Carbon Co-op

regen transforming energy

Energy Community Aggregator Services (ECAS)

A feasibility study analysing community-based aggregation of domestic and small organisation consumers using the UK smart metering system, commodity hardware, common open standards and open source software.

Part of the BEIS Flexibility Markets Feasibility Study Competition

August 2018

1 Executive Summary

1.1 Energy Community Aggregator Services

The Energy Community Aggregator Service (ECAS) is envisioned as an energy system intermediary that will play the role of an Aggregator, enabling multiple householders to take advantage of emerging local flexibility markets. The route to market for ECAS is as a federated body or social franchise, which enables small, not-for-profit and sometimes voluntary Community Energy groups to take advantage of local flexibility services via ECAS' pooled technical services, capacity and workforce. The nature of local flexibility markets suggests the creation of a federated energy system Aggregator intermediary which achieves both scale and a locally specific focus, has a great deal of potential. The Community Energy sector has a number of recognised strengths and opportunities including high levels of trust, a local focus and access to 'early adopter' householders that could be taken advantage of by such a model.

1.2 The role of demand side measures

Demand side measures are increasingly seen as crucial to meeting the UK's ambitious climate change targets as well as offering the potential for reduction in costs and improvements in grid reliability for UK consumers. Demand Side Response (DSR) has long been used as a resource by the system operator to support grid operations. However, there is also a 'long tail' of smaller appliances and a growing 'fat middle' of newer low carbon technologies embedded in distribution networks which to date has not been exploited for demand side response. The falling cost of control and communication systems delivered by the Internet of Things and Cloud Computing as well as the potential for new revenue streams from energy system actors willing to purchase this flexibility is moving aggregation of small amounts of flexibility towards commercial viability.

1.3 DNO flexibility procurement

Our analysis of DNO local flexibility efforts has highlighted that they are at different stages in exploring the potential of local flexibility. A range of approaches to this are currently being explored although they are generally characterised by longer term procurement of services under bilateral contracts rather than a more market-based approach as we have proposed in ECAS. New operational and business functions and approaches will need to be developed by DNOs to publicise and operate flexibility in either case.

1.4 DSR market is small.. for now

In this project, we have concluded that the current market for domestic DSR is immature and small. Recent announcements of local flexibility schemes by UK DNOs have improved the viability of potential schemes (although currently very geographically restricted). Reforms will be needed to existing ancillary services, capacity market and balancing mechanism to support the inclusion of aggregated domestic loads. These reforms centre on allowing aggregated portfolios (already possible in some markets) and changes to metering and assurance requirements, although others are likely to be required. Using the new local flexibility schemes, which typically have lower requirements, may be a route to market for new offerings, although partnerships with DNOs maybe required to support this activity initially.

Due to the highly geographical nature of this activity, community orientated schemes may have some advantages over larger top down solutions. There are also a range of consumer issues associated with domestic demand side response which will need to be addressed including data privacy and security and remote control of assets. These are partly issues of trust and confidence and a community orientated Aggregator may benefit from higher levels of trust from consumers (or member/stakeholders).

1.5 Achieving viability

Extrapolating from publicly available data, in particular the indicative revenues published in WPD's Flexible Power service, we have concluded that local flexibility schemes are only likely to provide value to those homes offering large automated loads (such as electric heating, batteries, and electric vehicles) for control. However, even then the activity is likely to be low margin and revenue stacking with income from other flexibility markets (and potentially other business activities such as ESCo) will be important for commercial viability. Similarly, manual DSR is unlikely to ever attract any income or be of value to other actors and should not be pursued in future schemes. In conclusion, viability is likely to be achieved by scale and when local, regional, and national markets for flexibility become more mature.

1.6 Developing technical systems

ECAS has a range of options for procuring and operating its system with our preference for open source systems based on common open standards. Due to the low margin nature of the activity a higher number of intermediaries will mean lower profit share which may undermine the business case. We therefore believe ECAS will find most success acting directly as an independent Aggregator rather than contracting out these functions to others. This however presents challenges in developing systems, which will require substantial investment. Existing Aggregators, large technology companies (Google/Amazon), Suppliers, manufacturers of systems, and 'platform' start-ups already have made these investments and it maybe that technology partnerships with these would be the best way to take ECAS forward. On the other hand, this is a new and fast developing market and there maybe future opportunities for an independent Aggregator to develop its own better technology.

1.7 Technical Project Recommendations

A technical feasibility assessment of the ECAS local flexibility concept has shown that some barriers remain to implementation. We have used these barriers as the basis for several recommendations to BEIS and the wider sector:

- **Consumer Access Devices (CADs)** will be an essential component in the provision of near real-time demand data from UK smart meters but their use cases are not explicit in SMETS or other parts of the SEC and up-to-date guidance around their widespread and systematic use is yet to be issued.

- There is currently **no user role for Aggregators** in the smart metering system DCC and they currently would have to apply and participate under the 'Other' user role. It may make sense to analyse the Aggregator use case in relation to the DCC and define a new user role and set of functions in DUIS etc. This will also help in monitoring how Aggregators are using smart metering data.

- A key missing component in the establishment of local flexibility markets is information about the **operational status** of distribution networks and how this will be created/provided/guaranteed. USEF describes a 'Common Reference Operator' role and we believe there is a compelling case for the establishment of something like this in the UK market to act as a clearing house for information where access to it may otherwise be monopolised and controlled by the DSO to the detriment of other actors.

- Our review of the ADE **Code of Conduct for Aggregators** has found that it is currently lacking in several areas which will become more important when working with large numbers of domestic consumers; it currently does not recommend the implementation of any standards for information management (e.g. IASME); there is no recommendation around live monitoring which will be important for preventing attacks in progress; there is no requirement to notify government or regulatory agencies in the event of an attack (e.g. National Cyber Security Centre).

1.8 Policy environment

We have identified some key policy initiatives which support ECAS, such as the Smart Systems and Flexibility Plan and Faraday Challenge (and recent announcements on electric vehicles). The main policy risks stem from the delays in the smart meter rollout. ECAS relies more on the functionality of smart meters rather than the level of penetration. So provided the key functionality relating to the DCC and CADs is implemented and any consumer who wants a smart meter can continue receive one, these risks will be mitigated. Local flexibility schemes also need a clear route to market and scale and we have highlighted some concerns around the regulatory sandbox approach which in some cases may be preventing this.

Our analysis of the regulatory environment has highlighted some areas for clarification and development around the role of independent Aggregators. There has been some activity in this area recently with Ofgem publishing a letter outlining their views as well as proposed code changes (P344/P354).

We believe a whole-system approach is required so that independent Aggregators can access markets on an equal basis to other parties but also take responsibility for the imbalance caused by their activity. There could be different solutions to this. Establishing independent balance responsibility parties (BRPs) in the UK with equal primary access to wholesale and balancing markets (as is found now in some EU countries) would potentially simplify these arrangements and lower the barriers to accessing these markets. This could be achieved by extending proposals found in P354 or otherwise. Aggregators can then appoint or become BRPs as a one-stop-shop for accessing wholesale and balancing markets. The alternative would be to add parties in an ad hoc fashion to existing markets which will multiply the costs involved and undermine the complex value proposition of flexibility services.

1.9 Next steps

Local flexibility markets are at a crucial stage of development and the partnership's view is that a demonstrator project (funded by BEIS and/or other stakeholders) aligned with strong engagement from one or more DNO has the potential to generate significant real-world data to inform ongoing policy, technical and business model development and crucially consumer engagement.

Alongside any demonstrator, the partnership will contribute the findings of this report to the ENA Open Networks Future Worlds consultation, ECAS has many similarities to the 'fifth world' described there and so we hope will be a useful contribution to the discussion, in addition to other smart system consultations and calls for evidence.

Alongside this project, under the BEIS Domestic DSR programme, Carbon Co-op, Regen and other partners have begun development of a domestic demand side response system based on OpenADR and the UK smart metering system which could in future be used to test a USEF-style local flexibility scheme in the UK. The aim of this is to develop a proof of concept to demonstrate the efficacy of open standards in demand side response and flexibility.

About the project

Authored between May and September 2018, by a partnership of Carbon Co-op, Regen and Community Energy Scotland, this feasibility study assesses the potential for local flexibility markets to be made accessible to domestic and small community organisations, through the development of a community energy-based aggregation model.

About the report

Work Package 2 describes and assesses the **business opportunity** for a community-based Aggregator flexibility provider, ECAS, in terms of current and emerging DNO income streams and provision of services to domestic and non-domestic end users.

Work Package 3 assesses the current and emerging **DSO market** potential interviewing DNO representatives as well as Aggregators to better understand market dynamics, trends and opportunities.

Work Package 4 is a **technical analysis** of the standards, tools and components necessary for a fully integrated local flexibility market system and assesses the development, operational and other costs for this system to function for a range of potential flexibility assets.

Work Package 5 places this project in a policy context, examining the relevant legal and regulatory factors that must be taken in to account.

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2 ECAS Business Planning

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2.1 Introduction

The Energy Community Aggregator Service (ECAS) is envisioned as an energy system intermediary that will play the role of an Aggregator, enabling multiple householders to take advantage of emerging local flexibility markets. The route to market for ECAS is as a federated body or social franchise, which enables small, not-for-profit and sometimes voluntary Community Energy groups to take advantage of local flexibility services via ECAS' pooled technical services, capacity and workforce.

In this section we outline the business and governance issues relating to ECAS as well as its potential market positioning and competitive advantages.

2.2 Community Energy

2.2.1 Definition

DECC's Community Energy Strategy 2014 defined Community Energy[1] as:
"...community projects or initiatives focused on the four strands of reducing energy use, managing energy better, generating energy or purchasing energy. This included communities of place and communities of interest. These projects or initiatives shared an emphasis on community ownership, leadership or control where the community benefits."

It estimated that up to 5,000 such groups existed in the UK at that time.

Community Energy groups can generally be typified as:

- Not for profit, with surplus re-invested back into communities
- Member owned and controlled.
- Motivated to take action on climate change and other environmental issues.
- Locally based.
- Volunteer run or featuring high levels of volunteering.

Most are involved in developing renewable energy generation but many are also involved in energy efficiency and smart energy applications with 17% of respondents to the Community Energy England State of the Sector Report 2018[2] involved in 'smart energy' activities and trials.

Community Energy groups often take advantage of the Community Shares[3] route to raising capital, a non-regulated investment methodology for registered societies in which equity shares are sold in the business whilst maintaining a one member, one vote governance model.

[1] Community Energy Strategy 2014 defined Community Energy, DECC, 2014
[2] State of the Sector Report 2018, Community Energy England (https://communityenergyengland.org/pages/state-of-the-sector-report-2018)
[3] Community Shares website (http://communityshares.org.uk)

The use of Feed in Tariffs and export tariffs led to a 'standard' Community Energy business model and a steady growth of groups, however, changes to incentives mean that organisations are seeking to diversify and looking for new opportunities.

2.2.2 Advantages of Community Energy

Community Energy groups generate a range of social and environmental benefits in their areas of operation.

Building stronger communities
Community energy activity can bring local people together to achieve something for their community, fostering common cause and empowering communities to take action on issues that matter to them

Developing new skills.
Members of the community can benefit from opportunities to learn new skills through involvement in community energy activity; some schemes have specifically engaged young people in work experience or energy and climate change education activities.

Financial benefits
Community energy presents opportunities to generate income for the community but also through local economic development by procuring from and developing local supply chains.

2.2.3 Key Strengths Weaknesses Opportunities and Threats

As noted, Community Energy groups are new to participating in smart systems and offering flexible services. Here we carry out a SWOT analysis analysing the sector's suitability to participate in local flexibility markets.

<u>Strengths</u> • Existing infrastructure ie organisational capacity, funds, expertise etc. • Trusted local profile with public and key stakeholders • A foothold in generation with the ambition to go further • Passionate, committed. • On the ground, local knowledge. • Can mobilise capital from Community Share issues relatively quickly.	<u>Weaknesses</u> • Relatively small sector in comparison to the energy sector as a whole. • Level of technical knowledge and expertise is generally low. • Ability to raise large amounts of capital quickly is limited. Governance structures often precludes venture capitalist investment. • Often limited to specific local areas.
<u>Opportunities</u> • A need to diversify and find new income streams. • Access to volunteers with skills and enthusiasm • Policy alignment with regards to Local Energy and Local Energy Communities.	<u>Threats</u> • Competition from private sector. • Regulatory requirements require large investment of staff and resources. • Inability to scale quickly.

• Members are often early adopters with smart tech eg EVs, PVs, heat pumps etc.	

Table 1. Strengths, Weaknesses, Opportunities, Threats analysis for Community Energy

2.3 ECAS in detail

In WP3, section 3.6, we assess the market for local flexibility and implications for the ECAS model. These are summarised here.

Finding	**Implication for business model**
DSO markets are at very early stages.	Viability of the model is some years away, model needs to remain flexible.
Amount of income on offer per kW/MW is likely to be modest.	Very large scale and value stacking via other income sources is required to ensure viability.
Income likely to vary significantly, largely according to location.	Ability to take advantage of locally specific conditions is required.
Systems for data collection, verification, and monitoring required.	Aggregator access to DCC and CADs is necessary.
Automated demand management required to meet baseline, entry and operational requirements of the DSO	Aggregator access to automated control systems is necessary.
Uptake of large flexible load technologies needed.	In early stages, there will be a premium for signing up householders with these technologies.

Table 2. DSO local flexibility market findings and implications for ECAS.

2.3.1 Role

The energy system role ECAS and the business model it adopts are informed by:

- The availability of value from DSO local flexibility markets (WP3).
- Technical constraints and opportunities (WP4).
- Current regulatory constraints and anticipated developments (WP5).

As identified in the SWOT analysis above, Community Energy groups benefit from a trusted, locally-focussed profile within the energy sector and as such seem well suited intermediaries to take advantage of local and temporally specific flexibility markets.

Conversely, very locally-focussed groups tend to lack the technical expertise, capacity and access to aggregation platforms necessary to take advantage of these markets. Furthermore, given that local constraints and conditions may change over time, should a local group develop a local flexibility business model in a specific locality, the income stream may reduce or dry up completely as energy system conditions change.

A solution to this tension is a hierarchically tiered approach. ECAS will be constituted to operate at a regional, national or even pan-European level, holding technical expertise, employing staff including customer relationship management and developing appropriate market platforms directly or via partners. ECAS will hold all necessary regulatory licences in order to trade flexibility and access markets.

At a local level, voluntary or semi-voluntary local groups with geographical exclusivity, act as sales or managing agents for the ECAS service. They identify local needs, establish trusted local partnerships and oversee the installation of appropriate flexible load technologies and/or Aggregator enabling tools such as HEMS/CADs. They benefit from close relationships with 'Early Adopter' members, householders motivated to take action to reduce their carbon impact and more likely to install low carbon technologies such as EVs, batteries etc.

Local groups are resourced through a combination of mechanisms such as finder's fees, taking direct contracting roles in the installation of technologies or acting as an Energy Services Company (ESCO). Despite this, for regulatory reasons and in order to simplify risk positions, contractual relationships are likely to be established directly between ECAS and householders.

To strengthen the link between local groups and ECAS and provide accountability, transparency and democratic control, some kind of ownership and/or governance relationship might exist between local groups and ECAS eg via a federation or social franchise. In effect, local Community Energy groups would be members of ECAS with voting and control rights.

Key elements of the ECAS model:

- ECAS acts as a trusted intermediary.
- ECAS contracts with householders and energy system actors ie DSOs.
- Staff, resources and technology held by ECAS
- Local groups incentivised via finder's fees and other mechanisms.
- Model benefits from economies of scale AND very local, trusted focus.

2.3.2 ECAS Relationships

As outlined in WP3, section 3.6, commercial arrangements could involve a number of different interactions between energy system parties. Scenarios might include:

(A) Community/Domestic DERs ❺❼ ECAS ❺❼ DSO

(B) Community/Domestic DERs ❺❼ ECAS ❺❼ Commercial Aggregator ❺❼ DSO

(C) Community/Domestic DERs ❺❼ ECAS ❺❼ Market platform ❺❼ DSO

(D) Community/Domestic DERs ❺❼ ECAS ❺❼ Commercial Aggregator ❺❼ Market platform ❺❼ DSO

The strength/weakness of these approaches will depend on a number of future market factors and roles played by ECAS covering: Subscription, Aggregation, Register and bid, Dispatch, Verification and Settlement.

In order to capture as much value as is available within local flexibility markets, short procurement chains will be preferred. As such, as possible ECAS should seek to own, develop and control its tools, technologies and resources.

2.4 Finances

Income
The market for flexibility is examined in greater detail in WP3. For now, it is not possible to make accurate estimates on the value of flexibility other than to estimate margins are likely to be tight with an emphasis on scale and value stacking.

In this context we don't anticipate that local groups will generate sufficient income from flexibility to establish independent businesses based on local flexibility income. Instead, viable scale is likely to lie in the regional, national or pan-European scale.

Local groups might derive income from finder's fees, or the ability for householders to access flexibility income via ECAS, might complement local group's other income generating activity, with the best fit coming around energy efficiency services, in particular deep retrofit, creating a non-financial benefit for local groups to participate in ECAS.

Expenditure
Areas of expenditure for ECAS include:

- Ongoing staff costs
- Upfront capital costs associated with setting up a DRMS (Demand Response Management System)
- Costs of supplying and installing HEMS/CAD in each property
- Upfront and ongoing costs associated with accessing the Smart Meter DCC
- Should if be necessary, upfront and ongoing costs associated with becoming a Balance Responsible Party.

ECAS has a range of possible householder arrangements that could be offered with a variety of advantages and disadvantages. For more detail see WP3, Section 6.

Arrangement	Pros	Cons
Fixed subscription fee *Domestic users pay an annual or monthly fee to ECAS for access to their DER assets, and user retains 100% of DSO income*	Guaranteed income to ECAS, removes risk to ECAS model	Risk of low or no income to user from either limited DSO calls or regular failure to respond.
Agreed percentage of income *ECAS and domestic users share DSO income*	Fair and equitable approach Proportion could be openly calculated to cover costs/ margin for ECAS in their role	Uncertain income to both parties
ECAS fixed annual payment *ECAS pays an annual or monthly payment to user, ECAS retains 100% of DSO income*	Guaranteed income to user, removes risk to them and could increases the potential to recruit participants	Risk of low or no income to ECAS from either limited DSO calls or regular failure to respond.

Table 3: High level ECAS commercial arrangement considerations

2.5 Governance assessment

The ECAS governance structure needs to:

- Ensure compliance with any regulatory conditions to ensure market participation.
- Offer a 'trusted' Community Energy status.
- Be flexible enough to enable a federated, consortia or tiered form of membership for local groups.

As such, only corporate forms that enable 'social enterprise' status and collective ownership have been considered.

Form	Market Compliant?	Community Energy status?	Tiered membership
Community Benefit Society/Multi Stakeholder Co-op (BenCom)	Yes	Yes: Asset Lock	Yes
Co-operative Society (Co-op)	Yes	Yes: Co-operative status	Yes
Community Interest Company (CIC)	Yes	Yes: Asset Lock	Yes
Company Limited By Guarantee (CLG)	Yes	Yes: including not for profit status, co-operative objects	Yes - as a consortia
Charitable Incorporated Organisation (CIO)	Probably precluded by Charitable Objects	Rare	No

Table 4: Governance assessment of ECAS corporate forms

As such, all forms reviewed other than CIO could be viable governance models for ECAS.
A multi-stakeholder co-operative opens up the potential for a further class of members: individual householders, increasing further levels of trust and involvement though the governance management implications of such a model would need careful consideration. Multi-stakeholder co-operatives are also one of the corporate forms able to raise capital via Community Share issues.

2.6 Competition

In a fast developing but still future market it is hard to assess competitors, but an interim assessment can be made.

- Large technology companies, ie Google/Amazon
- Existing Commercial/Industrial Aggregators (see WP3)
- Existing and future energy suppliers.
- Equipment manufacturers (e.g. car / battery producers).
- Local Authorities.

2.6.1 Stakeholder identification

Name	Power/Influence	Support/Attitude
UK Government	High. ECAS is potentially dependent on regulatory and legal changes. Policy support for smart energy is also important, such as mandating standards and providing innovation and business support.	Positive. Supportive of smart energy initiatives. Could do more to accelerate smart meter rollout and pressure suppliers to support opening smart meter systems to third party service providers.
Ofgem/Regulator	High. ECAS is potentially dependent on certain regulatory changes as well as the consistent application of existing policy.	Positive. Has been slow to support development of local energy markets, but has granted derogations for trials and created a 'regulatory sandbox' for market innovation.
EU	Medium. Depends on UK involvement in European Energy markets after leaving the EU.	Positive. Support for 'local energy communities' in latest Directive, although unclear how this relates to local energy markets.
National Grid/ESO	The ESO is a potential flexibility customer and is also currently in charge of overseeing various national flexibility markets.	Positive. Is taking steps to consolidate flexibility markets under control and lower barriers to entry.
DNO/DSO	High. DNOs are potential customers for ECAS. How they procure services will have a big impact on early flexibility markets.	Positive. DNOs have begun procuring flexibility. Several different approaches to this have already emerged, some of which are quite limited in their vision for the role of DER and flexibility provision.
Suppliers	Medium. Under the supplier hub model suppliers are currently in a privileged position in terms of access to domestic consumers.	Neutral. Suppliers are currently best positioned to procure domestic flexibility and have access to wholesale/BM markets so are potential competitors. They are also potential customers as they may wish to purchase flexibility to minimise portfolio risk.

Commercial and Industrial Aggregators	Low. Have not currently made inroads into domestic and SME sector. Not currently an effective lobby and have suffered due to overexposure to various changes in last decade.	Neutral. Likely competitors. Possible partners or suppliers in some scenarios.
Market/Platform Providers	Low. Many start-ups and new businesses, market still small and in flux.	Neutral. Potential competitors to ECAS, but also more likely to be suppliers of services/systems than Aggregators.
Prosumers.	High. The interest and support of prosumers is essential to the ECAS business model.	Positive. The customers/clients/members of ECAS and its member organisations.
Aggregator Platform Providers	Low. Current nascent platforms unlikely to resemble future systems.	Neutral. Potential suppliers but ECAS could develop own system.
Community Energy Organisations	High. ECAS is orientated towards supporting local and community energy schemes.	Positive. Possible partners/members of ECAS. Community energy groups have shown a lot of interest in participating in flexibility markets.
Housing associations	Medium. Maybe important customers in early stages in order to secure large enough volumes for participation in markets.	Neutral. Possible customers/partners/members of ECAS.
System Integrators	Low.	Positive.
DER Manufacturers/Suppliers	Medium.	Neutral.

Table 5: ECAS stakeholder analysis

2.7 Open Source approach

As outlined in WP4, the favoured technology development route for ECAS is via the use and integration of open source software. The choice for open source tools and components is both ethical and pragmatic conferring a clear competitive advantage.

Open Source is a form of software in which source code is released under a license that copyright holders grant users the rights to study, change, and distribute the software to anyone and for any purpose.

Open Source software is often developed in a collaborative, distributed and public manner. Such software creates a strong value proposition and competitive advantage as compared to proprietary formats, of particular interest as deployed in an energy system context:

- More secure software, more robust and less prone to attack,
- Cheaper software with reduced development and operation costs
- More open and transparent systems - important in public infrastructure context
- Increased interoperability benefiting from integration with multiple other systems

Additionally, a focus on low cost and minimum viable products (MVP) tends towards the participation of innovative, agile and investive start-ups and SMEs as well as 'disruptive' new entrants, challenging incumbents and sector monopolies.

Open source business models tend to focus less on protection of Intellectual Property and instead on development expertise, consultancy services and consumer service provision.

There are multiple examples of open source software and open source systems gaining a competitive advantage within a technology sector and in time displacing proprietary incumbents.

Such examples exist within:

- Internet browsers - the displacement of Microsoft Internet Explorer by Google Chrome and Mozilla Firefox.
- Phone operating systems - e.g. Android (Linux).
- Cloud computing - Linux based servers and systems.

The sector is not limited to software and there are examples of Open hardware including Raspberry Pi computers. Partners Megni deploy both Open Source hardware and software in their OpenEnergyMonitor and EmonCMS products.

Energy system actor	**Benefits of Open Source**
Regulators	Discourages monopoly reducing costs, benefits consumers.
DSOs	Enables greater choice of Aggregator
Technology providers	Promotes innovation for start-ups, encourages MVP development, community support, quicker development, low development costs, lower barriers to entry, greater longevity of software
Aggregator	Lowers entry barriers for new entrants, increased interoperability for novel technologies and services.
Customers	Lower consumer costs and/or higher incentives, more secure.

Table 5: assessment of open source benefits to energy system actors

2.8 Conclusion

The nature of local flexibility markets suggests the creation of a federated energy system Aggregator intermediary which achieves both scale and a locally specific focus, has a great deal of potential. The Community Energy sector has a number of strengths and opportunities that could be taken advantage of by such a model. Further research and piloting is required to assess the value of flexibility that could be exploited by ECAS and to build a fully operational business plan.

3 WP3: DSO Flexibility Market Overview

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3.1 Background

The UK energy system is undergoing a significant change, through the decentralisation and decarbonisation of electricity generation as well as a shift towards the electrification of both heat and transport. This shift to low carbon technologies that now provide significant contributions to UK energy[4], brings a number of operational challenges for both the national Electricity System Operator (ESO) and regional Distribution Network Operators (DNOs).

The ESO is under pressure to keep the lights on and manage an evolving generation supply mix. Other shift changes in UK energy also create a number of challenges for the ESO, namely:

- Increased intermittent and distributed generation
- Evolving electricity demand patterns and overall growth of demand
- System capacity margins becoming more complicated to forecast

The regional DNOs are also challenged to unlock constrained network areas and open up new capacity, whilst deferring/avoiding high cost options such as network reinforcement and grappling with the transition to their new, more dynamic roles as Distribution System Operators (DSOs)[5].

