (e.g., heat network regulation).

These categories are clearly interlinked and can be iterative, so placing a timeframe on specific solutions is difficult. However, the clear message from our workshops is that all the priority solutions need action now.

Priority solutions by category

Figure 1 in the executive summary prioritises solutions against the five themes of barriers and the four categories of solution types. These are the solutions prioritised by stakeholders from a long list of possible solutions. For the full list of possible solutions, please see the analysis and methodology document. We provide more details on each priority solution in terms of categories, barriers addressed, what it enables, key decision-makers, timeliness and interdependencies in tables 3-6. All the actions in tables 3-6 have been identified as priority solutions by stakeholders. The order they are presented in each table does not represent any further prioritisation within categories.

Stakeholders tended to prioritise solutions to three of the barrier themes. These were value streams (Barrier 1), coordination across scales (Barrier 5) and, to a lesser extent, market rules and governance (Barrier 2). The discussion revealed that the barriers concerning innovation (Barrier 3) and lack of attention on the demand side (Barrier 4) were seen to largely flow from the other three themes of barriers. For example, whilst specific actions were prioritised to improve the innovation landscape, even if these were implemented wider system barriers to achieving value or interacting with consumers would persist. Currently, innovators can try to solve specific business model barriers, but the scalability of many propositions is limited by the lack of a more transformative vision and reforms to create a decarbonised, smart, flexible energy system.

Category: Review solutions

Table 3: Summary of prioritised review solutions, key decision maker, timeliness and interdependencies

Barrier	Prioritised Solution	What does it enable	Decision maker	Timeliness	Interdependencies
1	Analyse and publish the distribution network benefits and costs of dynamic pricing at a large scale to inform network charging reform prior to ED3.	Creating a level playing field for distributed assets and services. Enable visibility of system benefits and costs.	Ofgem	Prior to ED3	Action on DE value streams, FSO whole system costing.
1	Develop an evidence base and assessment framework for local energy co-benefits to ensure consistent valuation and integration into policy assessments.	Consistent valuation of non-energy system benefits.	BEIS	Now	Other reforms to unlock local value streams.
4	Develop baselining tools and common methodologies so counterfactuals can be created for efficiency and demand-side response business models.	Increases investor and customer confidence. Allows comparability of value propositions.	ENA	Now	Links to other actions to enable value streams, Local energy planning and energy data.
5	Strategy for the future of the gas grid (including a hydrogen grid) and establishment of a new body to manage infrastructure decommissioning.	Clarity on key infrastructure.	BEIS	Within 5 years	DE value streams, local energy planning, DSO implementation.
5	Review progress on the DSO transition, including the ONP programme and progress on a data-driven approach. Ensure the DSO incentive and RIIO ED2[20] checks and balances are implemented i.e. reopeners and uncertainty mechanisms.	Clarity on progress and challenges in local coordination, data sharing and flexibility markets.	Ofgem	Now	Local energy planning, FSO whole system costings, heat zoning.
1	Review how local assets receive revenue from local and national markets and implement local markets across local balancing, flexibility, ancillary services, capacity and ANM. This review should also resolve interactions between markets, making clear rights of different actors to utilise the same asset for various services.	Establishes local value pools.	BEIS, Ofgem	Now	REMA, other action to support local value streams. Should build on Smart Systems and Flexibility Plan workstreams.

20 The Ofgem RIIO-ED2 price control sets the outputs that the 14 electricity Distribution Network Operators (DNOs) need to deliver for their consumers and the associated revenues they are allowed to collect for the five-year period from 1 April 2023 to 31 March 2028. REF www.ofgem.gov.uk/energy-policy-and-regulation/policy-and-regulatory-programmes/network-price-controls-2021-2028-riio-2/network-price-controls-2021-2028-riio-2-electricity-distribution-price-control-2023-2028-riio-ed2

Category: Strategy/vision solutions

Table 4: Summary of prioritised strategy/vision solutions, key decision maker, timeliness and interdependencies