The need to bring and operate flexibility into the energy system is therefore greater than ever before. The ESO have responded to this by developing markets for national balancing services[6] over the past few years, paying flexibility providers to participate in programmes such as Short Term Operating Reserve (STOR), Firm Frequency Response (FFR) or Demand Turn-Up. The development of these markets has driven a lot of activity in the sector, often being seen as an additional source of income for generators, storage operators and large energy users to target, alongside their existing revenue streams.

As part of the transition to DSO, Ofgem has stipulated the development of the market for flexibility services within regional network areas. Often described as 'local flexibility markets', these markets are in their infancy and DNOs are currently testing the waters, through publishing strategy papers and industry consultations[7], developing trial projects and trading platforms[8] or issuing calls for expressions of interest (EOI) and tenders[9].

The development of local flexibility markets potentially brings opportunities for the DSO, as a procurer of flexibility, to engage more directly with their connected customers and for providers of flexibility with smaller entry thresholds. In short, localised network constraints being addressed by local assets, contracting with their local network operators. Different providers of flexibility may be able to participate in these local markets in different ways, but community and domestic level flexibility resources are a potentially significant and untapped opportunity.

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[4] Wind power overtook nuclear energy in the UK for the first time in first quarter of 2018 for example, second only to gas fired generation, see article: https://www.independent.co.uk/environment/wind-power-overtakes-nuclear-uk-renewable-energy-climate-change-a8353686.html

[5] See Energy Networks Association 'Open Networks' project, work stream 3 'DSO Transition': http://www.energynetworks.org/electricity/futures/open-networks-project/open-networks-project-workstream-products.html/ws3-dso-transistion.html

[6] See National Grid balancing services: https://www.nationalgrid.com/uk/electricity/balancing-services

[7] See WPD "Signposting of distribution system needs" consultation, May 2018: https://www.westernpower.co.uk/About-us/Our-Business/Our-network/Strategic-network-investment/Signposting.aspx

[8] See Regen's map of local flexibility DSO trials and live projects, April 2018: https://www.linkedin.com/pulse/part-1-local-flexibility-trials-merlin-hyman/

[9] See example of Electricity North West (ENW)'s expression of interest for flexible services, April 2018: https://www.enwl.co.uk/innovation/our-approach/flexible-services/

This section of the report seeks to identify potential sources of value and income from DSO led flexibility markets, review similar approaches in other countries and identify the role of the Aggregator in the local flexibility space.

3.2 DSO transition strategy – considerations for ECAS

The transition to DSO is one of the biggest changes and areas of activity in the sector. Some of the most direct work in this area is under the **Open Networks** project coordinated by the ENA[10], exploring a number of work streams to establish how a DSO is defined (see Figure 1) and what the transition actually means for customers, for DNOs in their current roles and for the wider UK energy system.

Figure 1: ENA Open Networks DSO definition (June 2017)

> *"A Distribution System Operator (DSO) securely operates and develops an active distribution system comprising networks, demand, generation and other flexible distributed energy resources (DER).*
>
> *As a neutral facilitator of an open and accessible market, it will enable competitive access to markets and the optimal use of DER on distribution networks to deliver security, sustainability and affordability in the support of whole system optimisation.*
>
> *A DSO enable customers to be both producers and consumers; enabling customer access, customer choice and great customer service."*
>
> **ENA Open Networks, Work Stream 3 - DSO Transition, Product 1 a) DSO Definition**

Each of the UK DNOs have published a strategy paper that outlines their view of how they plan to transition to take on the role of DSO, a summary of which is captured in Table 1.

Table 1: DSO strategies - emerging principles from DNOs

DNO	DSO Transition Strategy Principles
electricity north west Bringing energy to your door [See: ENW DSO website]	• Network capacity provision • Network capacity market management • Network access management and forecasting • Service definition and charging • Wider market engagement
NORTHERN POWERGRID [See: NPG innovation site]	• Delivering further innovation projects to understand the transition to a flexible system • Seek more opportunities to buy and sell storage and Demand Side Response (DSR) • Deploy further Active Network Management (ANM)[11] areas
SP ENERGY NETWORKS [See: SPEN DSO vision]	• Rollout and extend the use of ANM to manage network constraints • Prioritise areas which are likely to benefit from the DSO model • Expand network monitoring to future proof legacy assets • Model and investigate ancillary services market and identify cost effective solutions • Put in place commercial arrangements with National Grid and DER providers within DSO trial areas

[10] See ENA Open Networks project portal: http://www.energynetworks.org/electricity/futures/open-networks-project/open-networks-project-overview/

[11] See ENA definition of ANM: https://uksmartgrid.org/wp-content/uploads/2015/07/ENA-GPG-Public-event-slides-v1_0-2.pdf

Scottish & Southern Electricity Networks [See: SSEN DSO Transition report]	• Greater choice and opportunity for customers, whilst ensuring the service remains reliable, efficient and resilient • Integrating learning from innovation projects • Neutral facilitation of local and national markets to unlock local solutions, by identifying and providing visibility to allow markets to function and trade energy throughout the network
UK Power Networks [See: UKPN FutureSmart]	• Facilitate cheaper and quicker connections using proven innovation • Use customer flexibility as an alternative to network upgrades • Develop enhanced System Operator capabilities • Collaborate with industry to enable GB wide benefits • Prepare and facilitate the uptake of Electric Vehicles (EVs)
WESTERN POWER DISTRIBUTION *Serving the Midlands, South West and Wales* [See: WPD DSO Strategy]	• Level playing field access for all customers • Maximisation of accessibility to services for vulnerable customers • Efficient and economic whole system outcomes • Facilitation of neutral markets • Provision of services where no market actor exists • Using flexibility services to deliver quicker, more efficient and cheaper connections • Deliver maximum value to individual customers offering network provided flexibility services and all customers through optimised use of smart grid flexibility • Environmental benefits through minimisation of losses

Some key themes for the transition to DSO are therefore:

- **Enabling cheaper, quicker connections for customers**
- **Creation of a level playing field for customers and neutral markets (i.e. technology or approach agnostic)**
- **Enabling and neutrally facilitating local flexibility services, to mitigate network constraints**
- **Increase the use of ANM**

DNOs are unified in an intention to facilitate markets and create an environment where flexibility services can be procured. Flexibility can assist them in unlocking network capacity and to manage network constraints/events, as an alternative to costly network reinforcement (see Figure 2).

Figure 2: Benefits of local flexibility services for DSOs

How these markets are to be operated, who can participate in them and how they can secure value from them, are key questions that are yet to be fully addressed. Local flexibility is an emergent market and when comparing it to national balancing services, for example, some clear distinctions can be made.

The ESO will call on assets to respond to system-wide conditions such as:

- Deviations in grid frequency, addressed through programmes like FFR
- The need for energy reserve to address a falloff in system-wide capacity, addressed through programmes like the Capacity Market or STOR

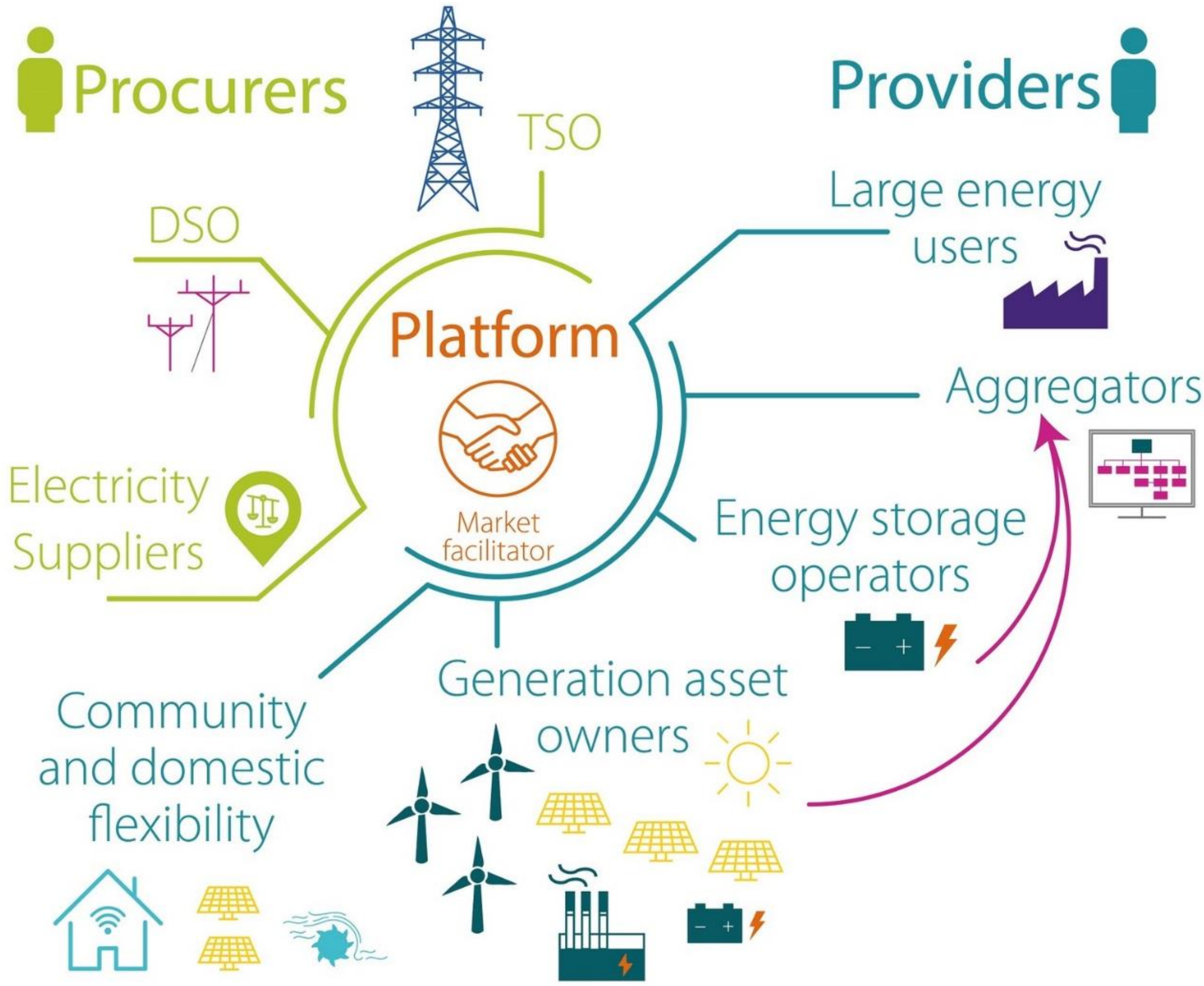
The location of the assets active in these markets is largely irrelevant.

With local flexibility markets however, the need for your local DSO to call on a local response, to local network issues, brings a new dynamic to matching solutions to needs. The calls for flexibility will therefore be centred around specific distribution network areas or even individual constrained substations. These are often referred to as Constraint Managed Zones (CMZs).

In a series of infographic led blogs that Regen produced in the spring[12], community and domestic flexibility was identified as one of five main 'classes' of flexibility service providers, alongside large energy users, generation asset owners, energy storage providers and Aggregators.

An open and easily accessible platform to enable DSOs to procure flexibility for their own operational needs, is vital to enable DNOs to meet their regulatory obligations; to act as a neutral market facilitator.

[12] See Regen blog series 'Development of local flexibility markets in five steps': Launch | Part 1 | Part 2 | Part 3 | Part 4 | Part 5



Understanding how domestic scale flexibility can actively participate in local markets, is a key objective of this feasibility study. Noting the relative position of community and domestic flexibility alongside competitors, is an important consideration for the ECAS model. These competitors include:

i) **Large and medium scale flexible distributed generation**
ii) **Industrial energy users with flexible demand controls on-site**
iii) **Standalone distributed energy storage assets**

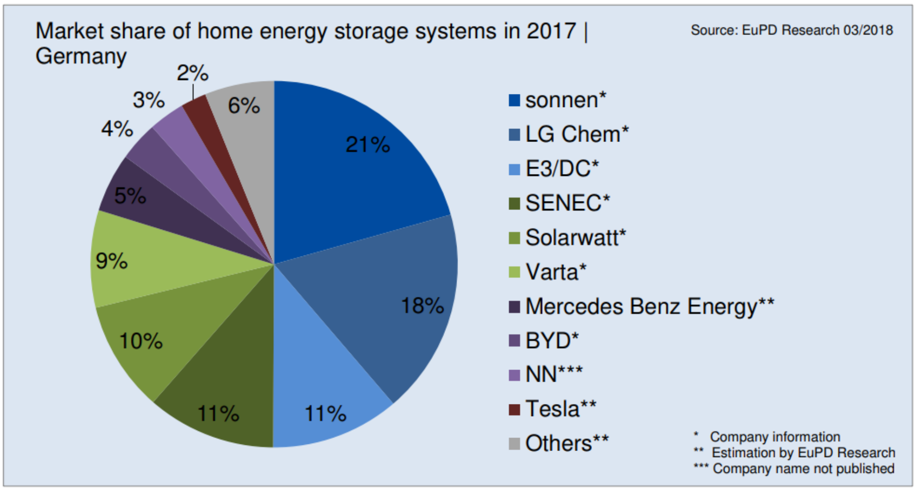
These parties are all poised and ready to bid in to local flex markets. An ECAS model must therefore consider some of the technical challenges and barriers to household flexibility competing, including:

- The inherent dilution of value through aggregation vs flexibility parties that can contract directly
- Understanding what firm, controllable and flexible load is reliably accessible in the home
- The need for verification of domestic responses, requiring a greater coverage of smart meters, or a potentially costly proprietary control and communications device in each home
- The need for automatic switching of household loads vs the need to rely on manual response

Domestic flexibility in the UK is set to become more apparent and dispatchable, drivers include:

- The forecast growth of EVs[13]
- The electrification of heat through a proliferation of heat pumps[14]
- Uptake of domestic storage[15] and the range of home battery products available, see Figure 3

Figure 3: European battery product manufacturers - market share
Source and credit: EuPD 'European Residential PV Energy Storage Market Overview 2017', see: https://www.eupd-research.com/fileadmin/content/download/pdf/Produkte_Technologische_Nachhaltigkeit/EuPD_Research_European_Residential_PV_Energy_Storage_Market_Overview_2017.pdf



Additional sources for flexibility in the home might include increased use of smart appliances[16], such as washing machines, refrigerators, water heaters, HVAC and boilers.

Though it is evident that despite baseline progress[17], the rollout of residential smart meters in the UK will need to be significantly accelerated to not only hit government targets, but to enable the verification of dispatching domestic flexibility in response to local (or national) calls.

3.3 Local flexibility services – market activity and trials

Many of the DNOs have begun to implement their strategies referenced in Table 1, kicking off innovation funded trials, commissioning the development of trading platforms, see Figure 4 for examples.

[13] Regen's future growth modelling, Committee on Climate Change (CCC) projections and National Grid's 2017 Future Energy Scenarios (FES) Two Degrees scenario, show a range between 10-13million EVs sold by 2035, see Regen's Harnessing the Electric Vehicle Revolution report, page 9: https://www.regensw.co.uk/Handlers/Download.ashx?IDMF=c2c53763-2f7f-4d70-96d3-aed4290c9021
[14] National Grid FES 2017 forecasts a 68% reduction in gas fired heating by 2050, predominantly replaced with heat pumps. See FES 2017 report, Section 3.3 key insights (page 32): http://fes.nationalgrid.com/media/1253/final-fes-2017-updated-interactive-pdf-44-amended.pdf
[15] REA data in 2016 showed at least 1,500 residential storage deployments had occurred as of Oct 2016, see: https://www.r-e-a.net/images/upload/news_415_REA_-_Energy_Storage_in_the_UK_Report_2016_Update.pdf
[16] See *European Commission Preparatory Study on Smart Appliances*: http://www.eco-smartappliances.eu/Pages/welcome.aspx
[17] Which? analysis from Feb 2018 showed there to be over 8 million smart meters now in homes, see: https://www.which.co.uk/news/2018/02/smart-meter-2020-target-will-energy-companies-meet-it/

Figure 4: Map of DSO trials and projects

Some DNOs are taking more direct action through instigating ‘business as usual’ signposting and live procurement processes for flexibility services in some licence areas. A summary of some of the key activities under each of these DNOs, is summarised in the following pages.

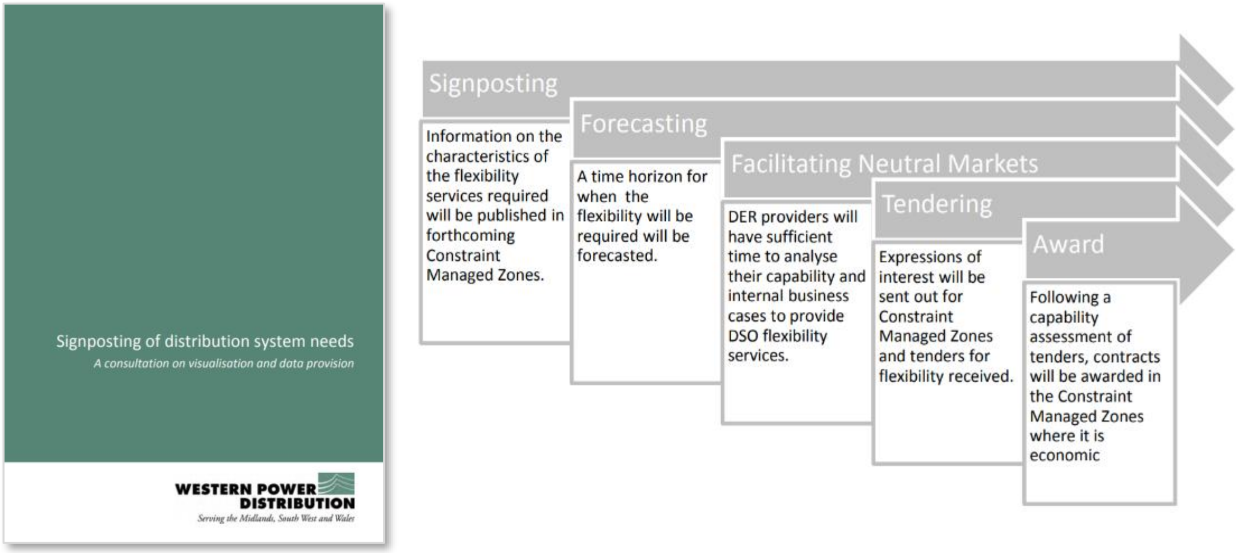
3.3.1 Western Power Distribution

3.3.1.1 Signposting

Through a consultation published in April 2018 (see Figure 5), WPD sought views on how best to collaborate with stakeholders, to develop a method of communicating and conveying needs for flexibility services to a wide range of potential providers.

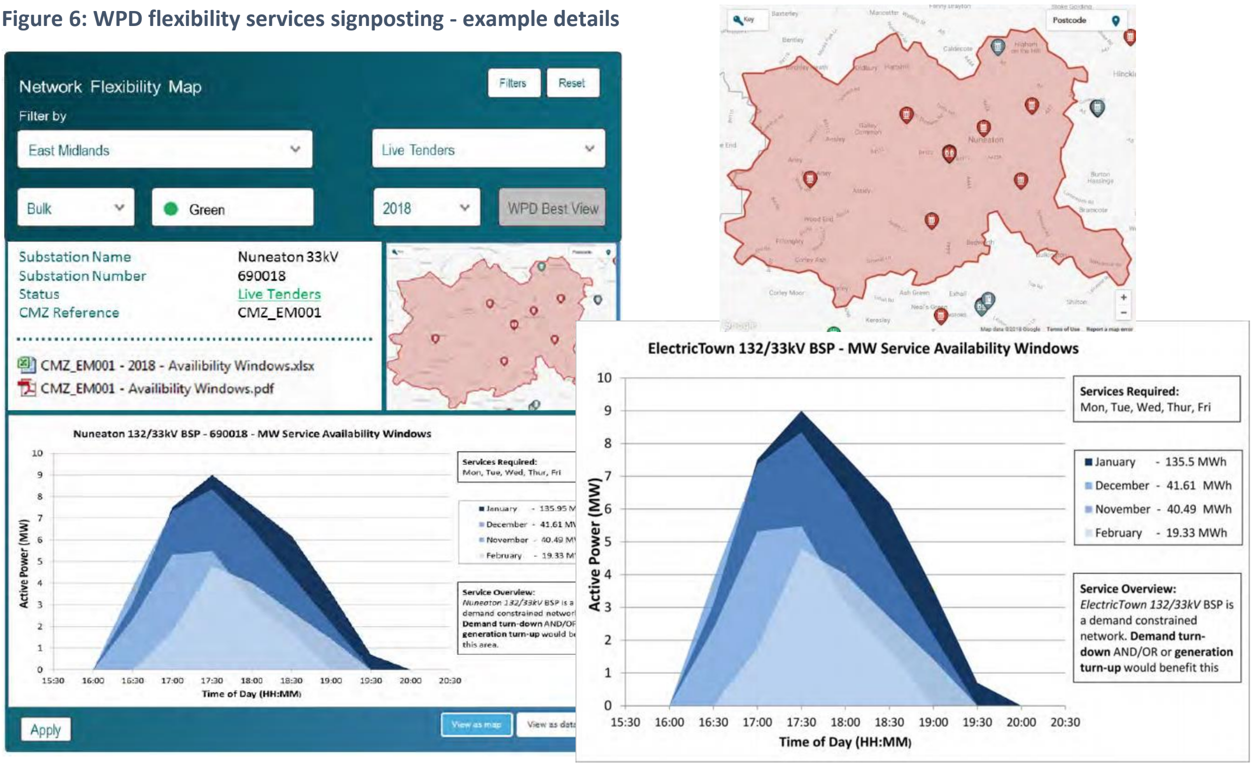
Figure 5: WPD signposting consultation, May 2018

See: https://www.westernpower.co.uk/About-us/Our-Business/Our-network/Strategic-network-investment/Signposting.aspx



WPD proposed that the information provided should detail the capacity (MW), the months and availability windows required and attempt to predict the volume of energy required in MWh in a given month. It was noted that the 'signposted' energy volume might differ from the volume put out to tender. An example of the type of information that would be signposted is shown in Figure 6.

Figure 6: WPD flexibility services signposting - example details



Flexibility providers and Aggregators can use this information to coordinate portfolios of generation, storage and DSR assets, to meet these future requirements.

With regards to revenue stacking, WPD indicated that providers will not be required to exclusively be available for WPD, when their services are not required. This potentially paves the way for participants to enter into multiple contracts, i.e. with WPD and with the ESO national balancing services.

The consultation therefore sought views on:

- If “Signposting” accurately describes the information and process proposed
- If it would be useful to use signposting across the network or just in current constrained areas
- If signposting long term distribution requirements should be issued ahead of a tender
- Using scenario modelling to predict a number of potential outlooks for future system requirements would be sensible
- If further caveats or explanatory material should be provided, to describe to what extent the signposting information can be relied upon to make business or investment decisions
- The proposed method of displaying information is clear and doesn’t miss anything important
- If the Information could be presented in a more useful way
- The proposed method to define the geographical boundary is sufficient
- An interactive mapping tool, that displays signposting information and live tenders, would be used by stakeholders
- Whether raw data should also be made available
- It is desirable to have system requirements for multiple compatible services simplified into regional system requirements
- DSO services are stackable with other revenue streams
- WPD not enforcing exclusivity is agreeable and if there are other services that do enforce exclusivity, that may affect the ability to engage with WPD’s flexibility services

WPD has developed its flexibility services in line with the reserve products procured by the SO. Calls for EOIs would be declared through an online platform, allowing participants to submit their availability schedules. WPD propose to then provide confirmation at noon on Thursday the week ahead of the window of operation, which would then run from Monday through to Sunday. This consultation closed on the 18th May.

3.3.1.2 Flexible Power campaign

WPD's signposting consultation builds on a trial in WPD's Midlands licence areas (under Project ENTIRE[18]) in 2017, where WPD sought to determine the potential flexibility services that could be provided within 14 stated CMZs in the Midlands.

WPD are advertising flexibility needs under their **Flexible Power**[19] brand, predominantly seeking businesses to reduce consumption or increase on-site generation, for at least 2 hours, in response to an automated signal. Flexibility responses required by WPD have been categorised into three types of service: **Secure**, **Dynamic** and **Restore**. Table 2 provides an overview of these.

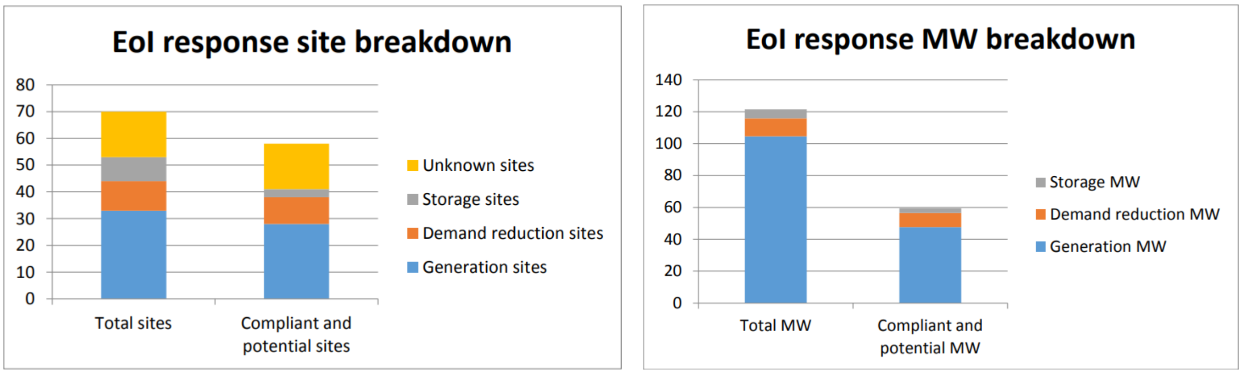
Table 2: WPD Flexible Power service categories for businesses (2017)

Service	Description	Requirement	Dispatch	Payment Structure
Secure	Used to manage peak demand loading on the network and pre-emptively reduce network loading.	Largely required on weekday evenings, all year round	**Declaration:** Week ahead (Thursday for the following Monday) **Dispatch notice:** Week ahead notification of need and 15min signal	**i) Arming Fee:** Credited when the service is scheduled **ii) Utilisation Fee:** Awarded when flex service is delivered
Dynamic	Used to support the network in the event of specific fault conditions	Largely required during maintenance periods, likely through British Summer Time	**Declaration:** Week ahead (Thursday for the following Monday) **Dispatch notice:** 15 minutes	**i) Availability Fee:** Credited when availability is accepted **ii) Utilisation Fee:** Awarded when flex service is delivered
Restore	Used to help with restoration following rare fault conditions, reducing stress on the network	Unplanned fault conditions are rare and largely in the event of equipment failure	**Declaration:** Week ahead (Thursday for the following Monday) **Dispatch notice:** 15 minutes	**i) Utilisation Fee only:** Premium reward for response that aids network restoration, awarded when flex service is delivered.

The 2017 EOI[20] closed to responses on 15 December 2017, with 70 sites totalling 121 MW of capacity responding. Energy generation uplift and demand reduction dominated responses, with energy storage also featuring (5% of responding capacity). Only 34 sites (41 MW) were fully compliant with some responding sites either being unknown, yet to be built or not supplying sufficient information, see breakdown of results
Figure 7.

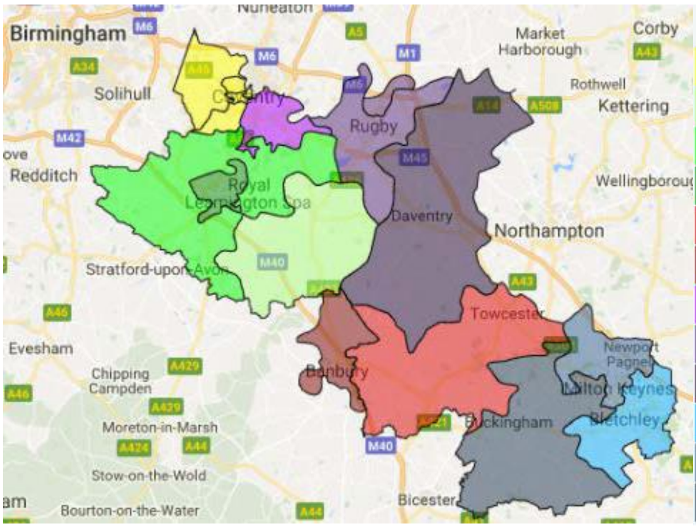
[18] See project summary page: https://www.westernpower.co.uk/Innovation/Projects/Current-Projects/Project-ENTIRE.aspx
[19] See Flexible Power campaign website: http://www.flexiblepower.co.uk/
[20] See 2017 Midlands trial EOI results: http://www.flexiblepower.co.uk/FlexiblePower/media/Documents/EOI-results.pdf

Figure 7: WPD Flexible Power 2017 EOI responses summary
(source and credit: http://www.flexiblepower.co.uk/FlexiblePower/media/Documents/EOI-results.pdf)



The results from the 2017 Midlands EOI show that 12 of the 14 identified CMZs are to be taken forward to the next stages of the flexibility procurement process, likely to be the signposting → forecasting → market tendering and contractual award of services. Figure 8 details the geographic areas of the 12 CMZs being taken forward, with Coventry Central and Pailton being omitted.

Figure 8: WPD Flexible Power - CMZs being taken forward from 2017 EOI and types of service provision



Colour	Zone	Name	Services
	1.1	Coventry Interconnector	Secure & Restore
	2.1	Harbury	Dynamic & Restore
	2.2	Warwick 33kV	Dynamic & Restore
	2.3	Warwick 11kV	Dynamic & Restore
	3.1	Brackley	Dynamic & Restore
	3.2	Banbury	Dynamic & Restore
	4.1	Whitley	Secure & Restore
	4.2	Rugby	Secure & Restore
	4.4	Daventry	Secure & Restore
	5.1	Bletchley	Secure & Restore
	5.2	Bradwell Abbey	Secure & Restore
	5.3	Stony Stratford	Secure & Restore

3.3.1.3 2018 call for EOIs

A further live EOI[21] was published by WPD in May 2018, for five additional constraint areas containing 18 new CMZs. This EOI followed a similar format with flexibility provider sites needing to meet the following requirements:

- Must be within one of the identified zones
- Must be half hourly metered
- Must have minute by minute metering
- Must be able to meet the 15-minute dispatch signal and respond
- Must be able to sustain response for at least 2 hours

[21] See live 2018 EOI document: http://www.flexiblepower.co.uk/FlexiblePower/media/Documents/Winter-2018-Summer-2019-EOI-Document.pdf

- Must be built or have a connection agreement with final milestone, before the end of procurement
- Provision of the flexibility service must not cause the participant to breach other agreements (e.g. their own connection agreement with WPD)

The details of these 18 new zones are outlined in Figure 9 and Table 3.

Figure 9: WPD 2018 EOI - Map of identified constraint areas

Source: WPD EOI document (May 2018)

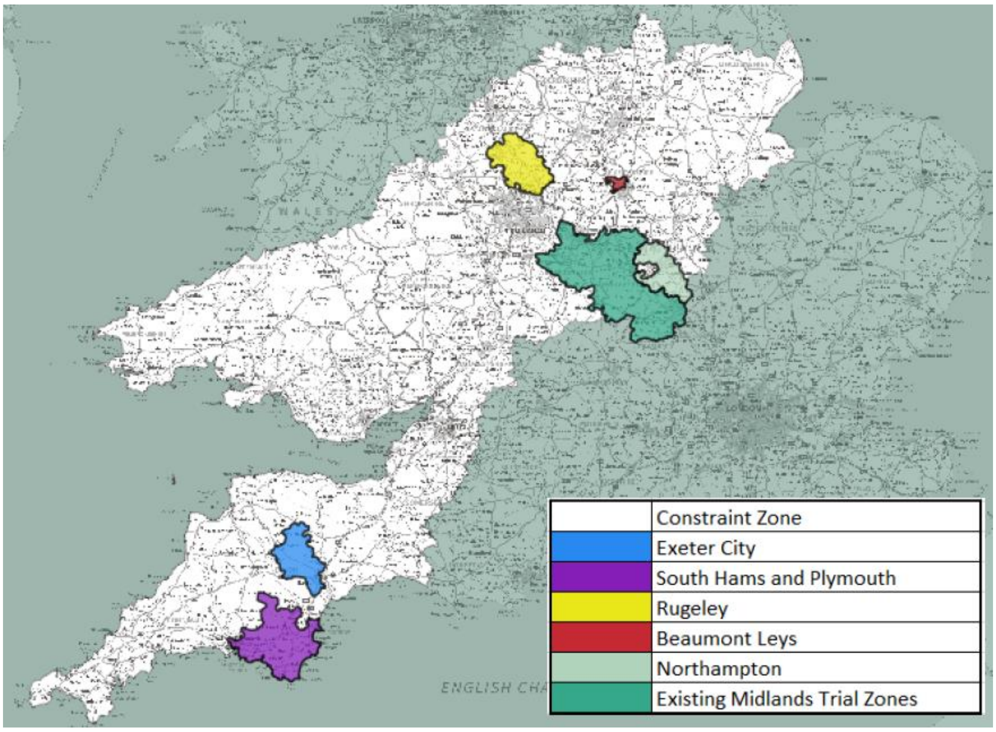


Table 3: WPD 2018 EOI - Details of flexibility requirements

Source: WPD EOI document (May 2018)

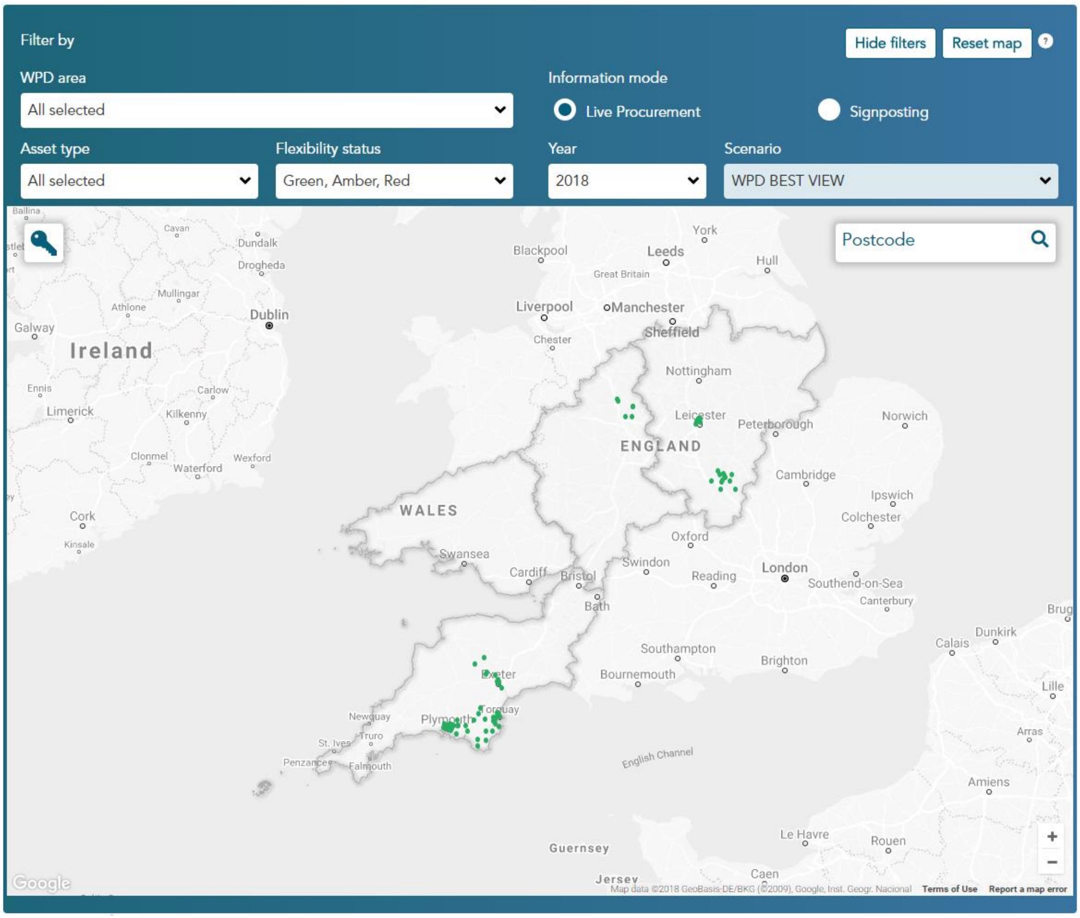
Constraint	Flexibility Zones	Flexibility Service Requirements		
		Flex Service	Days Required	Monthly Requirement
Exeter City	Exeter City	**Dynamic Restore**	Mon – Sat	Jan – 230.66 MWh Feb – 14.66 MWh Nov – 49.64 MWh Dec – 105.2 MWh
South Hams and Plymouth	Plympton Milehouse Plymouth Totnes Paignton Torquay	**Dynamic Restore**	Mon – Fri	May – 471.95 MWh June – 296.16 MWh
Rugeley	Stafford 132 Stafford South Rugeley Town Cannock Burntwood Lichfield	**Secure Restore**	Mon – Sat	Dec – 43.31 MWh

Northampton	Northampton East Northampton West Northampton	**Restore**	*No firm MWh requirements - could be on any day and anytime in the year*	
Beaumont Leys	Beaumont Leys Wider Area	**Secure** **Restore**	Mon – Sat	Jan – 92.96 MWh Feb – 28.21 MWh Nov – 12.89 MWh Dec – 7.07 MWh

3.3.1.4 Network Flexibility Map

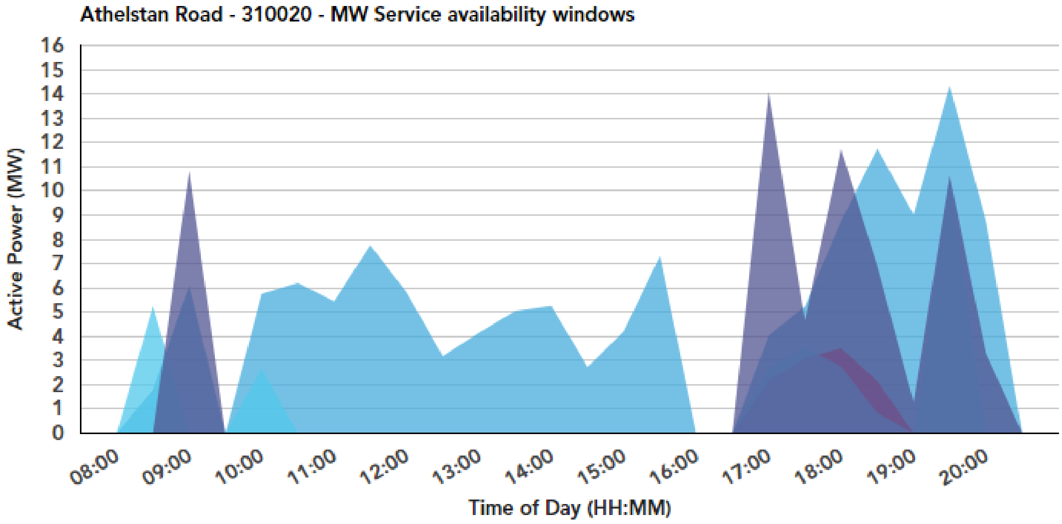
In July 2018, WPD launched an accompanying interactive online mapping service, their Network Flexibility Map. Using the same mapping interface as their Network Capacity Map launched in 2017, the flexibility map (see Figure 10) enables developers and potential providers of services, with an updated view of the flexibility requirements for specific substation areas.

Figure 10: WPD Network Flexibility Map (Source: WPD, 2018)



This map also provides a more granular level of information around the requirements, in addition to the EOI. Users are able to download PDF or spreadsheet versions of monthly flexibility needs, down to half hour settlement periods, see **Figure *11***.

Figure 11: Example of Exeter Flexibility Zone half hourly active power (MW) requirements (Source: WPD, 2018)



3.3.1.5 Payments and payment structure

Financial rewards to participants vary, depending on the type of service and location (I.e. which CMZ). The fixed payments on offer for each service in each zone is summarised in Table 4.

Table 4: WPD 2018 EOI - summary of proposed payments, by constraint area

Constraint	Flexibility Zones	Service	Arming Fee	Availability Fee	Utilisation Fee
Exeter City	Exeter City	Dynamic	--	£5/MW/hour	£300/MWh
		Restore	--	--	£600/MWh
South Hams and Plymouth	Plympton Milehouse Plymouth Totnes Paignton Torquay	Dynamic	--	£5/MW/hour	£300/MWh
		Restore	--	--	£600/MWh
Rugeley	Stafford 132 Stafford South Rugeley Town Cannock Burntwood Lichfield	Secure	£75/MW/hour	--	£150/MWh
		Restore	--	--	£600/MWh
Northampton	Northampton East Northampton West Northampton	Restore	--	--	£600/MWh
Beaumont Leys	Beaumont Leys Wider Area	Secure	£118/MW/hour	--	£150/MWh
		Restore	--	--	£600/MWh
Coventry Interconnector	Coventry	Secure	75/MW/hour	--	£150/MWh
		Restore	--	--	£600/MWh
Harbur and Warwick	Harbury Warwick 33kV Warwick 11kV	Dynamic	--	£5/MW/hour	£300/MWh
		Restore	--	--	£600/MWh
Brackley and Banbury	Brackley Banbury	Dynamic	--	£5/MW/hour	£300/MWh
		Restore	--	--	£600/MWh
Whitley, Rugby and Daventry	Whitley Rugby Daventry	Secure	£118/MW/hour	--	£150/MWh
		Restore	--	--	£600/MWh
Bletchley, Bradwell Abbey and Stony Stratford	Bletchley Bradwell Abbey Stony Stratford	Secure	£118/MW/hour	--	£150/MWh
		Restore	--	--	£600/MWh

Dependent on the type of flexibility service, non-performance from a flexibility provider could be approached in a number of ways. Instances of non-performance might be:

- A lack of response after declaring availability
- Not being able to sustain the service for the full duration (minimum requirement of 2 hours)
- Not ramping up declared capacity quickly enough, or dropping out part way through

For **Dynamic** and **Secure** services, WPD proposes the use of a 'sliding scale of underperformance' to enforce a reduced utilisation fee for underperformance. If a provider responds with between 100% and 95% of their capacity they will receive their full payment. Thereafter, for every 1% of under delivery below 95%, they will see a reduction in utilisation payments of 3%. Thus, if a participant delivers 63% (or lower) of their declared capacity, they will receive zero payment. **Restore** services use a 20% grace factor and a similar 2% rachet reduction. There is also the potential for pre-paid availability/arming payments to be clawed back, based on the average energy delivered per event. Based on this method, total average availability and arming payments are then to be reconciled monthly.

3.3.1.6 Baseline

The method by which WPD calculates the baseline, to which flexible capacity demand reduction/ generation turn-up is referenced against, is discussed within a supporting Flexible Power document[22].

For demand reduction:

This determines that on a monthly rolling basis, the baseline capacity will be defined as "*an excerpt from the first three full weeks of the month, between 3pm and 8pm, giving a sample over a total of 75 hours*".

The 5-hour daily consumption is divided by 75 hours to give an average monthly demand, which is then used as the baseline for the following month. This will therefore determine the demand reduction performance payments on a rolling basis.

With the likelihood that dispatches will be relatively infrequent across a given month, WPD do not foresee that the operation of demand reduction services will have a material effect on baselines. However, WPD state that any negative or unfair impacts to a party's baseline will be reviewed and a decision would be made on a discretionary basis.

For generation turn-up:

If a participant has back-up generation, the baseline is likely to be set at zero. This is due to the generator most likely starting offline. For other non-intermittent generation that operates more regularly, an average output would be determined and set as the baseline, so as to establish the level of increased output or 'turn-up capability'.

It will be interesting to see if diesel generators can participate in, when considering impending exhaust emission control stipulations under the Medium Combustion Plant Directive[23].

There are a number of considerations for the ECAS model with regards to setting a baseline, specifically with domestic DER assets/premises falling under the demand category.

- The 3pm-8pm window acting to inform the baseline may be an advantage, as this may be when the majority of existing peak demand occurs at the domestic level, thus setting a baseline for demand reduction to be fairly high and therefore lucrative.
- The method to determine an average sample baseline is sensible, from the perspective of trying to remove the potential for 'gaming' of utilisation payments, (i.e. by simply ramping up demand just before a likely availability window or similar).
- The flexible assets within a household are likely to be specific individual loads or appliances such as immersion heaters, home batteries of EVs. Therefore, to verify the full demonstrable reduction potential, homeowners may need to increase loads during these sample periods, either for the whole 75 hours or a majority of the daily period. This may result in additional electricity costs to consumers, that may even negate any potential revenue they would receive from responding to flexibility calls. This in itself wipes out any potential business model.
- This is also likely to be an operational challenge or additional cost burden for larger commercial and industrial (C&I) participants, who do not have regimented or predictable demand portfolios.

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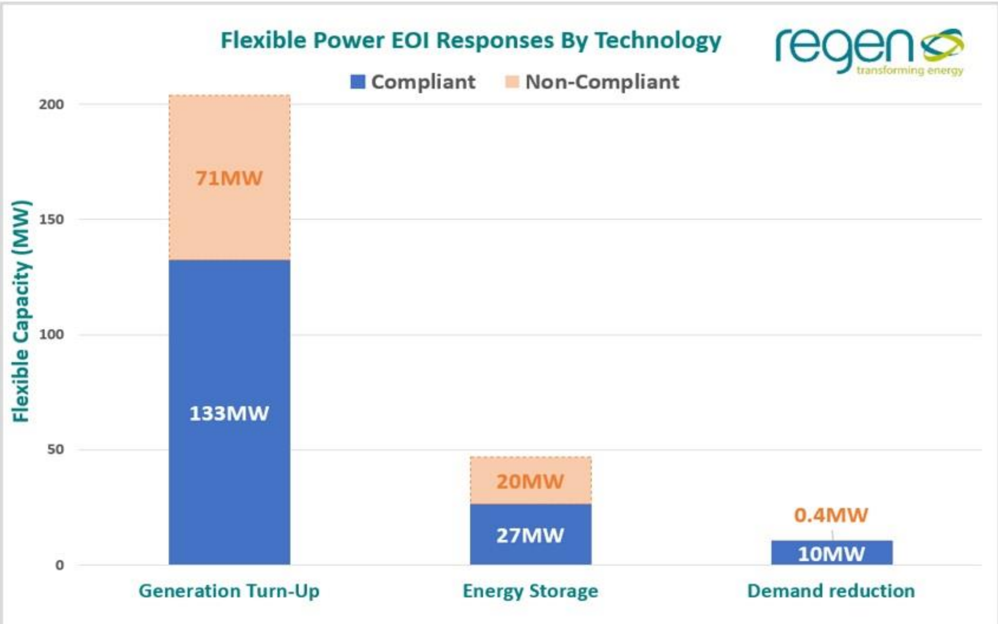
[22] See Flexible Power CMZ Payment and Contract Assistance Notes: http://www.flexiblepower.co.uk/FlexiblePower/media/Documents/CMZ-payment-and-contract-assistance-notes-MT.pdf
[23] See EU MCP Directive overview: http://ec.europa.eu/environment/industry/stationary/mcp.htm

3.3.1.7 2018 EOI results

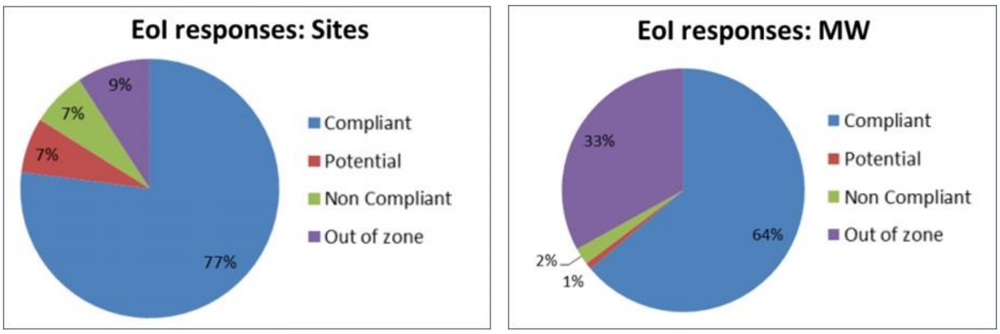
The results of the latest EOI have now been published[24], with WPD announcing an intention to take 16 of the 18 CMZs forward through to tender. The two CMZs in the Beaumont Leys area were removed, potentially related to low or non-compliant responses. The response totalled 87 sites, offering 261 MW of flexibility as a mixture of generation turn-up, demand reduction and energy storage. Only 67 sites (167 MW) were wholly compliant, with 8 sites (86 MW) located outside of the advertised zones and 6 sites (6 MW) classified as 'non-compliant'. From meeting with WPD, compliance potentially relates to factors such as the type of technology, flexible capabilities and the feasibility of a given site to meet the 15-minute response and two-hour duration. See summary by technology in Figure 12.

Figure 12: WPD Flexible Power EOI compliant technology breakdown (credit: Regen)



As Figure 13 outlines, generation turn-up was dominant, with 132.5 MW of the compliant capacity, across 12 sites. Three of the four storage projects (totalling 27 MW) that responded were compliant. Perhaps most pertinent to the ECAS model, in contrast, there were 58 compliant demand reduction sites, but in total only accounted for 10 MW (6%) of the compliant capacity, an average DSR site demand of 172 kW. This suggests that the lower (or non-specific) entry threshold is enabling much smaller demand-side sites and assets to participate in local flexibility.

Figure 13: WPD Flexible Power EOI response summary (source and credit: WPD)



[24] See WPD Flexible Power EOI responses, Aug 2018: https://www.flexiblepower.co.uk/FlexiblePower/media/Documents/EOI-results.pdf

Which projects engage in the follow-on tender process will be interesting to see, as the EOI was purely an exercise in gauging interest. Participants who didn't enter are still able to bid into the tender.

3.3.2 UK Power Networks

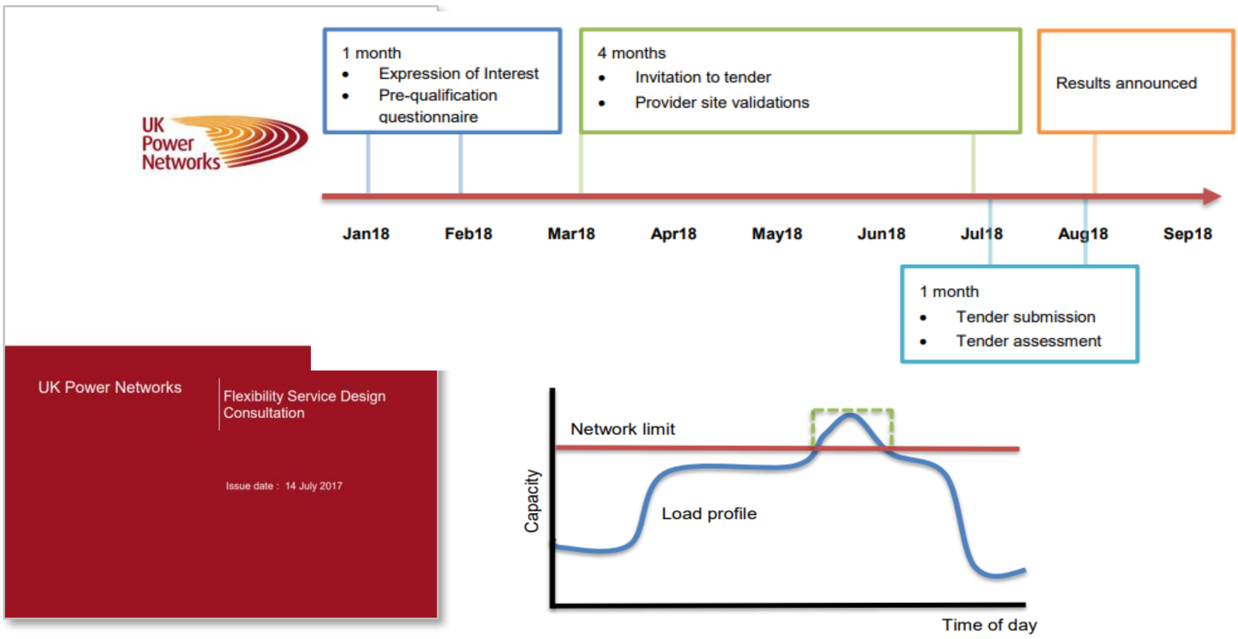
UKPN was one of the first DNOs to declare itself a DSO and to launch a structured consultation and tender process to create a new flexibility market.