Barrier	Prioritised Solution	What does it enable	Decision maker	Timeliness	Interdependencies
ALL	Create an overarching strategy and vision for energy system decarbonisation.	Clear vision for energy system transformation and clarity on benefits, roles and responsibilities and structures (markets).	HMG	Now	Everything.
1/5	Vision for electricity distribution price controls following RIIO-ED2 including roles and responsibilities for DNOs/DSOs.	Clarity and responsibility and role of DNO/DSO in delivering decentralised energy innovation.	Ofgem	Prior to ED3	Informed by various DNO/DSO reviews during ED2.
1	Develop ESO whole system costings role. This include taking a system view of local and whole system costs, managing the ESO/DSO relationship and ensuring visibility and information flows across scales, reviewing changes across the data and interoperability landscape, reform of final physical notification processes to focus on asset data transfer and visibility across scales.	ESO/DSO coordination and role clarity, efficient allocation of costs, data visibility.	BEIS/ Ofgem/ ESO[21]	Now	Links to recommendations on data, market rules and coordination.
5	Revised Ofgem Strategy and Policy Statement (SPS), including a clear statement of its support for local energy and its role and benefits in delivering Net Zero.	Clarity on support for distributed energy and policy certainty.	BEIS	Now	Link to Ofgem action on local governance of energy system change, LAEP and DSO transition.

21 National Grid Electricity System Operator

Category: Enabler solutions

Table 5: Summary of prioritised enabler solutions, key decision maker, timeliness and interdependencies

Barrier	Prioritised Solution	What does it enable	Decision maker	Timeliness	Interdependencies
1	Ensure half-hourly settlement is delivered by 2025.	A key enabler of innovative supply arrangements and dynamic ToU tariffs.	Ofgem	By 2025 with clear milestones	Other actions to access value streams.
3	Implement Energy Digitalisation Taskforce recommendations, particularly on standards and an enabling layer.	Supports innovation and coordination.	BEIS, Ofgem, ESO, DNOs	Now	FSO whole system review, DSO implementation, ONP.
5	Local Energy Planning: Ensure local/regional energy plans are in place in all areas and integrate with DNO/DSO evolution. Ensure methodology incorporates resilience planning, rather than the current focus on forward capacity planning.	Coordinated local delivery of decarbonised heat, power, transport.	BEIS, Ofgem	Within 5 years	DSO transition, heat zoning, methodology for co-benefits.

Category: Reform solutions

Table 6: Summary of prioritised reform solutions, key decision maker, timeliness and interdependencies

Barrier	Prioritised Solution	What does it enable	Decision maker	Timeliness	Interdependencies
1	Deliver and extend REMA package of market reforms to enable decentralised energy. The REMA analysis should include specific assessment of the impact of reforms on DE. Analysis and delivery should be connected to other reforms programmes (including the retail market review) to ensure it doesn't result in conflicting or perverse outcomes. Other options e.g., wire by wire network charging should be included in ongoing work.	Establishes value pools for local markets.	BEIS as lead, multiple other actors involved	Now – delivery over next 2-3 years	Links to strategy and market rules (theme 2 and 5). Setting regulatory and governance frameworks is central to creating revenue mechanisms. Similarly, if DE values were clearer then actors would take more regulatory risks. Need to address in concert. Key link to recommendation for a holistic reform programme (see theme 5).
1	Clarify the role, responsibilities and access for community energy.	Clarifies the route for local communities to retain value from local energy assets and actions.	BEIS/Ofgem (imple-menting EU policy, once formed)	Depends on EU policy development	Relates to other aspects of local value, local roles and responsibilities, and local markets.
1	Undertake a fundamental reform programme to reorientate the structures of the energy system to focus on people and the demand-side. This would incorporate strategic direction setting and market and governance reform. It would provide a clear vision and structure for other reforms to flow from.	Places people and demand at the centre of the energy system.	BEIS, Ofgem	Now – complete by 2028	Underpins most other action.
2	Implement meter splitting (B379) and Mandatory half-hourly settlement.	Enabler of business model innovation, including progressive tariffs.	Ofgem/ Elexon	Now	Interacts with retail market reform and consumer protection reform. Would place less emphasis on switching so the consumer protection regime could be more nuanced.