The flexibility service design consultation in July 2017 (see Figure 14) outlined UKPN's initial assumptions and approach to procuring flexibility including key elements such as:

- locational requirements
- minimum lead-times and duration
- contract length
- minimum capacity requirements a
- proposed approach to pricing.

As with other DNOs, the flexibility requirements identified were heavily weighted towards meeting demand constraints during peak demand load periods.

Figure 14: UKPN flexibility service design consultation (July 2017)
See: https://www.ukpowernetworks.co.uk/internet/en/have-your-say/documents/UKPN_Flex_Consultation.pdf



With regards to pricing, UKPN outlined their proposals around identifying the best method to value flexibility through a matrix table of high and low availability vs utilisation payments, see Figure 15. UKPN's analysis outlines the benefits and drawbacks of a high/low availability price (i.e. retainer) against a low/high utilisation price (i.e. call-off price per unit of dispatched energy).

As noted already the natural desire of a DNO to opt for a "pay-per-use" utilisation payment versus a fixed contract or availability payment is very likely to favour flexibility providers with existing assets, including diesel generators. If DNOs wish to grow the flexibility market and encourage new entrants, a higher degree of revenue certainty and more allowance to stack revenues from other services, will likely be required.

Figure 15: UKPN flexibility service - proposed pricing structure matrix table
See: https://www.ukpowernetworks.co.uk/internet/en/have-your-say/documents/UKPN_Flex_Consultation.pdf

		Utilisation Price (£/kWh)	
		Low	**High**
Availability Price (£/kW/h)	**Low**	**Low availability and utilisation** • Good for customers, but potentially not for providers. • Low service value could reduce the incentive for service reliability, and increase risks to the network.	**High utilisation and low availability** • The cost to providers of being utilised is covered, but reliance on utilisation payments may reduce revenue certainty. • If frequency of utilisation is variable, the higher uncertainty could lead to higher service costs to customers. • Higher utilisation costs may act as a disincentive for the DSO to use the service.
	High	**High availability and low utilisation** • Higher revenue certainty for providers. Providers may include a conservative estimate of frequency of utilisation, which could increase availability prices. • Customers will have greater certainty on service costs. • Lower utilisation costs may act as an incentive for the DSO to utilise the service more frequently.	**High utilisation and high availability** • Good for providers, but potentially not for customers. • High service value should increase the incentive for service reliability.

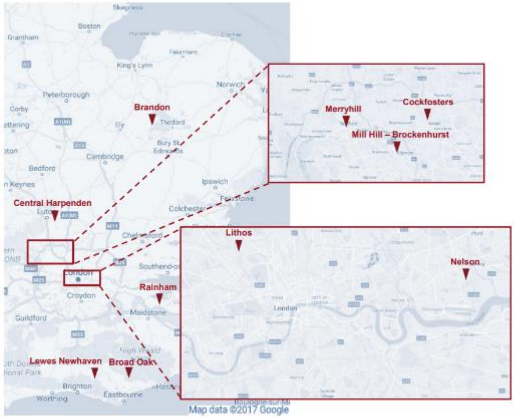
The consultation was followed by an EOI for flexibility services, targeting a range of MW requirements across 10 substation locations (see Figure 16) in UKPN's Southern and Eastern licence areas.

As a result of the EOI and subsequent tender, UKPN has this year agreed bi-directional contracts with a small number of flexibility providers. One of these parties is domestic battery company Powervault, who will be providing flexibility services to UKPN, through a portfolio of 40 x 8kWh batteries across the London Borough of Barnet[25].

[25] See Powervault press release, June 2018: https://www.powervault.co.uk/article/powervault-to-deliver-local-flexibility-in-london-with-ukpn/

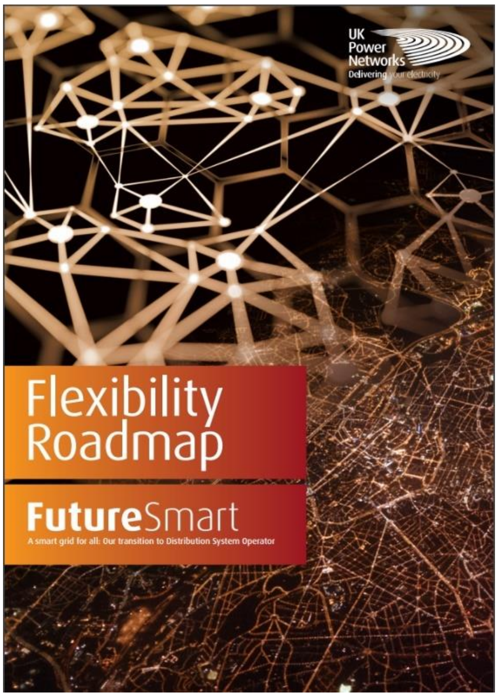
Figure 16: UKPN 2017 EOI - Map of substation areas for flexibility requirements

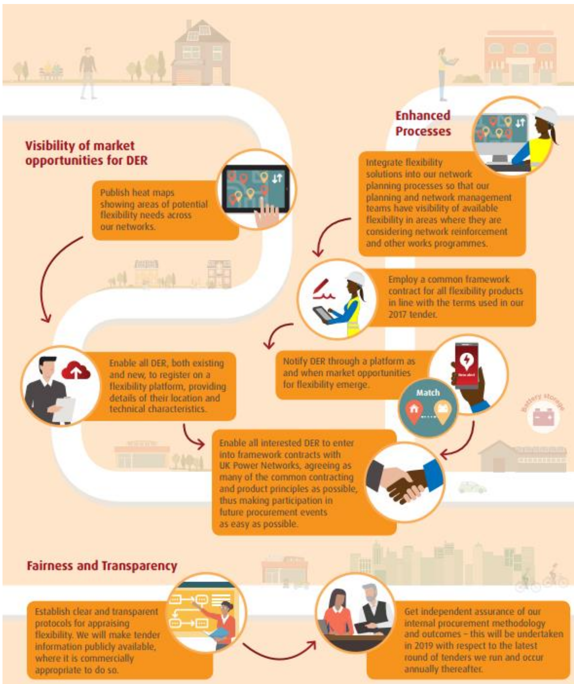
Network location	License area	Voltage level	Requirement 17/18 (MW)	Months	Earliest start date	Latest end date	Times	Days
Broad Oak	SPN	11kV and below	Up to 10	Sep-May	Jan18	May19	7:00 - 8:00am 4.30 - 8.30pm (5hrs)	All
Lewes Newhaven	SPN	33kV and below	Up to 8	Sep-May	Jan18	May19	7:00 - 8:00am 4.30 - 8.30pm (5hrs)	All
Rainham	SPN	11kV and below	Up to 3	Sep-May	Jan18	May19	7:00 - 8:00am 4.30 - 8.30pm (5hrs)	All
Nelson	LPN	11kV and below	1.5	Nov-Mar	Jan18	Mar19	4:00 – 7:00pm (3hrs)	All
Lithos	LPN	11kV and below	2	Jan-Mar	Jan18	Mar19	5:00 - 8.00pm (3hrs)	Weekdays
Merryhill	EPN	11kV and below	2.7	Nov-Feb	Jan18	Feb19	5.30 - 8.30pm (3hrs)	Weekdays
Mill Hill - Brockenhurst	EPN	11kV and below	1.4	Dec-Feb	Jan18	Feb19	5.30-7.30pm (2hrs)	Weekdays
Cockfosters	EPN	11kV and below	1.4	Dec-Feb	Jan18	Feb19	5.30-7.30pm (2hrs)	Weekdays
Central Harpenden	EPN	11kV and below	2.7	Nov-Feb	Jan18	Feb19	5.30-7.30pm (2hrs)	Weekdays
Brandon	EPN	11kV and below	2.7	Nov-Feb	Jan18	Feb19	5.30-7.30pm (2hrs)	Weekdays



3.3.2.1 UKPN FutureSmart: Flexibility Roadmap

Following the 2017 consultation and first round of flexibility tenders, in August 2018 UKPN published a more comprehensive roadmap[26] outlining its future plans and strategy to facilitate the future market for flexibility in its licence areas.





The roadmap document sets out a timetable for future flexibility tenders, as well as providing more detail and clarification of UKPN's flexibility requirements as it plots a transition from a DNO to DSO

[26] UKPN Future Smart Flexibility Roadmap, August 2018 : http://futuresmart.ukpowernetworks.co.uk/wp-content/themes/ukpnfuturesmart/assets/pdf/futuresmart-flexibility-roadmap.pdf

function. The roadmap articulates the increasing role that will be played by flexibility within a changing energy system and identifies four main value drivers for flexibility services within the UKPN network:

- Reinforcement investment deferral
- Planned maintenance
- Customer interruptions
- Avoided cost of temporary generation

The first two of these value drivers are planned and therefore suitable for availability contracts, while the latter two value drivers are related to unplanned faults and interruptions and therefore are more suited to a framework contract and utilisation payment structure.

Interestingly, the roadmap outlines a very transparent and inclusive flexibility market procurement process, including the use of a digital flexibility trading platform (Open Utility's 'Piclo Flex' platform[27]). Use of this platform will enable flexibility market participants to pre-qualify their services against UKPN's flexibility requirements, receive notifications of flexibility opportunities and manage service delivery. UKPN has stated that the fairness and transparency of the market will be underpinned by a set of procurement protocols and assured by a third-party assessor.

There is a lot of information in the roadmap about UKPN's role and ambition to facilitate a new flexibility market and to make the DSO a counterparty that is "easy to do business with", in a transparent and neutral way by providing visibility of market opportunities, enhanced tender and procurement processes and an overarching theme of fairness and transparency. The roadmap outlines a proactive engagement and communications process, designed to encourage participation from a wide range of DER providers.

[27] Piclo Flex Platform https://www.openutility.com/piclo/

Figure 17: Overall flexibility product requirements (Source and credit: UKPN)

Flexibility Products		Reinforcement Deferral	Planned Maintenance	Unplanned Interruptions	
				Pre-Fault Response	Post-Fault Response
Value Drivers		The present value of deferring capital expenditure	Managing unplanned interruption risk during planned maintenance	Customer Interruption (CI) and Minutes Lost (CML) incentives	Avoided cost of temporary generation and potentially CMLs
2023 Flexibility Potential (MW)		206	Available to eligible DER capacity		
High-Level Requirements	**Location Specific**	Yes			
	Response Time	30 mins maximum		<10 mins preferred, 30 mins maximum	
	Response Duration	Full availability window – case dependent. Pro-rated payment if available for part of window		3 hours. Pro-rated payment if available for part of window	
	DER Type	Generation, Storage and Load Reduction			Generation and Storage
Contracting Principles	**Procurement Type**	Competitive tenders or administratively set prices if low liquidity		Framework agreement. Optional updating of pricing through contract	
	Procurement Lead Time	6 months ahead and 18 months ahead	Case specific 1–12 months	DER applies if eligible	
	Payment	Availability and Utilisation		Utilisation only	
	Contract Term	1–4 years	Monthly or seasonal	Framework agreement	

The flexibility procurement timeline outlined in the roadmap envisages annual tenders for 6-month and 18-month ahead contracts, with an ongoing process of short-term contracting for planned maintenance and unplanned interruptions.

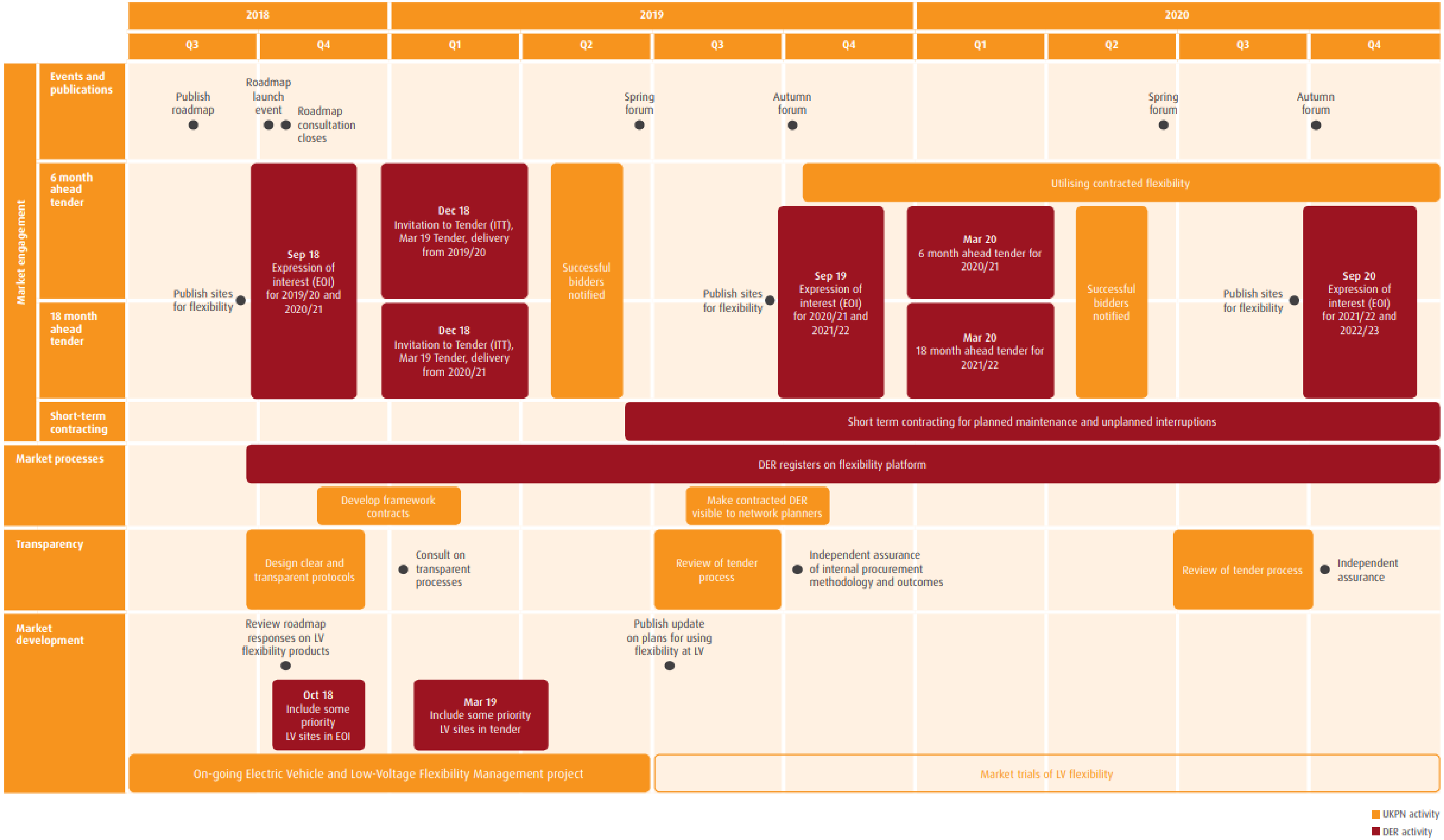
In terms of market size, the roadmap identifies a growing number of substations with flexibility potential, mainly driven by increasing demand from the increased uptake of EVs, reaching a total of 53 substations by 2022. At this point, the market for investment deferral could reach 206 MW.

UKPN suggest that the priority focus for tenders in 2019 will be to manage demand constraints on the high voltage (HV) network and Extra High Voltage (EHV) network. There is evidently a less pressing need for flexibility at the Low Voltage (LV) network discussed in the roadmap, but it is expected that flexibility requirements will increase on the LV network, due to the growth of EVs and the electrification of heat, which could create an even greater market opportunity.

"We expect the trend of decentralised energy to continue at lower voltage levels. As yet, we have not seen the same level of change on our low voltage networks as on our higher voltage networks, but expect this to rapidly change with electric vehicle take up, and an increase in electrification of heating. The future challenges on our low voltage networks could be greater than the ones we are already managing on our HV and EHV networks." **UKPN Flexibility Roadmap, August 2018**

This new market for LV flexibility could be significantly different with much more highly localised, dynamic and unpredictable requirements, which in-turn lends itself to more dynamic and real-time flexibility market solutions.

Figure 18: UKPN flexibility services timeline (source and credit: UKPN)



3.3.3 Electricity North West

In April 2018, ENW also went out to the market to understand the interest to provide flexibility for seven substation locations (see Figure 19), for winters 2018/19 and 2019/20. ENW is following a similar format to other DNOs, targeting DERs connected at specific locations, with financial incentives to adjust how much they consume or generate, in response to times of high demand or "*when the network is operating abnormally*".

Figure 19: ENW flexible services requirements (Source: ENW, Apr 2018)

Network location	Voltage	2018/19 Flex Requirement (MW)	Availability window		
			Months	Times	Days
Alston	LV or HV	0.5	Nov - Mar	06:30 to 21:30	All week
Coniston	LV or HV	1.0	Nov - Mar	All day	All week
Easton	LV or HV	2.0	Nov - Mar	All day	All week
Nelson	HV or 33kV	20.0	Oct - Mar	06:30 to 21:30	All week
Blackfriars	LV or HV	0.5	Jan - Feb	16:30 to 21:30	Weekdays
Cheetham Hill	LV or HV	2.5	Nov - Mar	11:30 to 21:30	All week
Stuart Street	HV or 33kV	9.5	Nov - Feb	06:30 to 21:30	Weekdays

There are a number of conditions that ENW require of potential providers, as follows:

- DERs have to be connected to the network assets being supported, checked via the submitted meter point administration numbers (MPANs)
- There are no restrictions on size of sub-sites of aggregated portfolios, but the total portfolio of flexible capacity needs to be at least 200 kW
- Minimum size for directly contracted resources should also be at least 100 kW
- Provider should be able to deliver and manage, upon ENW's request, a net reduction in the load or an increase in the export, as seen by the distribution network
- Flexible service provider should have the ability to act (provide a response) reliably and consistently, in both magnitude and duration, throughout the contracted windows
- ENW are open to all technology types that can meet requirements. Flexible service providers may represent any existing or new industry sectors and any type of response mechanisms, such as demand reduction, demand offset, generation export or electrical storage discharge
- Generators and storage (greater than 16A per phase) looking to export to the network, will need to have a long-term parallel connection and be compliant with the requirements of UK Engineering Recommendation G59/3-3[28]
- Flexible providers should be able to deliver the service during winter 2018/19 (starting November 2018) and/or next winter (2019/20)

This echoes similar principles to other DNOs, but is less prescriptive in certain areas, such as verification metering/monitoring requirements. In regards to pricing, ENW have stated they are open to discussion.

[28] See ENA EREC G59/3-3: https://www.nationalgrid.com/sites/default/files/documents/GC0079%20Annex%203%20Option%201%20G59%20%20proposals%20170731.pdf

The results of this EOI are currently being analysed and ENW be releasing the outcomes, next steps and what they are taking forward through to full tender.

3.4 Additional DNO engagement

The project undertook to engage contacts at all of the major UK DNOs, liaising with key members of innovation, DSO transition, smart grid and future networks teams, see Table 5. Unfortunately, the project was unable to engage SPEN on specific areas.

Table 5: DNO engagements - contacts

DNO	Contact	Engagement
electricity north west – Bringing energy to your door	**Simon Brooke** Capacity Strategy Manager **Helen Seagrave** Community Energy Manager	3 May Meeting, Manchester
Western Power Distribution – Serving the Midlands, South West and Wales	**Matt Watson** Innovation and Low Carbon Networks Engineer **Nigel Turvey** Network Strategy and Innovation Manager	28 June Meeting, Bristol
Scottish & Southern Electricity Networks	**Steve Atkins** DSO Transition Manager	29 June Phone interview
UK Power Networks	**Sotiris Geogiopoulos** Head of Smart Grid Development	4 July Phone interview
Northern Powergrid	**Jim Cardwell** Head of Regulation and Strategy	4 July Phone interview

The interviews discussed a number of key topics around the approach and basis of DNOs seeking to procure flexibility. Whilst there were bespoke questions aimed at individual DNO projects and activities, the interviews focussed on the following topics:

- **Approach and need for procuring flexibility**
- **The indicative size of the market**
- **Entry requirements**
- **Verification methods**
- **Payment structure and pricing**

In addition, the interviews sought to understand how each of the DNOs intended to meet their regulatory requirements of not only enabling and facilitating local flexibility markets, but also to level the playing field for community and domestic entrants to local flexibility markets.

The following sections detail a summary of the responses on these topics.

3.4.1 Flexibility service needs

All of the DNOs are working towards their regulatory requirements under the DSO transition and are almost all involved in Network Innovation Competition (NIC) funded projects[29]. The current operational need for flexibility varies across the DNOs, with UKPN, WPD, SSEN and ENW moving beyond innovation trials to seeking interest or issuing live tenders for flexibility services.

The actual requirements for flexibility was also stated by the DNO representatives as seeking to manage or mitigate peak demand 'pinch points' on the network, calling on demand turn-down or generation turn-up responses. WPD discussed the value of demand turn-up, referencing a trial with National Grid[30], but stated that there was no immediate intention to procure flexibility to help to manage generation

[29] See examples of NIC funded projects: WPD EFFS | SSEN & ENW Transition | SPEN FUSION
[30] See National Grid demand turn-up overview, January 2017: https://www.nationalgrid.com/uk/electricity/balancing-services/reserve-services/demand-turn

constrained areas. Measures for this are in-place through existing connection charging on distributed generation, alternative connection offers and ANM.
It was noted that if Ofgem's proposed changes[31] to make connection charging 'shallower' come to fruition, DNOs may no longer be able to pass the full upgrade costs onto generators and the potential for DNOs to procure flexibility to managing generation may change.

This approach to change to 'shallow' access charging would mean that new distributed generation would only need to pay "*for their own their own sole-use assets through the connection charge, and not also any wider reinforcement and shared operational costs that are triggered.*" This means that the DNO may turn to a flexibility procurement approach to help manage generation capacity constraints in certain areas, as they are currently doing for demand. In essence, in this scenario demand turn-up and storage charge-up (or even generation turn-down) may become types of flexibility response.

3.4.2 Geographical location

For the DNOs that have signposted their near term flexibility needs, a key consideration is that these demand constraint led services are very localised, with needs being specified against individual substation areas or geographically ringfenced 'flexibility zones'/CMZs.

This approach really encapsulates a key difference between national balancing services and local flexibility markets, suggesting that only DERs connecting to the distribution network within these areas, will be eligible to express interest and go on to contract with the DNO. Simply put, if a flexible asset is not located in one of the zones that their regional DNO has specified, they will not be able to participate in local flexibility markets, under the current arrangements.

3.4.3 Capacity thresholds

The ability for smaller scale participants to enter and provide paid-for services to the network is considered to be one of the main potential benefits of local flexibility markets. The entry threshold for national balancing services is a technical barrier to a direct contract between a smaller flexible asset and National Grid. The need for generators or demand sites that have a flexible capacity below 1 MW, for example, would require an arrangement with an Aggregator, to enter as part of a portfolio of smaller sites. The role of the Aggregator is discussed in section ▯ of this report.

The entry thresholds proposed through the live EOIs are lower than this, with some DNOs specifying specific entry capacity of 100 kW and ENW specifying 200 kW if part of an aggregated portfolio.

Other DNOs have been less specific on this issue, stating that whilst 100 kW seemed a sensible threshold, there is the potential for this to drop to say 50 kW in the future. There were other more agnostic views, with some DNOs being open to providers at any scale. Finding out the level of interest through a more open procurement process, was also seen by some DNOs as more valuable than dictating a specific minimum entry capacity.

The issue of 'single point of failure' was also raised, when discussing small participants being aggregated together through a single, central platform. If this platform was proven to be reliable in enabling an aggregated portfolio to respond, more than one DNO considered this would be acceptable.

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[31] See Ofgem consultation document "Getting more out of our electricity networks by reforming access and forward-looking charging arrangements": https://www.ofgem.gov.uk/system/files/docs/2018/07/network_access_consultation_july_2018_-_final.pdf

As part of their EOIs, WPD have also specified that in a situation where they have over-procured capacity (week-ahead), they would draw on a series of principles[32] that prioritises several smaller sites, over single or fewer larger sites.

3.4.4 Entry requirements

Aside from capacity and geographical location considerations, a number of specific technical requirements are stipulated by the live EOIs from the DNOs. These stipulations range from:

- The need for half hourly settlement metering
- Additional minute by minute monitoring (to verify flexibility has been dispatched)
- Response requirements ranging from 15min to 30min notices periods, or no specific time
- Sustained duration ranging from 2-5 hours
- Assurances that existing connection agreements are not breached

The discussions with the DNO representatives suggested that some requirements were left intentionally open. It was also suggested that some specifications may be assessed and agreed through the EOI process and more specific or detailed requirements would be put in place at tender or contract stage.

3.4.5 Contract duration

There was some alignment in this area, with multiple DNOs suggesting an indicative contract length of between 2-4 years. Others stated that this was an area that remains undecided and may be related to the purpose that the flexibility is serving. This suggests that a local flexibility contract duration could range from a 6-month rolling arrangement to a firm 4-year contract and may depend on the licence area, the type of flexibility service and the specific network location. Longer contracts are unlikely.

3.4.6 Non-delivery

There was a lot of alignment around this area, with the DNOs largely aligned that they would not enforce a penalty for underperformance or non-response. Instead the intention was that the incentive payment would be withdrawn or reduced, based on the amount of frequency of underperformance.

WPD have probably shared the most detail around this area, through their 'sliding scale' methodology for utilisation payments, see Figure 20. This relates to an approach where during a call, a DER asset either takes too long to ramp up to full capacity, drops out half way through or doesn't respond at all. WPD have proposed giving an initial 5% 'grace factor' and then to reduce utilisation payments by 3% for every 1% underdelivered against declared flexible capacity, on a minute by minute basis. Effectively meaning that between 95% and 100% of declared capacity, a DER would receive full payment, between 95% and 63% payments would decrease at a ratio of 3:1 and below 63% zero payments would be made.

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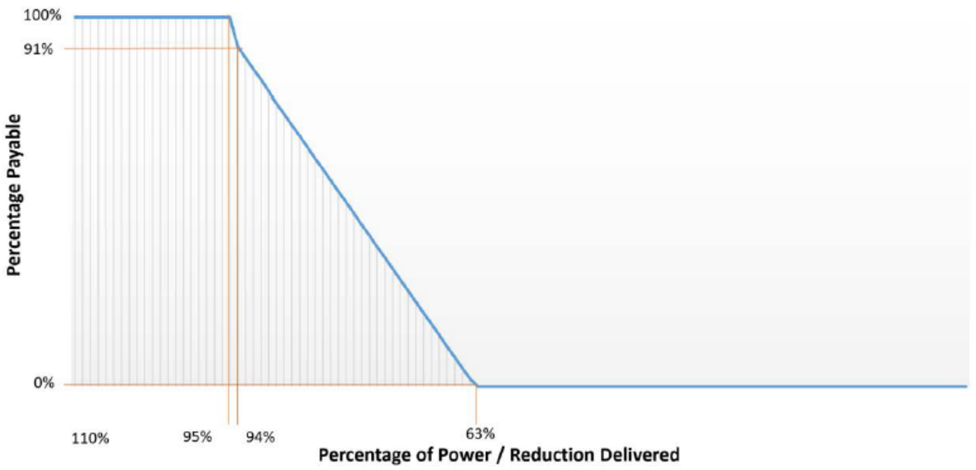
[32] See Flexible Power Winter 2018 and Summer 2019 EOI, page 14, "Assessments": https://www.flexiblepower.co.uk/FlexiblePower/media/Documents/Winter-2018-Summer-2019-EOI-Document.pdf

Figure 20: WPD sliding scale of utilisation payments under Secure and Dynamic services
(Source and credit: WPD Flexible Power Invitation for EOIs: Services for Winter 2018 and Summer 2019)



Whilst not necessarily a standard approach, the feedback received from WPD and other DNOs was that the services need to be reliable and to the capacity that was agreed, when the DNOs call them to action. There were discussions about recovering payments made if responses were not valid. A '3 strikes and out' view to cancelling contracts with parties that continually underperform, was also discussed.

3.4.7 Procurement approach

There are again some areas of similarity in the approach to engaging and procuring flexibility across the DNOs. Some examples include DNOs consulting on the method of engagement and 'advertising' flexibility needs through EOIs, online questionnaires or design consultations.

The actual approach to procuring, contracting and calling on DERs is, however, insufficiently established to determine trends or consistent approaches. At present, a number of the DNOs are working through EOIs, with a view to moving to full tenders. The examples of some of the timelines are shown in Figure 21 and Figure 22.

Figure 21: WPD timeline for procuring flexibility services in 2018

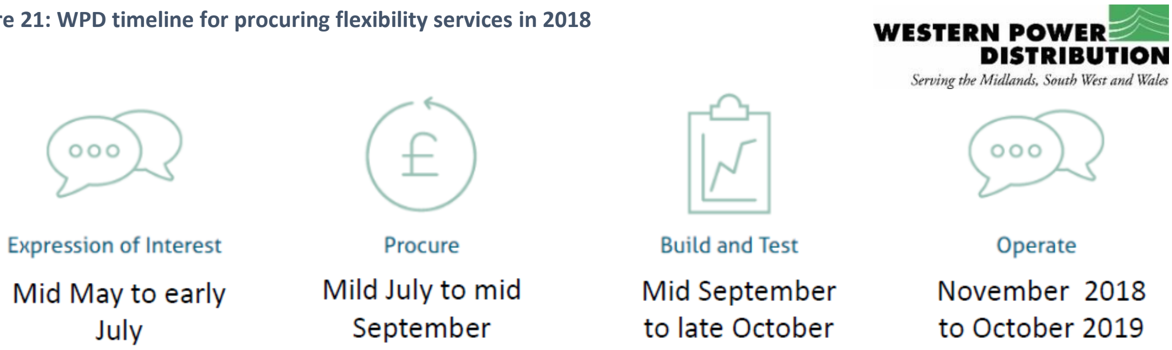
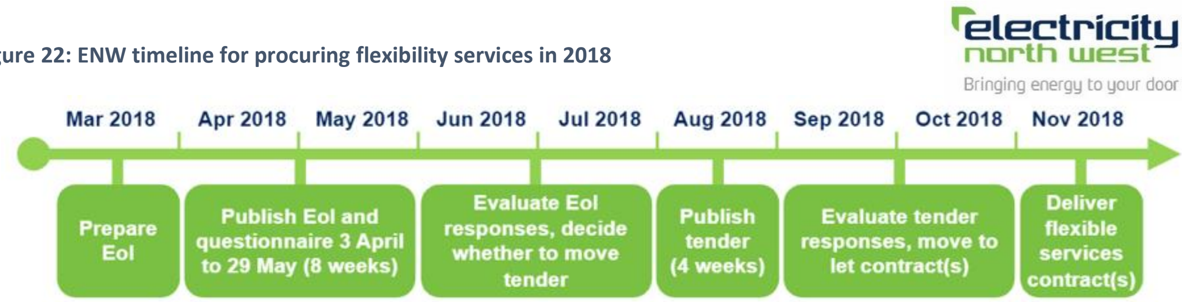


Figure 22: ENW timeline for procuring flexibility services in 2018



Whilst EOIs are an open method by which DNOs are seeking overall interest in flexibility services, some of the DNOs proposed a potential need to use additional, parallel or follow-on approaches to advertise flexibility needs. WPD was clear that responding to the EOI was not the only method by which DERs could participate or bid their flexibility to the DNO. It is assumed that other DNOs would follow a similar approach, so as to ensure that they gain access to sufficient cost-effective flexibility to meet their needs.

One method by which flexibility is to be advertised, bid for and potentially contracted is to advertise through central flexibility trading platforms. One such example is Piclo Flex[33], developed by Open Utility, with three DNOs now announcing intentions to publicise their flexibility on this platform.

Another example is Centrica[34], who are trialling the technical interactions of a local energy market platform in Cornwall. This project is aiming to deploy control devices and flexibility assets across various sites in Cornwall, communicating back to a central platform. This platform is then to be loaded with test constraints (both demand and generation) from WPD, to simulate how a platform of local flexibility services might respond. This project is currently not assessing the commerciality of flexibility responses.

[33] See Open Utility Piclo Flex platform: https://www.openutility.com/piclo/

[34] See Centrica Cornwall LEM project: https://www.centrica.com/innovation/cornwall-local-energy-market

3.4.8 Levelling the playing field for smaller entrants to flexibility markets

From speaking with all of the DNO representatives there was a clear awareness that they would not wish to exclude or block energy flexibility at any scale. However, at this stage, the perception of the value and reliability of domestic flexibility (in its current form) is varied across the DNOs.

When discussing what actions are being undertaken to level the playing field for smaller participants, effectively seeing DNOs following through on the requirement of being non-discriminatory, there was some diversity in the approach. Overall, the DNOs all cited engagement work with local organisations as a key method to gauging feedback and raising awareness of the local flexibility needs and actions.

Engagement ranged from independent organisations such as Regen, Community Energy England, Community Energy Scotland and Low Carbon Hub, through to local bodies such as Local Enterprise Partnerships, Local Authorities and Scottish Government.

The approach to consulting on market design and signposting, was also referenced as the DNO turning to their connected customers to provide feedback on the method by which they are seeking to advertise flexibility needs and services.

Regen worked closely with WPD to deliver a series of events[35], seeking to provide information about the development of flexibility markets. Speakers from WPD, Regen, Carbon Co-op, Piclo (previously Open Utility), developers and community energy organisations provided a summary of recent developments and the potential opportunities for communities.

Figure 23: WPD 'flexibility markets for beginners' event Birmingham, July 2018 (source and credit: WPD)

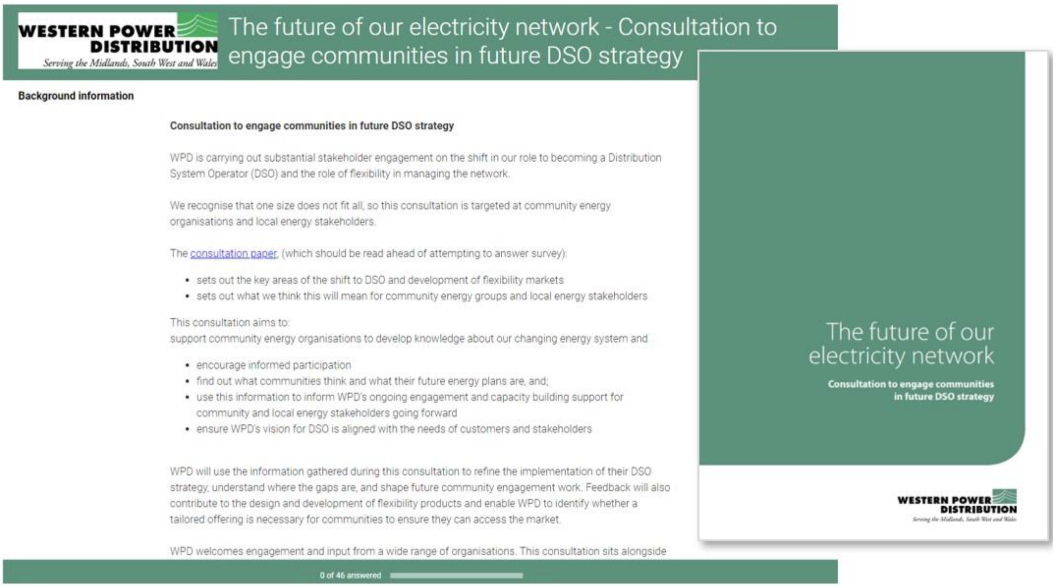
In addition to this, WPD have recently launched a consultation seeking communities' views of flexibility and the wider transition from DNO to DSO. The consultation comprises an online questionnaire[36] and an accompanying consultation paper[37] that aims to:

- *Support community energy organisations to develop knowledge about our changing energy system and encourage informed participation*
- *Find out what communities think and what their future energy plans are, and;*

[35] See summary of 'Flexibility Markets for Beginners' WPD events, July 2018: https://www.westernpower.co.uk/About-us/News/Flexibility-Markets-for-Beginners.aspx
[36] See WPD survey monkey questionnaire: https://www.surveymonkey.co.uk/r/3DQV9HS
[37] See WPD consultation paper, 'The future of our electricity network – Consultation to engage communities in future DSO strategy', August 2018: https://www.westernpower.co.uk/docs/connections/Generation/Community-Energy-Schemes/WPD-DNOtoDSO-Community-Consultation-Paper.aspx

- *Use this information to inform WPD's ongoing engagement and capacity building support for community and local energy stakeholders going forward*
- *Ensure WPD's vision for DSO is aligned with the needs of customers and stakeholders.*

Figure 24: WPD consultation paper and online questionnaire (source and credit: WPD)


WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales
The future of our electricity network - Consultation to engage communities in future DSO strategy

Background information

Consultation to engage communities in future DSO strategy

WPD is carrying out substantial stakeholder engagement on the shift in our role to becoming a Distribution System Operator (DSO) and the role of flexibility in managing the network.

We recognise that one size does not fit all, so this consultation is targeted at community energy organisations and local energy stakeholders.

The consultation paper, (which should be read ahead of attempting to answer survey):

- sets out the key areas of the shift to DSO and development of flexibility markets
- sets out what we think this will mean for community energy groups and local energy stakeholders

This consultation aims to:
support community energy organisations to develop knowledge about our changing energy system and

- encourage informed participation
- find out what communities think and what their future energy plans are, and;
- use this information to inform WPD's ongoing engagement and capacity building support for community and local energy stakeholders going forward
- ensure WPD's vision for DSO is aligned with the needs of customers and stakeholders

WPD will use the information gathered during this consultation to refine the implementation of their DSO strategy, understand where the gaps are, and shape future community engagement work. Feedback will also contribute to the design and development of flexibility products and enable WPD to identify whether a tailored offering is necessary for communities to ensure they can access the market.

WPD welcomes engagement and input from a wide range of organisations. This consultation sits alongside

0 of 46 answered

The future of our electricity network
Consultation to engage communities in future DSO strategy
WESTERN POWER DISTRIBUTION

The consultation refers to various topics under WPD's DSO transition, seeking views, community interest to participate, the nature of information that is made available and general feedback under the areas of:

- WPD's DSO strategy and its core principles
- The role and value of flexibility in an electricity system
- Alternative connections
- WPD signposting of flexibility need
- WPD's online mapping information (network capacity network flexibility maps)
- Types of flexibility responses
- WPD as a neutral market facilitator
- Ability to access multiple services/revenue streams
- Tender process
- Where, when, how much and how often flexibility is required
- Metering, payment structure and pricing

The consultation paper is available to download from WPD's website:

https://www.westernpower.co.uk/Connections/Generation/Community-Energy/The-future-of-our-electricity-network.aspx

Some requirements of these services are more readily achievable by C&I parties than potentially by aggregated communities or domestic loads. However, with some DNOs potentially aiming to encourage and even prioritise smaller scale flexibility, some of the more stringent entry requirements may need to be targeted or revised.

SSEN's discussed an intention to create 'Social CMZs', seeing SSEN directly supporting communities through the complexities of a flexibility tender process. Other technical barriers such as metering and verification, could also potentially be mitigated by DNOs providing a monitoring device as part of the contractual arrangement with community/domestic participant.

DNOs are required to remain impartial and agnostic to their connected customers/service providers, so how these support measures are to be deployed for certain parties and not to others, may need to be carefully stipulated and justified. Similarly, DNOs cannot discriminate (positively or negatively) one technology over another, one class of DER over another or, in principle, one group of actors over another. Thus, the complexities of entering or contracting with the DNO should not act as a barrier for one group of potential flexibility providers.

3.5 DSO flexibility markets - conclusions and considerations

From reviewing DNO to DSO strategies and market activities, and direct engagement with DNO network innovation teams, some key conclusions can be drawn in relation to the feasibility of an ECAS engaging with a DSO led flexibility market:

i) DNOs are at different stages in terms of procuring flexibility locally.

All of the DNOs are moving away from funded trials and innovation projects to their business as usual processes. Some (such as UKPN, WPD and ENW) are further along the process than others. This is limited by a number of factors:

Location: By its nature, DNO led flexibility is focussed around pre-determined areas within regional networks. Certain communities and participants will therefore be limited by how far along the local flexibility markets are, in their specific licence area. This is in some ways linked to the needs of the network, with disruptive demand causing constraints on e.g. more urbanised areas of the network.

Process: Similarly, the need for flexibility has driven some DNOs to further develop their capabilities to call for and contract with DERs to support operational challenges. This has led to some divergence in the approach that potential providers of flexibility have been engaged. Some networks have consulted directly on the method by which flexibility services are advertised, others have publicised open calls for EOIs. Other networks have yet to publicise this information. This effectively has created a small number of 'hot spots' for flexibility needs, creating a geographical limit on those providers that can – and cannot – enter markets directly.

It should be considered that publicising flexibility needs and calling on interested parties to bid their services in a market is not the only method by which domestic flexibility is rewarded. Other approaches, such as NPG's 'GenGame'[38] effectively enables homeowners, to play a role in supporting the DNO with their peak demand management challenges.

Whilst this approach is a completely different offering, this gamification method sees households flexing their demand in response to a signal, which is verified through a home energy monitor device (supplied by NPG) and then paid a financial reward for doing so.

ii) Local flexibility is currently about managing demand peaks

The current focus of procuring flexibility for local networks, is centred around mitigating local network demand peaks and managing unplanned events, maintenance or loss of generation. This effectively denotes three types of flexibility response actions that are currently required:

- **Generation 'turn up':** Activating or increasing generation
- **Storage 'discharge'**: Switching your energy storage asset to discharge/export operation
- **Demand 'turn down'**: Switching off or ramping down energy consuming equipment

Flexibility services required to perform the opposite action, i.e. excess distributed generation management, is not currently being targeted by the DNOs. This is largely due to the regulatory

[38] See NPG GenGame website: http://www.npg-ace.com/get-involved/play-gengame/

framework that requires electricity DNOs to invest and increase network capacity to meet demand growth retrospectively.

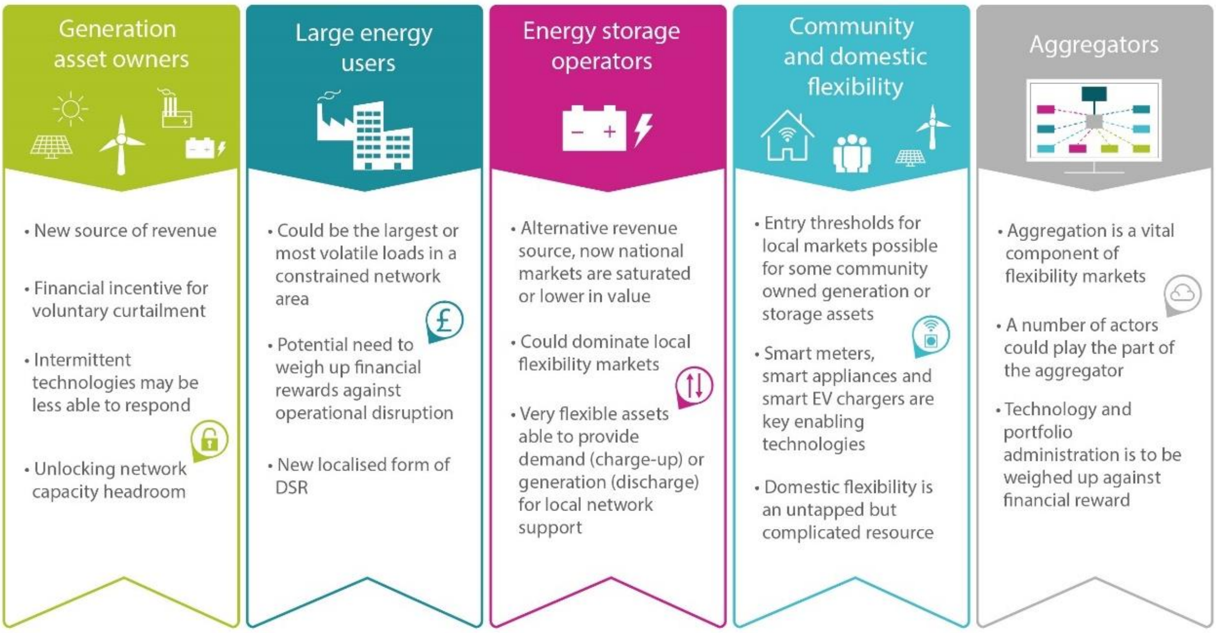
In terms of generation capacity growth, the cost to reinforce networks is either directly chargeable to the developer of that generation or mitigated through measures that DNOs can employ. These measures include offering Alternative Connections[39] such as timed connections, export limiting, temperature monitored connections etc. or more dynamic monitoring such as ANM[40].

iii) The local markets are more readily accessible to commercial and industrial providers of flexibility

From the initial calls for flexibility services, the requirements of providing flexibility services in response to an event or signal, is arguably more readily suited to larger industrial energy users or generators.

The providers of flexibility services could be categorised into five ‘classes’ of DERs, see Figure 25. For each of these, the development of a local flexibility market is an opportunity, either as a new source of financial income, or the potential to engage in network support to relieve demand constrained areas. However, despite DNOs being technology/approach agnostic, some parties will be able to enter and extract value from local flexibility markets more directly, more easily or more lucratively than others.

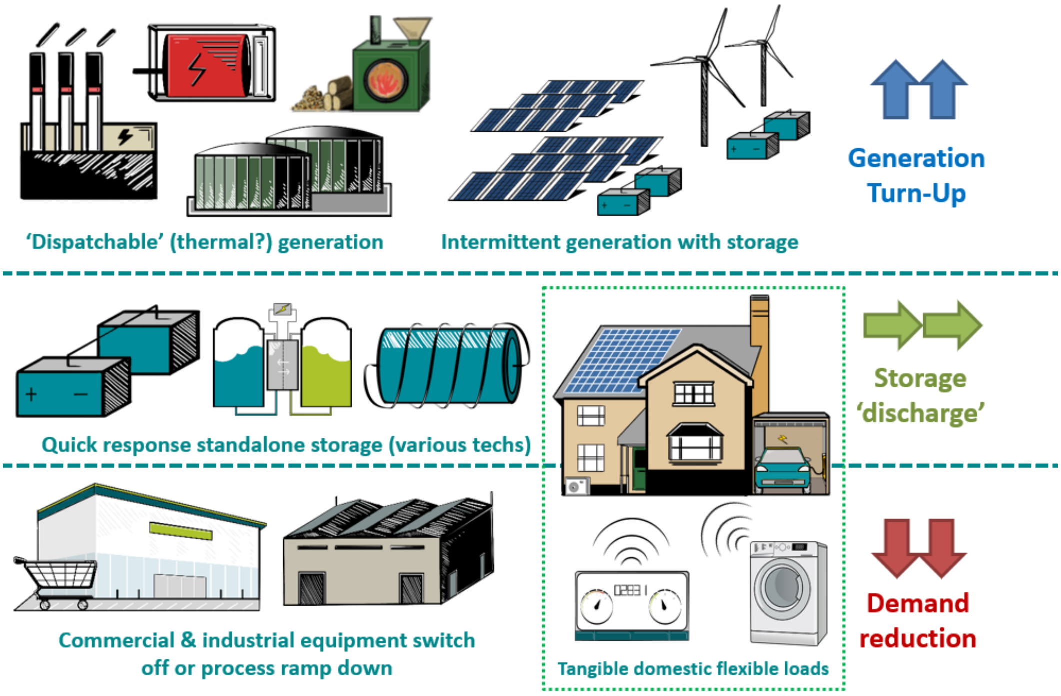
Figure 25: Benefits to classes of flexibility service providers



Under the current proposed entry and technical requirements, there are certain technology classes that will potentially be more readily able to bid into EOIs and move forward to contracting. Dispatchable generation, intermittent generation with storage, standalone storage, large energy user reduction and aggregated reliable domestic loads (such as home batteries) are the strongest contenders.

[39] See examples of Alternative Connections from WPD | SSEN | SPEN |
[40] See summary of Active Network Management here: https://www.westernpower.co.uk/Connections/Generation/Alternative-Connections/ANM-Further-Info.aspx

Figure 26: Technology classes potentially able to readily access local flexibility markets

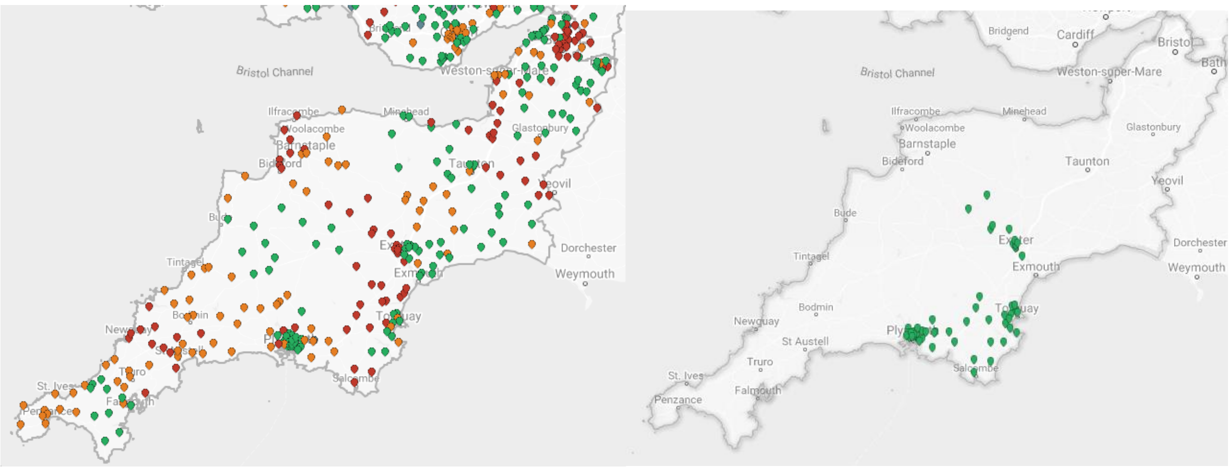


iv) Location is key

Local flexibility markets are, by definition, localised to specific DNO areas and CMZs. This is perhaps the most distinct difference to the national balancing services, in that the ability to access markets is restricted to those assets that are connected to specific substations with flexibility needs.

For example, see Figure 27 that shows the primary substations in the SW area that require flexibility services, compared to all primary substations in the same area.

Figure 27: WPD Network Capacity Map and Network Flexibility Map showing primary substations requiring flexibility
Source and credit: WPD



This means that there will be assets in areas outside advertised CMZs that are automatically discounted from being able to enter. This also might potentially create a scenario where flexibility assets target specific zones or substations to gain access to these markets. With EOIs being at relatively early stage, this is unlikely to happen in the near term.

v) Income will be modest

Flexibility payments are being seen, perhaps prematurely/inadvertently, as a new or alternative source of revenue. Whether to boost income for investing in generation or storage, or as a new method for high energy demand sites to be financially rewarded for dynamically managing their usage, local flexibility is inadvertently being considered as a new source of income for developers.