Barrier	Prioritised Solution	What does it enable	Decision maker	Timeliness	Interdependencies
1/2	Implement retail market reform. Take action on the 2018 Ofgem statement that "there is a strong case for considering fundamental reforms to the supplier hub model, and for evaluating how alternative arrangements might operate in practice".	Enables innovative supplier propositions, potentially more in keeping with wider reforms (such as dynamic and locational pricing + local energy propositions).	Ofgem (or BEIS if Ofgem are stalled)	Alongside REMA	REMA and other retail market reforms, such as meter splitting.
3	Establish Energy Innovation Zones. Create safe spaces for local actors and DNOs to innovate and addresses local resourcing challenges.	Support business model scaling and innovation within specified areas.	BEIS, Ofgem, IUK	Now	Links to market rules. Would allow progress to be made in the context of huge complexity and wider reform programme.
5	Implement heat zoning and heat regulation (as per the Energy Security Bill).	Enabler for more structured local energy planning.	BEIS then Ofgem	Now	Local energy planning, DSO transition, clarity of sub-national roles and responsibilities.
4	Regulate waste heat sources to explicitly incentivise these sources to supply heat to heat networks (e.g. waste water, energy from waste, data centres).	Increased viability of low carbon heat networks.	Ofgem, BEIS, Ofwat, Ofcom, DfT	Within 5 years	Local energy planning, heat zoning, baselining tools.

Cross-cutting themes

The framework and solutions we present provide a series of steps that could better enable decentralised energy. Our analysis and discussions in the workshop also revealed that these solutions alone are insufficient. There are six cross-cutting issues and challenges that pervade decision-making in energy and will affect the outcomes of any measures to enable decentralised energy. These cross-cutting issues are important because they affect both how decisions are taken (for example, a centralised mindset) and the constraints on decisions (for example, the availability of skills and capabilities). We summarise these six cross-cutting issues in Table 7.

Table 7: Cross-cutting issues preventing decentralised energy innovation.

Cross-cutting theme	Description
Centralised mindset	A linear, centralised logic pervades in the energy system. This logic permeates key decisions, such as the REMA programme and retail market reform, skewing them towards centralised and engineering solutions. The impact includes a lack of recognition of the benefits and role of distributed energy and a lack of valuation of demand-side solutions.
A lack of definition and agency of decentralised energy assets and actors	Decentralised energy assets, such as electric vehicles and behind-the-meter assets such as batteries and heating systems, are not defined (in a legal or regulatory sense) in the same way as conventional assets, such as power stations. Consequently, DE assets, their owners (e.g., households, businesses, and communities) and intermediaries (such as aggregators) lack visibility and agency in the energy system. The impact is that DE asset can be invisible and undervalued in the energy system and not represented in discussions about rules changes.
Coordination, transparency, and clear roles	There is a lack of clarity on the role of decentralised energy and its customers and communities in the current and future energy systems. There is also a lack of attention on how the future energy system will be coordinated across scales, including between national, regional, local and individual asset scales. The impact is a lack of clear roles and responsibilities, for example, between DNOs and local actors on energy and spatial planning.
Risk-based approaches to managing change	The overly prescriptive nature of current licensing and innovation processes is a barrier to developing new, customer-centric business models. The impact is a regulatory regime which struggles to accommodate decentralised energy customer propositions. Shifting towards a more risk-based approach to regulation (such as the regimes in food and finance), licensing and innovation would support innovation and provide better consumer outcomes.

Table 7: Cross-cutting issues preventing decentralised energy innovation cont'd.

Cross-cutting theme	Description
Resilience	The definition and approaches to energy systems and climate resilience are not keeping pace with the energy system transition. There is a need for greater coordination, and allocation of responsibilities, between cross-sector resilience forums such as the Energy Emergencies Executive Committee (E3C), UK Regulators Network (UKRN), and National Cyber Security Centre (NCSC). Future energy (and wider cross-sector) resilience should also be integrated across scales through local energy and wider spatial planning. Resilience should also be integrated into wider energy decisions, such as the REMA programme.
Recognising the diverse values of decentralised energy	The energy and wider system benefits of decentralised energy are not fully considered in energy systems decisions, particularly those by Ofgem and BEIS. The impact is that decentralised benefits are left off the table in decisions. Decentralised energy can contribute to lower whole system transition and operating costs. It can also deliver additional local benefits, such as health and social benefits. Consequently, it is important that these benefits can be incorporated into decision-making frameworks.

Conclusion: The need for a holistic future energy vision

One solution stands out from this review. A clear, holistic, and inclusive vision for the future energy system.

This vision would set out the principles for future reforms and address the cross-cutting barriers that pervade decision-making in energy.

It would accommodate the economic and wider benefits of decentralised energy and the needs, preferences and values of citizens, communities, customers, and consumers.

It would clarify and assign the roles and responsibilities of energy system institutions and actors at all scales, ensure data is open and accessible, and allow innovative business models to emerge whilst protecting customers.

It would also ensure that all supply and demand-side assets are treated equally and can play a full role in future system operations.

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