This is however against a backdrop of generators securing 20-year Feed In Tariff or Renewables Obligation (RO) contracts. The local flexibility markets are not going to be an equivalent to these subsidy programmes. Contract length will be shorter and income will be moderate at best.

Calculating an annual estimated income figure for a given flexible capacity is very difficult. This is due to locational differences in daily/monthly requirements, flexibility service types, prices and a general uncertainty as to the actual frequency and number of calls that will happen per month.

3.6 What does the development of a DSO flexibility market mean for an ECAS model?

In regard to a business model for a service that subscribes/aggregates community or domestic level participants in order to access flexibility services, some key conclusions can be drawn:

- DSO markets are at very early stages across the UK and the ability to assess whether these markets are a definitive source of revenue for the ECAS business model is currently difficult.
- The core specifications of DSO flexibility services, such as entry requirements, location, response times and pricing, may evolve as these markets mature and lessons are learned. The value of smaller assets with a shorter duration of response, may therefore have a value further into the future, as DSOs seek levels of flexibility across their networks.
- The amount of income on offer per kW/MW is likely to be modest; the model may need to pursue additional markets and sources of income to supplement the DSO income. It is thus unlikely that payments to end users would be sufficiently attractive or economically viable.
- The amount of income is also likely to vary significantly, largely according to location. The DSO element of any business model for ECAS, could therefore only be viable in specific areas.
- Fundamentally, increased second generation smart metering in the home will be essential. Additional verification monitoring supplied by the DSO as part of the contract may also be a key enabling factor to make the business case for domestic flexibility stack up.
- To enable domestic flexibility to meet baseline, entry and operational requirements of the DSO, manual operation of appliances or electronic devices is unlikely to have sufficient impact.
- further uptake of technologies, such as home batteries, heat pumps, electric water tank heaters and EVs will be needed.

The key parties related to an ECAS model are outlined in Table 6.

Table 6: Parties involved in DSO flexibility markets through an ECAS model

Party	Potential Roles
ECAS host organisation	Legal entity Host of subscription/member service Host and coordinator of revenue to/from members
Community or domestic participants	End consumers, host or owners or DER assets Flexibility responders Recipients of fixed or variable payments
Third party commercial Aggregator	Aggregator with or without supply licence Incorporation of ECAS member portfolio into existing Aggregator portfolio Potential to contract with DSO
Flexibility market platform facilitator	Entity that sits behind visibility/procurement platforms (such as Piclo Flex) Advertising DSO flexibility requirements and coordinating bids and auctions
The DSO	Procurer of flexibility services Contractual counterparty for either ECAS directly or Aggregator

The commercial arrangements could involve a number of different interactions between these parties. Scenarios might include:

(A) Community/Domestic DERs ←→ ECAS ←→ DSO

(B) Community/Domestic DERs ←→ ECAS ←→ Commercial Aggregator ←→ DSO

(C) Community/Domestic DERs ←→ ECAS ←→ Market platform ←→ DSO

(D) Community/Domestic DERs ←→ ECAS ←→ Commercial Aggregator ←→ Market platform ←→ DSO

The strength/weakness of these approaches will depend on a number of factors. A primary consideration is what the core functions of the ECAS will be, whether it is to undertake some or all of the following functions:

[1] Subscription: Engaging, recruiting and signing up individual households to the ECAS service
[2] Aggregation: Combining loads and responses to be a portfolio of sufficient size, that can be bid into, entered and called upon in local flexibility services
[3] Register and bid: Submit necessary portfolio data/locational information in response to EOIs or tender processes
[4] Dispatch: Either notifying or remotely activating domestic flexible loads in response to DSO calls or notifications
[5] Verification: Collate and submit flexibility response evidence/data for the duration of flexibility calls (HH smart meters and minute-by-minute devices)
[6] Settlement: Distributing revenue returned to the ECAS portfolio (if applicable)

Under these actions, the involvement of a third party Aggregator and market platform host (as possible intermediaries) could be determined by:

- The capability and remit of the ECAS organisation,
- The level of recruitment that ECAS has achieved in a given DSO flexibility CMZ,
- The appetite for commercial Aggregators to enter into a sub-agreement with a community Aggregator and how revenue is therefore to be distributed (could be Aggregator-specific),
- Whether the DSO seeks to advertise flexibility needs outside of visibility platforms, or whether these may become the sole routes to market,
- The support DSOs are willing to provide ECAS as a representative of community/domestic participants, in terms of both guidance through the procurement process and physical support by providing necessary verification monitoring as part of the contract.

Evidently the fewer parties involved will mean there is more revenue available to each party. The ultimate preference would therefore be Scenario (A), where ECAS contracts directly with domestic DERs and a portfolio of aggregated loads is offered and contracted directly with the DSO. The involvement of a third party commercial Aggregator to incorporate the ECAS loads, would dilute secured revenues. The need to route revenue through a flexibility platform may also reduce the benefit to end parties. In terms of the commercial arrangement between ECAS and domestic participants, a number of options could be considered. These are outlined, alongside the pros and cons in Table 7.

Table 7: High level ECAS commercial arrangement considerations

Arrangement	Pros	Cons
Fixed subscription fee *Domestic users pay an annual or monthly fee to ECAS for access to their DER assets, and user retains 100% of DSO income*	Guaranteed income to ECAS, removes risk to ECAS model	Risk of low or no income to user from either limited DSO calls or regular failure to respond.
Agreed percentage of income *ECAS and domestic users share DSO income*	Fair and equitable approach Proportion could be openly calculated to cover costs/ margin for ECAS in their role	Uncertain income to both parties

ECAS fixed annual payment *ECAS pays an annual or monthly payment to user, ECAS retains 100% of DSO income*	Guaranteed income to user, removes risk to them and could increases the potential to recruit participants	Risk of low or no income to ECAS from either limited DSO calls or regular failure to respond.

3.7 Existing commercial Aggregator activity

3.7.1 Background

The DSR market is rapidly diversifying, from a small number of industrial and commercial consumers, to more recently an increasing number of actors entering the market through aggregation models and flexible technologies. This has enabled a wider participation in flexibility and balancing markets with financial incentives. Aggregators are at the centre of these markets, as they help to bridge the gap between small-to-medium sized consumers and the procurers of flexibility[41]. National Grid references a wider term of Demand Side Flexibility (DSF), to incorporate demand, generation and storage[42] actions.

An Aggregator in this context is a third-party intermediary, which coordinates DSF responses from individual parties, aggregated to meet the technical requirements of the ESO or the DNO, as a route to market[43]. Some Aggregators coordinate this response by sending signals to their customers to modify their generation or demand through a manual 'call and respond' notification arrangement via text message or email, whereas others take full remote control of a customer's on-site asset, to automatically respond to SO or DNO requirements or a market price signal. There are also examples of instances where Aggregators operate a middle ground between these methods, by integrating their DSR response within the consumer's existing site's control systems.

Over the past few years with the development of the national balancing services market[44] (under their *Power Responsive* programme), the Aggregator business model has centred around these services, providing a route to market for smaller participants that are unable to contract with National Grid directly. This helps the SO to balance the network through services such as DSF, Frequency Response (such as FFR or EFR) and Short Term Operating Reserve (STOR). The development of this market has provided a business model for commercial Aggregators, who are able to enable flexibility from participants who are individually too small to enter these programmes to participate. For example, many balancing services have an entry threshold of 1 MW[45], as is the case for Enhanced Frequency Response (EFR), which can be aggregated through a portfolio of smaller sites. Over 90 per cent of Aggregators listed by the National Grid as providing aggregation offer services to both DSR consumers and small generators as a way of diversifying their business models[46].

Following on from the development of this national market, Ofgem has mandated DNOs need to develop markets for flexibility services at the regional level as part of the DNO to DSO transition, often referred to as 'facilitating local flexibility markets'[47].

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41 ADE Demand Side Response Code of Conduct Consultation https://www.theade.co.uk/news/ade-news/ade-demand-side-response-code-of-conduct-consultation

42 http://powerresponsive.com/wp-content/uploads/2018/02/Power-Responsive-Annual-Report-2017.pdf

43 https://www.ofgem.gov.uk/system/files/docs/2016/07/Aggregators_barriers_and_external_impacts_a_report_by_pa_consulting_0.pdf

44 https://www.nationalgrid.com/uk/electricity/balancing-services

45 https://www.nationalgrid.com/uk/electricity/balancing-services/reserve-services/demand-turn?technical-requirements

46 https://www.ofgem.gov.uk/system/files/docs/2016/07/Aggregators_barriers_and_external_impacts_a_report_by_pa_consulting_0.pdf

47 https://www.ofgem.gov.uk/system/files/docs/2017/07/upgrading_our_energy_system_-_smart_systems_and_flexibility_plan.pdf

3.7.2 Current Aggregator market activity

Details of some of the organisations who are active in commercial aggregation are listed on National Grid's DSR website. An overview of these organisations and a high-level assessment of their involvement in local flexibility markets, is outlined in Table 8.

Table 8: Commercial Aggregator local flexibility summary

Aggregator	Local Flexibility Involvement
Actility See: ThingPark Energy website	Internet of Things (IoT) platform, ThingPark Energy delivers DSR. Collects data from 1000's of assets and aggregates available flexibility using Aggregation Server (DAAS), mainly from industrial sites
AMERESCO Green • Clean • Sustainable See: Ameresco DSR website	DSR primarily in the US
eDF See: EDF DSR website	DSR flexibility for businesses at least 250 kW of flex
GridBeyond formerly Endeco Technologies See: Endeco website	DSR flexibility for industrial/commercial users, National Grid (NG) scheme
Energy Pool See: Enery Pool website	DSR flexibility, mainly for businesses, NG schemes
ENERNOC See: EnerNOC DSR website	DSR flexibility for businesses, NG scheme
e·on See: E.ON VPP/DSR website	DSR flexibility for businesses to DNO
Flexitricity See: Flexitricity DSR website	DSR aggregation to DNOs
engie See: Engie Energy website	DSR (STOR) aggregation from 250 kW loads for NG

KiWi POWER demand management See: Kiwi Power website	DSR/DSF for businesses, looking to enter potential local flexibility markets
limejump See: Limejump website	Aggregation for NG, mainly for businesses, 'Virtual Power Plant' (VPP) platform
npower See: Npower DSR website	DSR/DSF for businesses, NG scheme
open energi See: Open Energi website	DSR/DSF, aggregated from local generation through 'Dynamic Demand 2.0' platform
origamienergy See: Origami Energy website	Ancillary/balancing services flexibility, NG scheme
Pearlstone Energy See: Pearlstone Energy website	Aggregates from C&I clients to create VPP of 'Negawatts', Automated Demand Response (ADR) for DSR flexibility
reactive technologies See: Reactive Tradenergy website	DSR flexibility for businesses, NG scheme, 'Tradenergy' platform
REstore See: REstore website	'FlexPond' DSR flexibility for industrial consumers through IoT
VPS Virtual Power Solutions See: VPS website	Aggregation from individual buildings into VPP. Kiplo, Kisense and Cloogy platforms
ukpowerreserve See: UKPR website	Aggregates flexible small-scale power generation/storage
upside See: Upside Energy website	Aggregates small-scale capacity and would look to be active in local flexibility markets

3.7.3 Summary of Aggregator Engagement

Following on from this initial research, phone interviews were conducted with a sample of the above Aggregators, to clarify the level of engagement of national level Aggregators with local, small-scale flexibility. Part of this engagement was to gauge the views of commercial Aggregators on the feasibility and value of the ECAS model, or any similar service which could provide a platform for community scale actors to participate in local or national flexibility markets.
Phone interviews were conducted with representatives from three different Aggregators across June. The purpose of these phone interviews was to obtain perspectives on:

a) Their activity in aggregating small-scale flexibility
b) What are the barriers to aggregating domestic flexibility?
c) Are there financial benefits for homeowners and an existing model to share income and risk?
d) Would a service that bundles domestic flexibility (i.e. ECAS) for Aggregators or DNOs be valuable?

Graham Oakes upside

Graham was confident that a service providing a platform for households and communities to interface with local and national flexibility markets is feasible – either a peer-to-peer localised flexibility model or households and communities interfacing with the wider system – but it needs buyers and sellers.
Key points:

- An ECAS is feasible using a cloud service although a barrier could be the duration of flexibility required
- The main barriers are regulatory as the system is not configured to do this and there is no widespread existing model for:
    - peer-to-peer trading cutting across electricity suppliers
    - DNOs to engage with households using real time data
    - how to share the income between the homeowner, Aggregator, supplier and DNO
- Financially, flexibility could be worth around £100 per kW, but it depends on how the value is captured
- An ECAS would be valuable, especially for DNOs in constrained areas, but process and operational standards need to be developed.

Richard Hardy KiWiPOWER demand management

Richard was also confident that such a service will soon be feasible, with KiWi already looking into residential batteries and the flexibility they can provide. Key points:

- The cost of domestic installation makes the business case marginal as it's not cost effective per KW of domestic flexibility
- Other barriers are regulatory such as the framework for domestic billing
- Shifting demand and consumption is potentially valuable to homeowners but it needs a suitable variety of tariffs beyond Economy 7
- Constraint management is an important emerging market that suppliers and DNOs are looking into, in anticipation of EVs
- The Aggregator would finance the installation of technology and charge a management fee but wouldn't own the technology
- Suppliers may be reluctant to get involved due to domestic contracts and a lack of long term guarantee of domestic clients.

- An ECAS model would be valuable, but Kiwi are looking to enter the market themselves and wouldn't wait for such a service to bundle domestic flexibility loads for them.

Alex Howard origamienergy

Alex was the least confident of the three Aggregator representatives about the feasibility of an ECAS, at least in the short to medium term. Key points:

- Research suggests there are benefits, but local flexibility markets don't currently exist, and there aren't many financial incentives
- Metering and retrofitting issues in homes mean the cost of installation and participation may put homeowners off as the market currently stands
- Households may be willing to participate for moral reasons, with little risk to the individual as it's taken on by Aggregators and DNOs
- There are promising isolated innovation projects such as Piclo and Centrica which are pushing DNOs to be more approachable
- Origami are working on a project attempting to configure a smarter system where local actors can trade amongst themselves and the DNO can intervene in an area where the network is struggling with new housing developments
- There are easier routes to scale than the residential and community level for aggregating flexibility which have not yet been exploited, Origami are mainly focused on C&I level actors
- For an ECAS to feasibly operate within a local flexibility market, there must be plenty of willing participants in a given area, with an application program interface into the system for households and communities allowing smaller actors to participate

3.7.4 Conclusion and considerations for ECAS

From these discussions and reviewing the publicity of many other Aggregators, some key considerations can be drawn in respect to the potential feasibility of an ECAS service:

- Many Aggregators are already exploring the opportunities in smaller scale aggregation and entering local markets fuelled by the uptake in smart appliances
- The current framework is not configured to accommodate small-scale providers of flexibility accessing revenue streams, and there are many regulatory barriers to them being able to access this value
- Another key barrier is the level of smart equipment required in individual households
- Some propose developing market platforms as a route to enabling peer-to-peer trading led by innovation projects
- Most see the value of an ECAS, some would choose to bundle domestic loads themselves, while others are sceptical of its efficacy within the current system and regulatory framework

3.7.5 The regulation of Aggregators

Ofgem consultation

Ofgem are of the view that permitting independent Aggregators (those that do not also act as suppliers) to gain access to additional markets can deliver benefits to the consumer, under carefully designed regulation[48]. This can be aided by ensuring a level playing field in the access to markets for participants, which will lead to greater competition, while the balancing costs and delivery risks should be the responsibility of the Aggregator and not the customer. They also say that payments for sold-on energy should be agreed in the retail contract between the supplier and the household level consumer, but they anticipate lessons to be learned once such arrangements become more widespread.

Such lessons are already being implemented with Ofgem's decision to grant derogation to Limejump[49], allowing it to participate in National Grid Balancing Mechanism (BM) scheme by submitting aggregated data at a Grid Supply Point (GSP) group level, rather than down at the single GSP level. These developments follow a consultation from Ofgem last year, as the potential for Aggregators to access the BM starts to become a reality, with Flexitricity potentially following suit.

ADE Code of Conduct

The Association for Decentralised Energy (ADE) is in the process of developing a Code of Conduct for Aggregators, in order to help build confidence amongst DSF providers and advance flexibility opportunities[50]. This Code of Conduct will be mainly targeting these four areas of the market:

- sales and marketing, ensuring an honest and technically proficient relationship between Aggregators and customers, allowing customers to make decisions based on accurate information to promote high performance in the industry
- technical due diligence and site visit, ensuring the best practices to protect data and assets from cybercrime, as well as requiring that member installations be built to ensure protection of employees and liability coverage in the event of an accident
- proposals and contracts, requirements that tenders are fair and accurate, with benefits and risks clearly laid out so as not to deceive customers into signing up for services they do not want or need, enabling Aggregators and customers to enter into mutually beneficial agreements
- complaints, requiring members to give continued support to customers after a contract has been signed, helping disputes to be resolved in a timely and attentive manner.

The code is being developed by a committee of Aggregators, suppliers and industrial customers. It will be voluntary and industry-led, developed by a committee of Aggregators, suppliers and industrial customers, due to be implemented later this year[51].

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48 https://www.ofgem.gov.uk/system/files/docs/2017/07/ofgem_s_views_on_the_design_of_arrangements_to_accomodate_independent_Aggregators_in_energy_markets.pdf

49 https://www.ofgem.gov.uk/publications-and-updates/decision-further-limejump-energy-limited-s-request-derogation-under-standard-condition-111-compliance-grid-electricity-supply-standard-licence-conditions

50 http://powerresponsive.com/wp-content/uploads/2018/02/Power-Responsive-Annual-Report-2017.pdf

51 https://www.theade.co.uk/news/ade-news/ade-demand-side-response-code-of-conduct-consultation

3.8 The growth of energy storage – key flexible technology

As an inherently flexible energy technology that can act as demand (when 'charging') or a generation (when 'discharging'), energy storage (particularly solid-state battery based) has seen a significant level of interest and investment in recent years. The level of interest to connect battery storage projects to the electricity networks has, for example, been unprecedented. Regen's analysis of storage connection data on the distribution shows that for 8 out of the 14 electricity licence areas, there are 200 projects, totalling over 4 GW of capacity now with an accepted connection agreement or online and operational, see Table 9. In addition to this, the UK transmission network has 2.7 GW of connected pumped hydro and 7 additional energy storage projects that are seeking to connect, as a mixture of battery and pumped hydro, totalling 2.5 GW - see. The near-term pipeline of new, largescale flexible energy assets in the UK is therefore significant and likely set to grow even further.

Table 9: DNO energy storage connection data
Sourced from WPD (June 2018), UKPN (Feb 2018) and NPG (May 2018)

	Accepted		Connected	
DNO	Number of Sites	Capacity (MVA)	Number of Sites	Capacity (MVA)
WPD	96	1,469	12	52
UKPN	53	1,441	6	89
NPG	30	1,070	3	4
TOTAL	**179**	**3,979**	**21**	**145**

Table 10: Transmission energy storage connection data
Sourced from National Grid Transmission Entry Capacity (TEC) Register (May 2018)

	Built and Operational		Under Construction/ Commissioning		Consents Approved		Scoping	
DNO	Number of Sites	Capacity (MVA)	Number of Sites	Capacity (MVA)	Number of Sites	Capacity (MVA)	Number of Sites	Capacity (MVA)
Battery Storage	0	0	1	138	0	0	1	25
Pumped Hydro	4	2,744	0	0	2	822	1	1,500
TOTAL	**4**	**2,744**	**3**	**138**	**2**	**822**	**1**	**1,525**

An up to date value of domestic storage deployment is largely unknown, but with up to 1,500[52] installations as of late 2016, the number is likely to still be very low, due to relatively high cost vs low/uncertain rewards for homeowners.

[52] REA estimated at least 1500 residential batteries had been deployed as of October 2016, see *Energy Storage in the UK – An Overview (October 2016)*: https://www.r-e-a.net/news/new-data-shows-extent-of-existing-energy-storage-deployment-and-planned-projects-in-the-uk

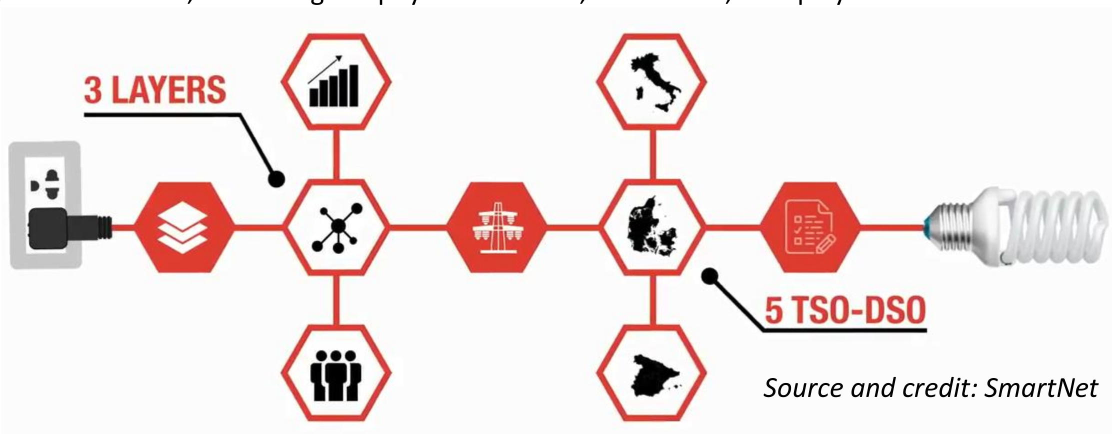
3.9 Overview of European Case Studies

A number of examples of enacting flexibility to mitigate local network constraints exist in European markets. Some examples are described below.

SmartNet **2016 – Ongoing**

http://smartnet-project.eu/

SmartNet is a three-year project funded by the Horizon 2020 programme, involving 22 partner organisations from nine European countries, including TSOs, DSOs, universities, research centres, manufacturers and telecoms companies. It is a modelling project focussed on exploring five TSO←→DSO coordination schemes around three case study nations: Italy, Denmark and Spain. The project is lab-based, simulating the physical network, the market, new players and ICT architecture.



Source and credit: SmartNet

A Danish case study explores the role of thermal inertia as a source of flexibility, testing the effectiveness of using price signals to control heated swimming pool thermostat levels in 30 rented summer houses. Laboratory testing and implementation was carried out in 2016 and a full demo of ten houses is ongoing since early 2017. The pilot focuses on system balancing and is operated by a 'bidding and clearing' procedure operated by a market operator (MO), which is distinct from the DSO or TSO and can be likened to the role of a UK flexibility market platform operator.

The process is as follows:

- The MO receives grid status information from the DSO and TSO and interacts with commercial market parties (CMPs) to gather the required flexibility
- The CMPs use a flexibility model that predicts electricity demand as a function of prices and sends out prices and price forecasts which aim to balance the grid for the coming hours
- Prices and price forecasts are received by a technical Aggregator, who calculates an optimal set point for individual thermostats based on price, weather data and booking information
- Data from the summerhouses is then collected to feedback into flexibility model

If the summerhouses were exposed to dynamic price tariffs and the smarter thermostatic control enables more efficient heating of the pool, there could be notable benefit to the owner/operator of the pool. The project is ongoing and results are expected to be published in 2018.

Key points:

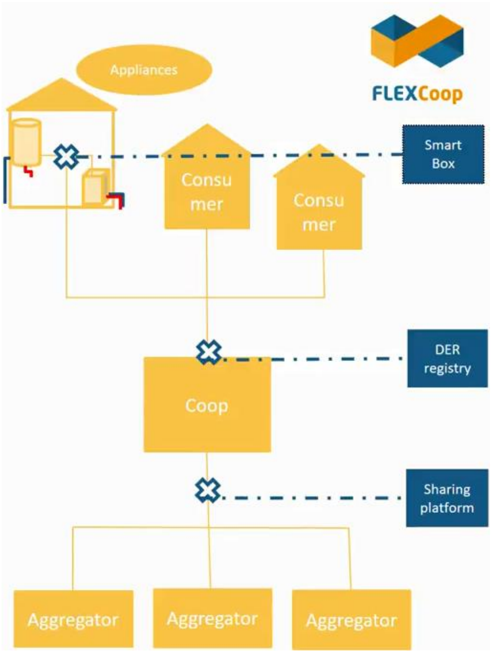
i) Thermal inertia is potentially a strong small-scale flexibility resource, due to resilience to short-term calls to switch off/on. But fairly unique to heated swimming pools, so very limited opportunity.

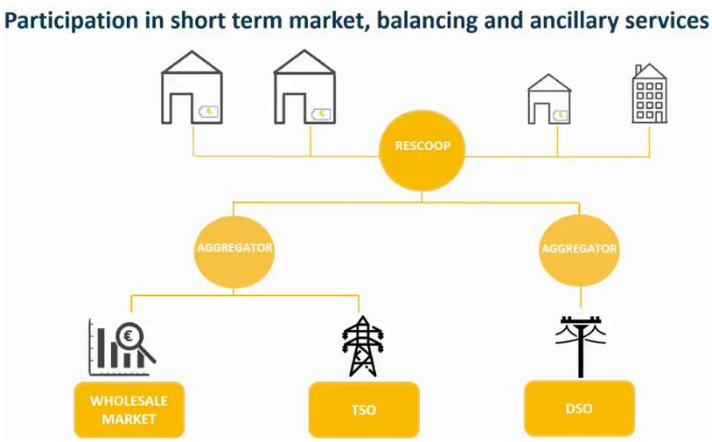
ii) Automatic control of thermostat set point based on price, creates two-fold benefit from both the benefits of price arbitrage and from energy/heating efficiency benefits

FLEXCoop **Ongoing**

http://www.flexcoop.eu/about-flexcoop

FLEXCoop is another Horizon 2020 funded project to develop an automated demand response framework for domestic consumers. Its aim is to develop a suite of tools which together, form a demand response optimisation framework, allowing energy cooperatives to become Aggregators and exploit consumer flexibility to provide balancing and ancillary services to system operators. Launched in January 2018, the project is targeting an end-to-end approach, from smart box devices in the home, to a DER registry for energy co-ops to bundle, through to sharing platforms to interface with flexibility Aggregators.





Source and credit: FLEXCoop Consortium 2017-

The system operates by implementing an Open Smart Box (OSB) in the home to collect individual household information, from household DERs such as controllable electric boilers, dimmable lighting, heat pumps and EVs. This data is sent to the local demand manager, which calculates available flexibility (taking into account consumer preferences). The cooperative/Aggregator then collects information from all DERs and communicates to a global flexibility manager, which calculates overall flexibility available depending on grid and market dynamics. This aggregated flexibility is then made available to all potential users (including DSO and TSO) through an open market.

These tools are very similar in concept to the ECAS approach, ensuring end to end interoperability, enabling information to flow from consumer devices to Aggregator systems. In this approach, local energy cooperatives have the opportunity to exploit new revenue opportunities by optimising supply and demand at a local level, to minimise its imbalance exposure and to sell services to the network. Individual energy consumers can also potentially receive new revenue streams, by enabling them to participate in flexibility markets with smaller scale aggregation.

The project is also exploring the concept of a ‘microgrid-as-a-service’ solution, where a local energy cooperative could manage local generation, balancing and distribution infrastructure for consumers.

Key points:

i) Currently very early stages of the project with no published results as yet.

ii) Many synergies with the approach for the ECAS model, but reliant on a local energy co-op being in place already, which references UK community energy groups.

NICE GRID — UN QUARTIER SOLAIRE INTELLIGENT 2012 – 2016

One of the six demonstrators under the GRID4EU project (co-funded by EU 7th Framework Programme for research, technological development and demonstration), Nice Grid is a project based in Carros, France. The trial focuses on the potential for network-connected microgrids to increase reliability and manage grid congestion. Community level demand response was tested through the provision of five offers (three in the summer and two in the winter):

1) Solar Bonus Offer: Over 40 days in 2014 and 2015, volunteer households were sent texts and/or emails a day ahead, asking to shift their energy demand towards time of high solar output between 12pm and 4pm, effectively falling under their supplier's (EDF) off-peak tariff, which usually only applies to overnight hours. Volunteers who responded were compensated with gift vouchers. This approach has similarities to the Sunshine Tariff project, where Regen worked with WPD, community energy group Wadebridge Renewable Energy Network (WREN) and supplier Tempus Energy.

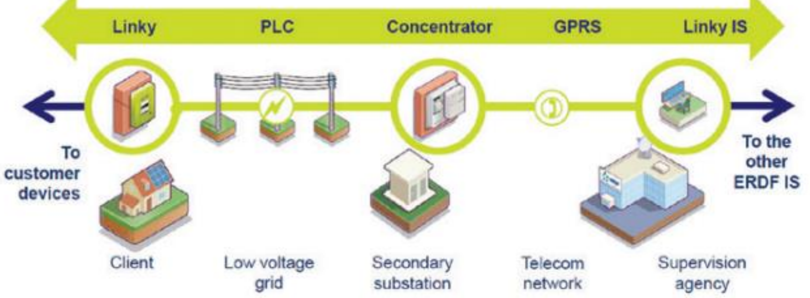
2) Smart Water Tank Offer: A group of participants agreed to have remotely controlled hot water tanks installed in their homes, that were switched on when local solar generation was available.

3) Smart Solar Equipment Offer: PV and domestic batteries offered to volunteers for remote control

4) Behavioural Load Management: Households were incentivised, again through gift vouchers, to reduce their consumption during the 6pm-8pm evening period, across 20 peak demand days.

5) Electric Heating Control: Household electric heating was programmed to be turned off, using Linky Smart Meter interface and controls, during peak demand periods. Customer heating/comfort was not compromised.

Source and credit:



Key points:

i) Experiments were positively received

ii) Regarding summer offers:

- 76 households took part
- Smart water heater households reduced demand by an average of 56% on a solar day
- Participants in the solar bonus trial reduced demand by 22% on eligible days
- Main motivators were stated to be the financial benefits on offer for shifting consumption, the environmental benefits and the desire to cooperate with the community to enhance the security of their supply.
- Use of text/email alerts was deemed as unpredictable and not a strong constraint/trigger to enact demand reduction.
- The presence of someone at home contributed to how much consumers were able to engage with the offer and respond to alerts.

iii) Regarding winter offers:

- Behaviour was mostly changed through changing washing machine and dishwasher usage patterns, and to lesser extent cooking appliances.
- 220 households took part, reducing consumption during peak periods by an average 21%

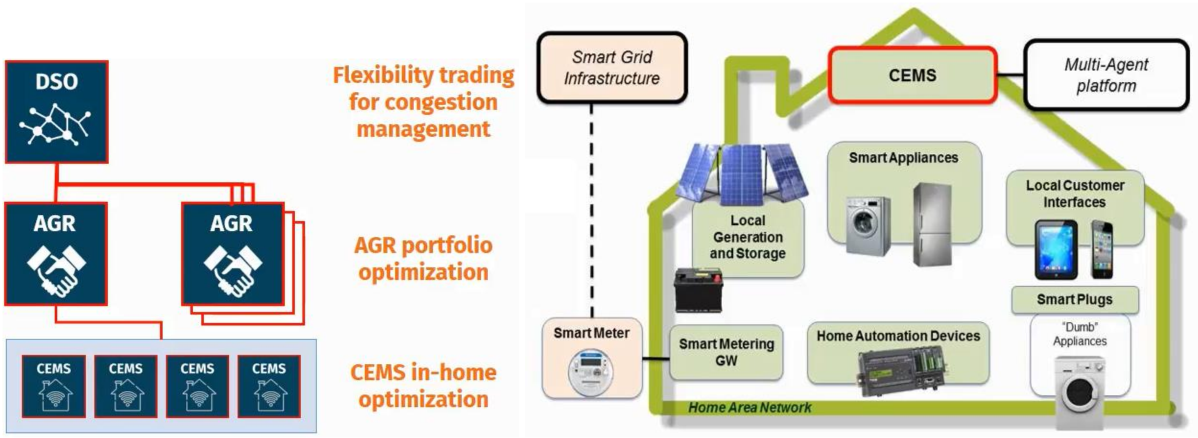
iv) General point that incentivisation through the use of e.g. gift vouchers, may limit participants and longevity/sustainability of behavioural change.

Mas²tering

2014 – 2017

A three-year consortium project to develop and test an ICT platform for the monitoring and optimal management of local community prosumers. **MAS²TERING** (**M**ulti-**A**gent **S**ystems and **S**ecured coupling of **T**elecom and **E**nergy g**R**Ids for **N**ext **G**eneration Smartgrid Services). The project aimed to validate the technical and business viability of residential flexibility management, using a Multi Agent Systems (MAS) approach to decision making. It should be noted that the platform was tested using ENGIEs test facilities, which consisted of two buildings and a smart building, thus is not wholly representative of a local smart energy community.

Data on prosumer demand and generation output is collected and shared with the network via a home energy box device. Historical data is stored. Day-ahead forecasts of individual generational output and non-adjustable loads are predicted using this information, along with weather forecasting and social variables the participant families. This information is then made available to local Aggregators, in order to carry out local system balancing and the DSO to manage overall distribution constraints. The USEF market framework is employed as the overarching model, for the trading and commodification of residential energy flexibility in this case.



Key points:

i) Prosumers were able to self-optimise, setting the parameters of their home area network (HAN) in order to utilise low energy prices or maximise use of local generation, by automating the use of their devices available for flexibility.

ii) Local flexibility Aggregators were able to build portfolios of flexibility prosumers and carry out local

optimisation, engaging prosumers with DSO flexibility incentives. Aggregators were also able to carry out local system balancing and trading surplus local generation with other communities.

iii) The negotiation protocols by which Aggregators can draw on prosumer flexibility, are pre-set by the prosumer using his energy box.

iv) DSOs were able to monitor and analyse the network, providing dynamic incentives for flexibility that, through Aggregators and self-optimisation of HANs, help to reduce network constraints and potentially defer investment

v) Ultimately, DSOs could use the platform to aggregate proposed plans of local Aggregators and highlight potential network constraints. Flexible incentives could then be based on this information.

vi) Intra-day optimisation was further tested by running simulations for one section of the low voltage (LV) Belgian network, defined as a local energy community. Whereas simulations of part of the Cardiff LV network tested day-ahead optimisation capabilities over a wider network area.

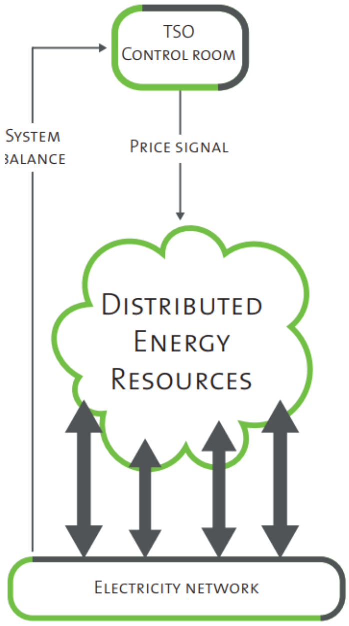
vi) The project was successful in proving that the platform could accurately forecast and manage signals to control load profiles in a cyber secure way. The project estimated that if implemented, the MAS²TERING system could reduce European grid losses by 5-8%, potentially reduce DSO reinforcements to up to €28 billion and increase the penetration of local renewable

EcoGrid eu www.eu-ecogrid.net **March 2011 – August 2015**

http://www.eu-ecogrid.net/

The EcoGrid trial was carried out on the Danish Island of Bornholm and demonstrated the operability of smart grids by using real-time pricing signals by grid operators. Flexibility was realised through either manual customer engagement or automated devices. The trial also tested the ability of Aggregators to control a portfolio of customer devices. This system varies from many other examples and trials, as it reduces the need for a direct flexibility market, instead the actors respond to real time price signals that are updated every five minutes.

Source and credit:



Source and credit:

Key points:

i) A real time price signal can be used to activate flexible consumption
ii) Activation of flexible demand via price signals, reduced peak load of participants by 670 kW (1.2%)
iii) Households with equipment that automatically controlled heating systems in response to price signals accounted for 87% of peak demand reduction
iv) Involving customers is the key to success and personalised advice is most effective
v) Standardised second generation smart grid equipment and metering is necessary

3.9.1 Key considerations for ECAS model

There are some lessons that can be drawn from reviewing these case study trials and projects, namely:

- Automatic control of domestic loads reduces the risk of non-response. Smart appliances, metering and communication devices are key enabling technologies to make ubiquitous domestic flexibility a reality.
- The level of reliable flexible load in a household is limited to certain appliances or those homes that have electric heating (electric boilers or heat pumps), home battery systems or EVs. Turning attention to electronic devices, chargers, computers etc. is likely to have a very limited effect.
- Aggregation can happen at more than one level and/or by different parties. Triggering flexibility at multiple households concurrently, can be seen as ‘bundling’ or aggregating demand response action, but many of the domestic flex projects listed have central platforms that interface with Aggregator parties and their own platforms. The principle of aggregation is therefore likely to be

Carbon Co-op regen transforming energy

a key route to market for smaller participants, occurring potentially more than once between a DSO call and domestic DSR action

3.10 Terms of Reference / Glossary

SO/TSO/ESO/NETSO: UK System Operator (National Grid), look after the electricity transmission network and system in the UK.

DNOs: Distribution Network Operators, the 6 regional companies licenced to distribute electricity within 14 defined licence areas across Great Britain.

DSOs: Distribution System Operators, the evolving role of regional DNOs to "*…operate and develop an active distribution system comprising networks, demand, generation and other DERs*"

DERs: Distributed Energy Resources, assets connected to the distribution network that could be called upon to provide flexibility services.

CMZ: Constraint Managed Zone, a discrete geographical area, likely related to an electricity substation supply area, where flexibility services may be required.

Flexibility services: Modifying generation and/or consumption patterns in reaction to an external signal for a financial reward (payment for the service delivered).

Revenue stacking: Using assets to access multiple incentive programmes, paid for services or contracts – i.e. both national balancing and local flex services.

Aggregation: 'Bundling' smaller loads into a portfolio, which can participate in programmes where entry thresholds are too high (i.e. 1MW for national balancing services, 100kW for local flex markets etc.)

4. ECAS Technical Feasibility Assessment

Author: Ben Aylott, Carbon Co-op

Content

This work package report is organised into three sections; a requirements analysis, an example system design based on a description of the high-level concept and use case, and an analysis of the example system.

4.1. Introduction

The development of local flexibility markets (and local energy markets more broadly) sits at a nexus of changes in the energy system, policy, and wider technology. There is an increasing amount of smart, generation, and storage assets (collectively referred to as Distributed Energy Resources or Active Demand and Supply) being connected to the distribution network, creating 'prosumers' who can store, generate, and reduce/increase power use. This resource is commoditized as 'flexibility' which can then be bought and sold by energy system actors. Local flexibility and energy markets are seen as a potential way of valuing and directing this activity to support energy system actors and the UK government in achieving their commercial, non-policy, and policy objectives.

Flexibility can be created in different ways with different implications for how it is valued and the technical systems needed. Implicit demand side response is price-led with prosumers basing their decisions about what flexibility they will provide to the system on the price of energy they are offered. The benefits of this in liberalised electricity markets is mainly economic e.g. improving market efficiency by allowing prices to better reflect supply and demand. It is also largely possible today with the first generation of smart meter-enabled electricity tariffs coming on to the market. Future reforms to charging could also support locational and temporal charging for use of network, enabling price signals to be sent by the DSO and ESO. The technical systems required to enable this type of demand response are ready now, relying only on the prompt 'broadcast' of price data to prosumer energy management systems (something achieved recently with the Octopus Agile API and supporting services) which can then determine an optimal schedule for operation of DER assets based on local requirements.

The other type of demand response is explicit demand response, where a flexibility provider is directly incentivised. The technical requirements of this type of demand response are higher, requiring more real-time systems targeting specific changing groups of flexibility providers and the automated exchange of information and negotiation between multiple actors followed by rapid dispatch of flexibility assets.

The focus in this study is on the feasibility of a market and technical concept (dubbed ECAS) for enabling explicit demand side response in a local flexibility market (local here meaning that its purpose includes supporting the activities of the DSO), with flexibility providers receiving payment for creating specific amounts of flexibility for different system actors (in the first instance the DSO, but potentially also suppliers and the ESO). This form of response can meet the operational requirements of DSOs and the ESO (such as capacity management and redundancy support) in addition to supporting the more traditional market-based economic objectives of suppliers.

The development of such systems is now well underway, enabled by parallel developments in mobile computing and electronic appliances towards increasing internet connectivity (the so-called 'internet of things') backed by cloud computing systems for rapid analysis of data and automated intelligent control (machine to machine communication). These developments will enable the cost-effective and reliable control of millions of devices required for creating an 'internet of energy'.

4.2. Requirements Analysis

3.10.1 Technical Standards

4.2.1.1. Role of standards

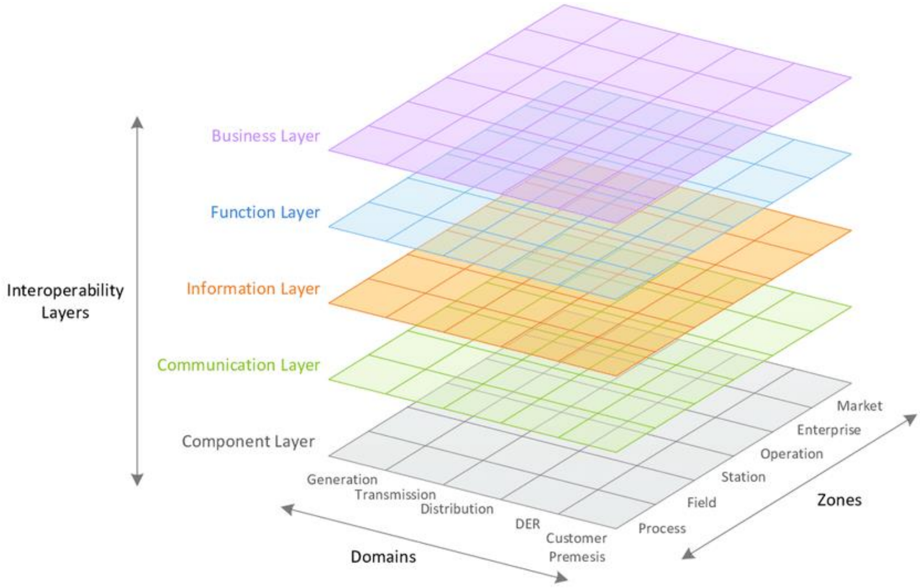
Electricity networks and markets are by their nature very complex and the application of technical standards serves to codify good practice and ensure critical systems in their operation and maintenance. The transition to a smart grid will bring further complexity including the need to exchange and operationalise large amounts of data from different parts of the system as well as support a much higher degree of interaction between business and information processes and more traditional operations. In order to achieve this there needs to be an increasing focus on interoperability in order to support the parallel and rapid development of new systems. For critical operational systems affecting grid stability and security there is no question that their operation should be carefully defined and controlled. But there is significant areas where standards should be sufficiently open, changeable, and flexible to facilitate innovation.

We have focussed here on the application of several complementary standards for the smart grid and local flexibility markets:

- Smart Grid Architecture Model (SGAM) which provides a framework and common language for the smart grid which enables use cases and business models to be mapped to the technical infrastructure.
- Universal Smart Energy Framework (USEF) which describes the mechanisms of local and national flexibility markets.
- OpenADR which specifies the information and control flow involved in the dispatch of ADS/DER/flexibility assets.

Our interest in promoting particular technical standards for the architecture of the smart grid and flexibility markets is in encouraging interoperability between systems. This lowers the cost (to end consumers) of integrating different systems through ‘plug and play’ operation and interchangeability of different manufacturers systems.

4.2.1.2. Smart Grid Architecture Model (SGAM)



The Smart Grid Architecture Model[53], developed by CEN, CENELEC, and ETSI under an EU mandate, is an attempt to create a reference architecture for future smart grids which captures the structure, information flows, and processes in a smart grid. This can be used to model and test high-level use cases (e.g. a local or national flexibility market) and help to identify deficiencies in process, functionality, interoperability, and information exchange. It has a high-level of correspondence with a similar US initiative by NIST[54]. However, SGAM necessarily reflects various differences between the EU and US electricity networks and markets, in particular SGAM incorporates the concepts of DER and flexibility.

The SGAM model splits the smart grid architecture in three conceptual dimensions. The first is the ‘domain’ which groups functions and processes by their relationship with traditional areas of the energy conversion chain such as generation, transmission, distribution, and behind the meter as well as the new class of DER. The second is zones which relates to the hierarchical levels of power system management. The plane formed by zones and domains is then divided into five ‘Interoperability’ layers which categorise business processes and objectives.

It is important to note that although SGAM can describe certain systems, information, and processes which may be involved in the operation of a local flexibility market (such as the format and content of information exchanged or the type of communication protocol between systems) it does not currently describe market mechanisms for energy or flexibility.

The relevance of SGAM to ECAS and local flexibility markets is:

- Its adoption by the EU (and the US through the NIST model) as a reference architecture for smart grid development.
- Its use in the ENA Open Networks project as well as various NIC projects in describing and modelling the operation of future UK smart grids and flexibility markets.

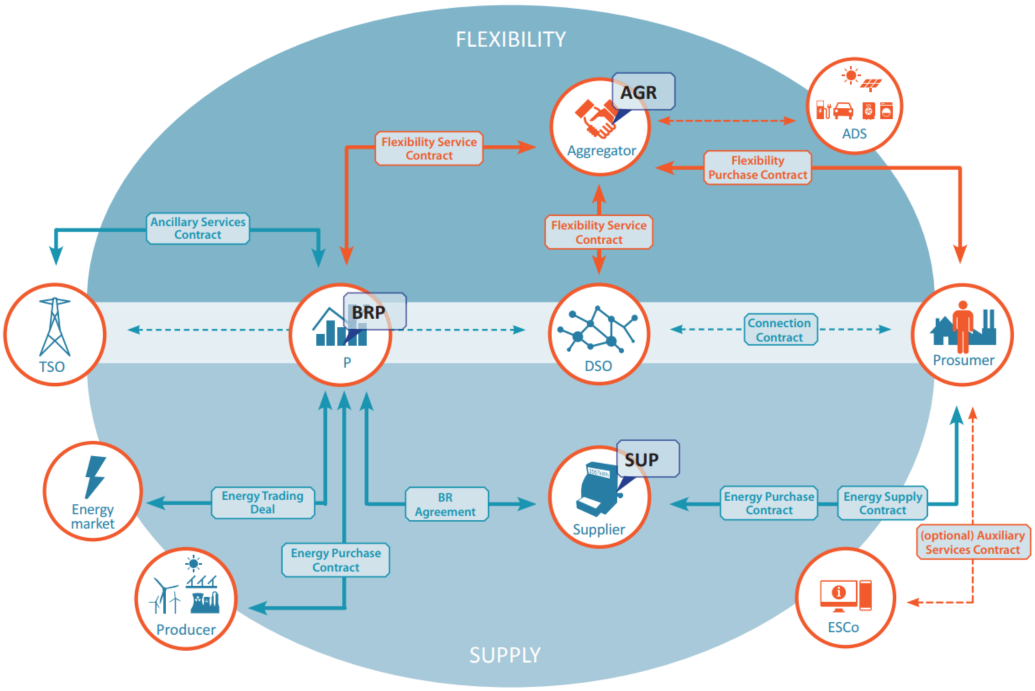
53 "CEN-CENELEC-ETSI Smart Grid Coordination Group Smart Grid ...." 8 Nov. 2012, https://ec.europa.eu/energy/sites/ener/files/documents/xpert_group1_reference_architecture.pdf. Accessed 21 Aug. 2018.

54 "NIST Framework and Roadmap for Smart Grid Interoperability." 3 Sep. 2014, https://www.nist.gov/document-2643. Accessed 21 Aug. 2018.

- Adopting a common language for smart grid architectures. By making reference and utilising the concepts and terminology used in SGAM it enables those working in other related domains (such as IT services, regulation, and policy) to more easily communicate and identify areas of common working. This is particularly important to the operation of future local flexibility markets where there is a high level of communication and coordination between DNO/DSO actors and platform providers, DER manufacturers, and Aggregators.
- The current lack of any real alternative. WIth the exception of the NIST architecture model (on which SGAM is partly based) there is currently no other major standards effort or mindshare in any alternative in the EU and North America.

Below we undertake an initial modelling exercise under SGAM for the ECAS system, describing the high level use cases and making a first mapping of these to different interoperability layers, zones, and domains.

4.2.1.3. Universal Smart Energy Framework (USEF)



The Universal Smart Energy Framework[55] is an open standard for describing the structure and operation of a local/national flexibility market. ECAS proposes a USEF-style local flexibility market which could be extended organically to incorporate additional local/national markets. Indeed, the potential economic value of flexibility is maximised when there is a single national (or even supranational) market for flexibility.

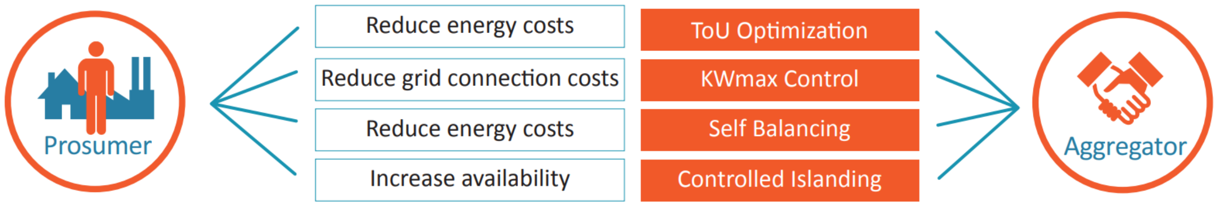
The value of a flexibility market is maximised when the impact of flexibility procurement is reflected in settlement through the participation of suppliers (who themselves can benefit from procuring flexibility to improve their position in different markets by e.g. reducing their imbalance risk). This is why it is important to plan for the inclusion of suppliers in local flexibility markets (many current discussions focus only on the participation of DSOs) and USEF facilitates this by enabling suppliers to easily join at a later date.

[55] "Universal Smart Energy Framework." https://www.usef.energy/. Accessed 21 Aug. 2018.

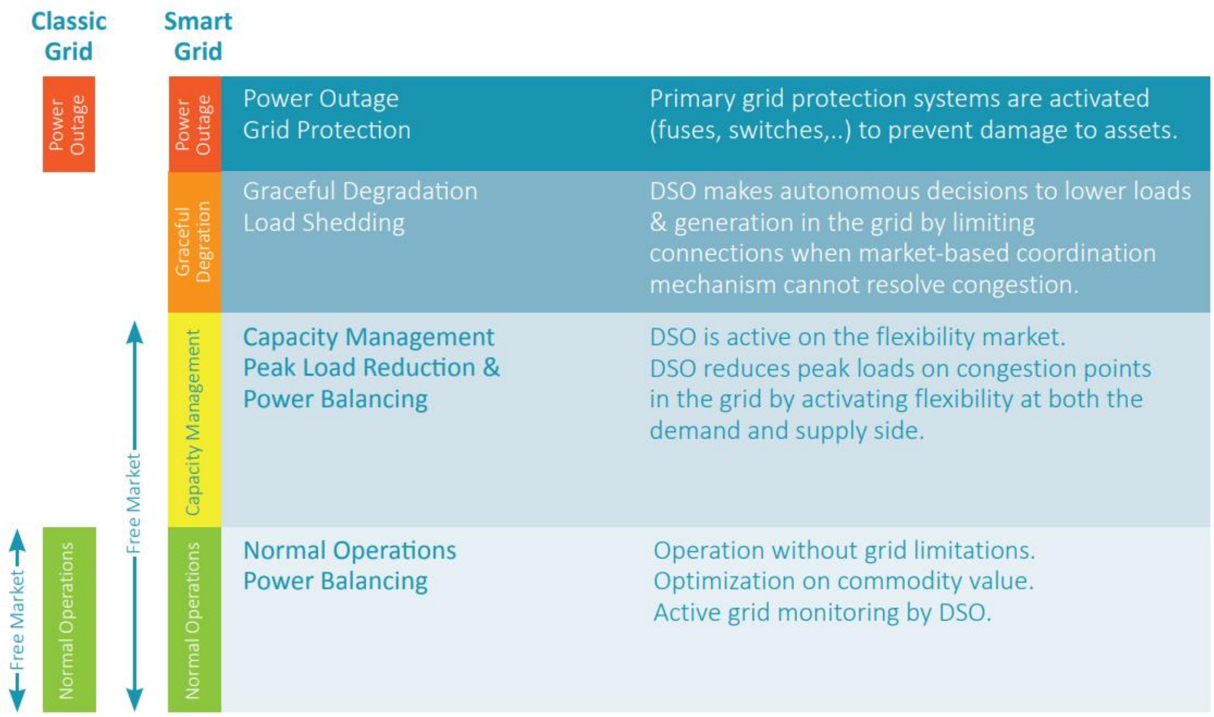
One of the benefits of the flexibility concept is that it can initially be developed in parallel with the existing electricity markets, starting with local markets for DSOs procuring flexibility and then linking these together to form a single national flexibility market which could eventually be able to supplant many existing ancillary services.

3.10.1.1.1 Key features of USEF Flexibility Markets

Central to USEF is the role of the Aggregator which acts as the intermediary between prosumers, communities, and other system actors. The Aggregator enters into bilateral agreements with prosumers, DSOs, and suppliers but there is a single market for flexibility through which all parties submit requests and offers for flexibility. Some of the use cases making up the value proposition of an Aggregator under USEF are depicted in the below figure.



In a traditional grid, markets are applied to non-critical/economic operating regimes such as wholesale and balancing. A USEF local flexibility market also supports peak load reduction and capacity management in the distribution network. This can also be extended in a future smart grid to redundancy support and controlled islanding (of microgrids). More critical operating regimes relating to grid protection and preventing outages continue to take priority over market-based operations. This extension of markets to other operating regimes is depicted in the figure below.

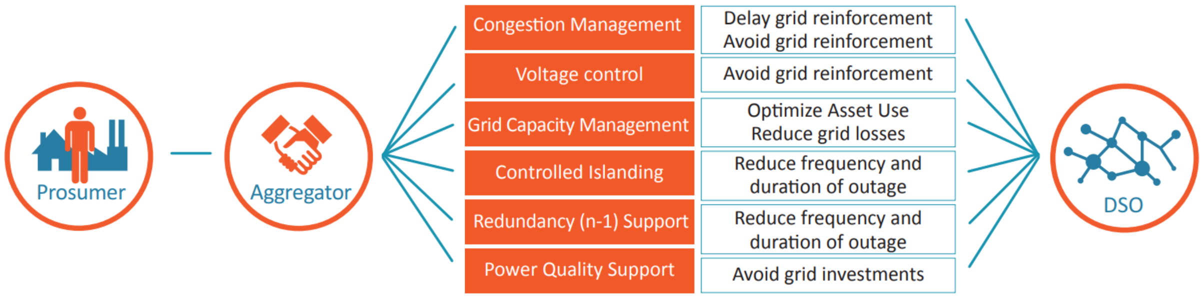


The way that USEF performs this segregation between market/non-market is through a 'market coordination mechanism'. This single process allows for both market and non-market operations to be integrated. This is divided into several stages during which different actors establish their requirements and what they can offer subject to economic and operational constraints.

Importantly, this market process allows for the sometimes competing needs of different actors to be rationalised. The fact that the needs of the DSO, ESO, and supplier are sometimes opposed is often overlooked in discussions around flexibility which assume the requirements of different actors are always aligned. This was demonstrated clearly in the first USEF pilot[56]. This suggests a price-based market mechanism would be more effective at valuing system flexibility (if the interests of all actors were aligned then non-market coordination maybe a better choice in system terms).

USEF links flexibility requirements to so-called 'congestion points' corresponding to a node in a logical graph representing the physical infrastructure of the electricity grid. This is similar to the concept of a 'constraint managed zone' as is currently used by UK DNOs however it applies to all points of common connection in a distribution network rather than a boundary at a particular level. The relation between congestion points, settlement, and DSO/prosumer parties is the 'Common Reference' and is maintained by a 'Common Reference Operator' (CRO). In a later section we outline how current and future UK systems can be combined/developed to form such a Common Reference.

USEF supports a wide range of use cases including all the ECAS use cases described below. The below diagrams illustrate the USEF use cases for the prosumer, Aggregator, and DSO in a local flexibility market. There are additional use cases for the supplier/BRP and TSO which may also be relevant to the future development of the market (or other markets).



4.2.2. Relation to UK market context

USEF has been designed to be sufficiently general so it is applicable to current and future European market contexts and it is straightforward to map this to the current UK market context. The main difference between the USEF default model (as presented in reference documents) is the explicit separation of the BRP and 'supplier' roles - in the UK these are currently combined in the supplier. Reforms to balancing market access proposed for introduction in 2019 and future changes to wholesale market access will make this distinction more relevant in the UK. In the event of the 'supplier hub' approach ending, a separation of the BRP functions could be one way forward and it would arguably open up the retail, wholesale, and balancing markets to more competition.

Another largely semantic distinction to current UK market roles is that of TSO (USEF) and the Electricity System Operator (ESO). This is partly a reflection of the different roles of transmission operators in the wider European market. In the UK, National Grid currently plays the role of TSO but is being split up into

[56] "Flexibility from residential power consumption - Universal Smart ...." https://www.usef.energy/app/uploads/2016/12/EnergieKoplopersEngels_FinalReport_2016_vs4-1.pdf. Accessed 11 Sep. 2018.

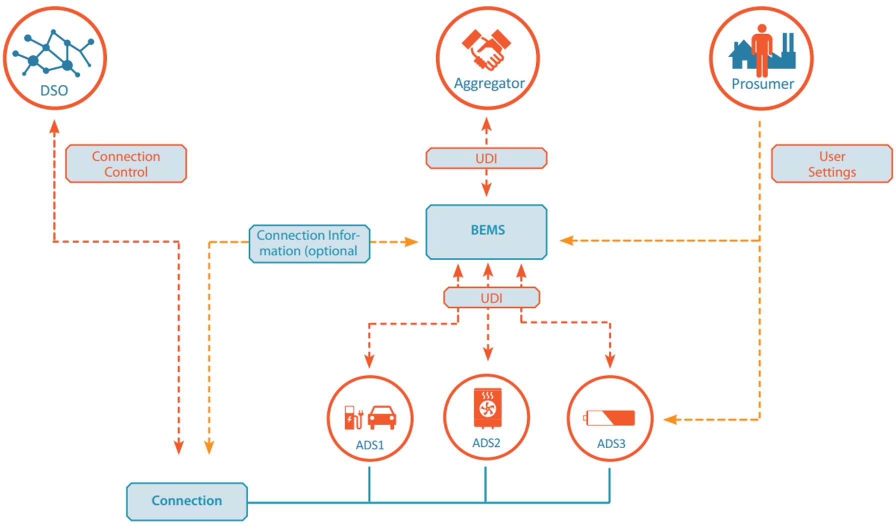
an ESO (Electricity System Operator) and ETO (Electricity Transmission Owner). The new ESO role maps well to the USEF TSO role.

In the standard model of USEF, Aggregators do not contract directly with the TSO to provide flexibility but go through the BRP instead. In the UK currently Aggregators contract directly with the ESO and the UK government for providing ancillary grid services and (in a more limited sense) strategic capacity. This will make market coordination more complex (effectively more 'Plan' / 'Operate' / 'Validate' stages would need to be added). Another possible route would be to allow UK Aggregators to effectively become BRPs with independent access to balancing and wholesale markets. This is not so far away from the recent decision to grant Aggregators access to the balancing mechanism. Whichever route is pursued USEF allows for such differences between national markets and the picture can be redrawn to show a relationship formed with either these parties or an intermediary.

The USEF framework roles do not contain an explicit definition of a market platform (which we have included in ECAS). A market platform can be seen to take on a number of roles in USEF or simply act as an equipment provider.

The USEF framework describes a 'meter data company' (MDC) and 'allocation responsible party' (ARP). The MDC role and some of the ARP role will be played by the DCC (part of the UK smart metering system). We envision that other aspects of the ARP role would be played by the market platform or similar.

4.2.3. ADS Control using OpenADR



USEF does not apply to the control of ADS (USEFs terminology for DER or flexibility assets) although it does outline (see diagram) in a 'USEF Device Interface' (UDI) how it envisages this working within the market context. To aid conceptualisation of the way the market would operate we have chosen to describe the ADS system in terms of OpenADR which is an open royalty free standard for control of ADS/DER which has been mandated for use in HVAC and other systems in California. The OpenADR Alliance and USEF Foundation have signed an MoU stating their intention to harmonise the operation of the two standards. The two standards have many synergies and a similar philosophy in promoting a vendor neutral approach to smart grid solutions based in open internet technologies. However, an alternative standard could be used without unduly affecting the operation of ECAS.

4.2.4.Other regulations and standards

There are a plethora of engineering, regulations, and other standards covering specific smart grid physical, functional, business, and information domains. We reference the most important and relevant of these below with some comment on how they may be applied in ECAS:

- Data Protection Regulations (EU GDPR/UK Data Protection Acts)[57]: Due to the large amount of data which will be collected by ECAS it is likely that there will be issues around anonymisation/pseudo-anonymisation of data and data minimisation as well as consent (although not all uses of personal data will rely solely on consent in the context of providing a flexibility service to consumers). Some of this could be mitigated using technical measures such as aggregation of data and edge computing (i.e. high resolution data is not transferred or processed outside of the home network). There is also a legal requirement under the GDPR for companies to implement 'Data protection and design by default'.
- Zigbee SEP 1.x[58]: One of the main technical standards underpinning the UK smart metering system. Aggregator systems will need to interact with smart metering devices to obtain metering and tariff data and may need to be 'aware' of this. Zigbee SEP 1.x also incorporates some functionality for control of DER assets.
- SMETS, DUIS, and Smart Energy Code[59]: Standards relating to the technical requirements, operation, and governance of the smart metering system. ECAS will interact with the system through the DCC (specifically the DUIS system) and using SMETS compliant CAD devices. Cybersecurity is covered in far more detail in the current standard than
- IASME[60]/ISO 27001/ISO 27002: These standards cover information assurance and management and implementing them may help in managing the cyber security risks posed by the operation of a flexibility market. The appropriate standard depends on the size and activities of the organisation. These only provide a high-level framework to enable the effective management of information security risk and will need to paralleled by effective standards in implementation.
- IEC 62056: Describing DLMS/COSEM as well as various communications with smart meters. UK smart meters produce data in this format and so intermediate systems (such as the Aggregator) will either need to understand it or be able to transform it.
- IEC 61970 / IEC 62325: Standards describing the Common Information Model (CIM) and specific extensions to this for deregulated electricity markets in Europe which have been adopted by ENTSO-E. Again, although the details of this is likely to be abstracted, various ECAS sub-systems (such as the market platform) may need to deal with information transmitted in compliant formats.
- IEC 61850: A widely promoted standard for defining communication protocols at substations and automation of substation control which is likely to be heavily utilised in the future UK smart grid. Although the details of this are likely to be abstracted by intermediate DSO systems it is possible that the common reference operator (CRO) may need to exchange information

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[57] "Data Protection Act 2018 | ICO." 25 May. 2018, https://ico.org.uk/for-organisations/data-protection-act-2018/. Accessed 28 Aug. 2018.
[58] "Smart Energy | Zigbee Alliance." https://www.zigbee.org/zigbee-for-developers/smart-energy/. Accessed 28 Aug. 2018.
[59] "Smart Energy Code: SEC." https://smartenergycodecompany.co.uk/. Accessed 28 Aug. 2018.
[60] "IASME." https://www.iasme.co.uk/. Accessed 28 Aug. 2018.

according to this standard and may provide information in context when publishing information about congestion points etc.

4.2.5. Existing commercial providers/alternatives

No existing commercial provider advertises a USEF-compliant system but below we highlight how a selection of existing services could be developed to provide different parts of a USEF flexibility market.

4.2.5.1. Piclo Flex

The Piclo Flex[61] platform is a new service from Open Utility which is aimed at simplifying the process of matching DER assets which can provide local flexibility to the requirements of DNOs looking to procure it. DER assets are registered on the platform and these are then periodically submitted to DNO local flexibility tenders. The service does not currently undertake any dispatching of DER assets or include other flexibility markets, although these are both on the roadmap for development. In the context of ECAS, the service could play the role of the market platform and/or provide the DSO interface under USEF, however this would require further development.

4.2.5.2. Moixa GridShare

Moixa manufactures and supplies integrated home battery systems and optionally connects these to GridShare[62], an Aggregator platform service which pays homeowners for allowing their batteries to be remotely controlled (currently believed to be a loss leading activity as most flexibility markets are still not open for participation from aggregated domestic loads). There is some suggestion this is compatible with other third-party DER assets although a list of compatible products is not published. The functionality of GridShare overlaps substantially with the described ECAS Aggregator platform and could play that role subject to the addition of a USEF compatible Aggregator interface and any additional business logic required.

4.2.5.3. Upside Energy

Upside Energy[63] have developed an Aggregator platform dubbed the 'Virtual Energy Store'. This platform in many ways seems to be the closest in vision to the ECAS Aggregator and is one of the only alternatives with a clear aim to engage domestic customers. By providing suitable USEF compliant interfaces, the Upside service could play the role of either the market or Aggregator platforms in ECAS.

4.2.5.4. WPD Flexible Power Participant API

WPD's 'Flexible Power' local flexibility scheme provides a REST API[64] which will be used for sending requests to those providing flexibility. The paradigm for communication and control between actors represented by this (using IP networks and standard internet protocols to peer requests) is the same as that used in USEF and this could be easily developed to provide a USEF-compliant interface (for DSO).

[61] "Piclo Flex Summary - Power Responsive." http://powerresponsive.com/wp-content/uploads/2018/05/OpenUtility-Piclo-Flex-Summary-May-2018.pdf. Accessed 28 Aug. 2018.
[62] "Make Money Selling Electricity with Moixa GridShare : moixa." http://www.moixa.com/products/gridshare/. Accessed 28 Aug. 2018.
[63] "Upside Energy." https://upsideenergy.co.uk/. Accessed 28 Aug. 2018.
[64] "Flexible Power Constraints Manager." https://flexiblepowerwpd.co.uk/. Accessed 28 Aug. 2018.

4.2.5.5. *Electron*

Electron have developed a flexibility market platform[65] based on blockchain technology. This could play the role of the market platform in an ECAS scheme with the addition of an appropriate USEF-compliant interface.

4.2.5.6. *Centrica Cornwall Local Energy Market*[66]

Provides a market platform with some Aggregator functionality for buying/selling energy and flexibility. Could play the role of the market platform in ECAS.

4.2.5.7. *Energy Local*[67]

Energy Local, in partnership with Co-operative Energy and others, have implemented a range of systems to support a local balancing trial in Wales. This does involve behind the meter control of flexibility assets using a HEMS in response to price signals. Some aspects of the HEMS and other back end system may be relevant to a ECAS Aggregator system.

4.2.5.8. *OpenLV*[68]

OpenLV is an innovation project to provide access to data from substations to approved third-party developers, businesses, and communities. The technology behind OpenLV could be applicable in the CRO systems in ECAS.

4.2.5.9. *Elexon BMRS*[69]

Elexon administers the BSC and provides a Balancing Mechanism and Reports Service (BMRS) which is widely used as an authoritative source of information about the electricity market. These services are similar to what would be required for the CRO and/or market platforms (although the volumes of data would be much greater).

Product / USEF Role	Aggregator Platform/Interface	Energy Market Platform	ADS	DSO Platform/Interface	CRO
Piclo					
Moixa					
Upside					
WPD Flexible Power Service					

[65] "Electron | Blockchain Systems for The Energy Sector." http://www.electron.org.uk/. Accessed 28 Aug. 2018.
[66] "Cornwall Local Energy Market | Centrica plc." https://www.centrica.com/innovation/cornwall-local-energy-market. Accessed 28 Aug. 2018.
[67] "Energy Local." 9 Dec. 2014, http://www.energylocal.co.uk/. Accessed 29 Aug. 2018.
[68] "Open LV | The groundbreaking project that's making local electricity ...." https://openlv.net/. Accessed 29 Aug. 2018.
[69] "What is BMReports.com? - ELEXON." https://www.elexon.co.uk/knowledgebase/what-is-bmreports-com/. Accessed 29 Aug. 2018.

Electron					
Centrica					
Energy Local					
OpenLV					
Elexon BMRS					

4.2.6. Cybersecurity and Data Privacy

The operation of a demand side response system at scale presents significant cybersecurity and information management challenges. Recent studies[70] have highlighted how even unpredicted changes of 1% of total demand (well within the anticipated levels of demand side response in a future smart grid) can cause costly frequency deviation, blackouts, and cascading infrastructure failure with consequent economic and national security implications. There are some circumstances in which the improper operation of assets could cause damage to those assets and increase the risk of fire or explosion and threat to human life. A range of state and non-state adversaries with a wide range of objectives could be motivated to conduct such attacks.

On the other hand, risk mitigation efforts should be proportional to the level of demand response under control which for the near future is unlikely to be large enough to pose any threat to grid operations. We note the proposed ADE Code of Conduct for Demand Side Response/Aggregators[71] contains a section on cybersecurity with some broad guidelines which should be a good starting point going forward but maybe become unsuitable when/if a large amount of load and devices are under control in domestic properties. There are several areas which are not covered:

- The proposed code does not recommend any information management standards (such as Cyber Essentials or IASME).
- Most guidelines focus on design, pre-emptive, and post-attack actions (both obviously important); but there is no discussion of the need for online incident detection which will be essential in stopping attacks in progress.
- There is no requirement to notify regulatory or government agencies (e.g. National Cyber Security Centre).

With the inclusion of these provisions we would judge the adoption and implementation of the Code of Conduct (or similar) to be an important (but not the only step) in mitigating the unique cybersecurity risks presented by demand side response systems.

Data privacy and the rights of data subjects has received increased attention due to recent high profile data losses and the introduction of new Data Protection Regulation (EU GDPR 2018/DPA 2018). Businesses are exposed to increasing financial and reputational risk as more of their operations are digitalised. Apart from the collection of personal information in the course of running typical business

[70] "BlackIoT: IoT Botnet of High Wattage Devices Can Disrupt the ... - Usenix." https://www.usenix.org/conference/usenixsecurity18/presentation/soltan. Accessed 12 Sep. 2018.
[71] "Download ADE Demand Side Response Code of Conduct Consultation." 18 Jul. 2017, https://www.theade.co.uk/assets/docs/nws/DSR_CoC_Consultation_Document_-_Final_-_18_July_2017.pdf. Accessed 12 Sep. 2018.

processes, demand side response systems require access to real-time information about domestic energy usage which is of a potentially sensitive nature and in certain contexts and combinations constitutes ‘personal information’ as defined under the DPR. The new DPR contains requirements for ‘privacy by design’, data minimisation, and data pseudo-anonymisation and this will need to be explicitly considered as part of the architecting and design of the system.

It is the opinion of the author that demand side response systems benefit greatly from the use of IaaS cloud computing services (such as AWS) which impose beneficial architectural and design choices, and provide extensive guidance and tooling (often at no extra cost) which is of great assistance to cybersecurity and information management.

4.3. Example design and analysis of ECAS

4.3.1. USEF Aggregator Implementation Model

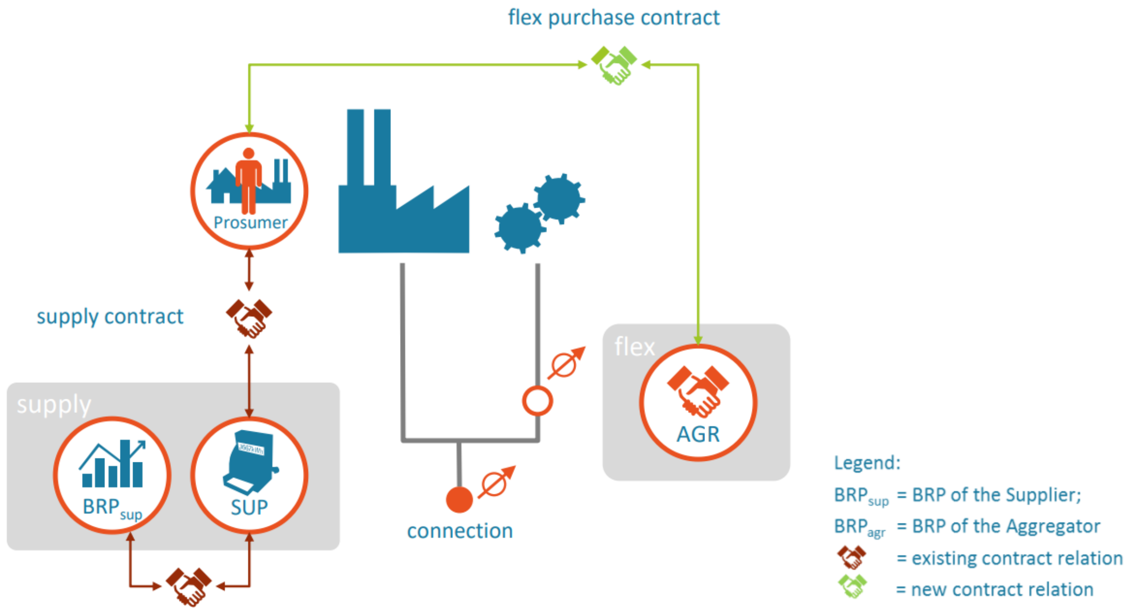
Our starting point in the design of the ECAS system is an aligned USEF use case description of the operation of ECAS in the context of settlement and balancing arrangements referred to as an ‘Aggregator implementation model’. The USEF foundation has identified seven types of these models[72] which are classified according to the configuration of contractual relations between BRPs (suppliers in UK) and the Aggregator. The interaction between DSO and Aggregator is also important but it is simpler to model in the context of balancing and settlement.

When flexibility is ‘activated’ it causes imbalance for the supplier as well as incurring any energy costs from changes in the supplied volume. If the actions of the Aggregator do not take this into account this is (arguably) non-optimal for the system as the impact on balancing is not priced in. For this reason Aggregators in some European markets are required to appoint a BRP (or even be a BRP themselves), indeed the UK is one of the few markets where Aggregators operate without this requirement.

There are different ways the imbalance created by Aggregator operations can be resolved. Where the Aggregator and supplier are the same entity this is simple as the correction should not create an imbalance (unless due to error). We are concerned here mainly with ‘independent’ Aggregators who do not have supply licenses.

The situation where the activation of flexibility is ‘uncorrected’ is depicted below.

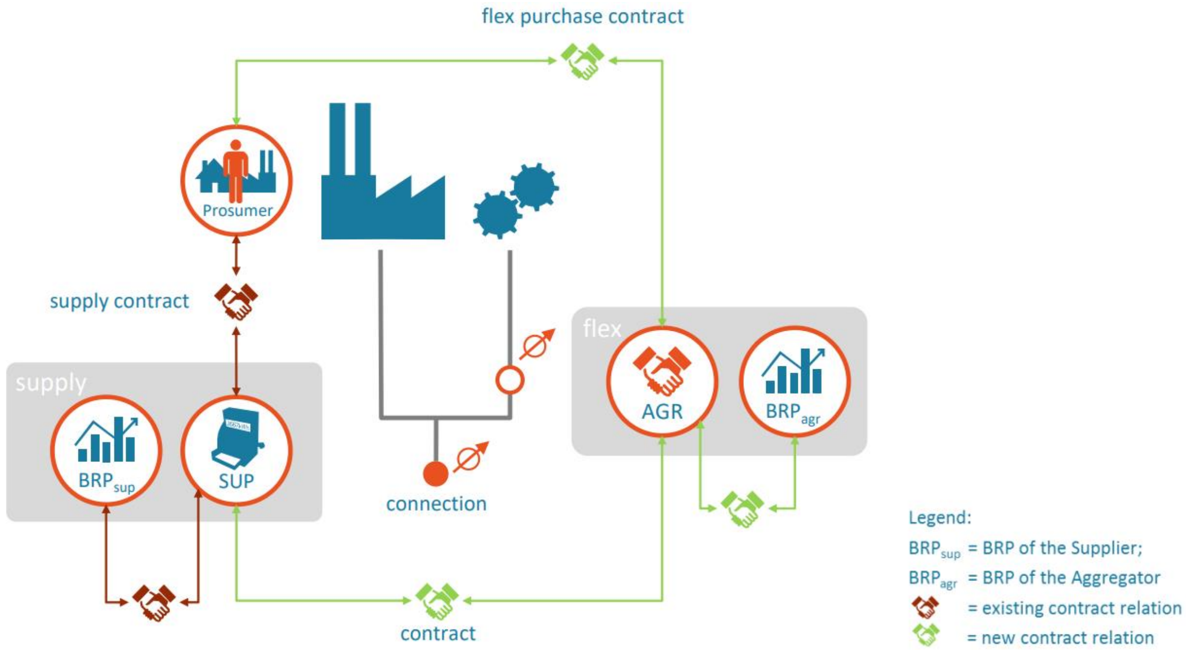
[72] "Recommended practices for DR market design - Universal Smart ...." https://www.usef.energy/app/uploads/2017/09/Recommended-practices-for-DR-market-design-2.pdf. Accessed 5 Sep. 2018.



In this situation Aggregators create imbalance but this is 'uncorrected' - suppliers must either source enough BMUs to compensate or risk being fined.

One alternative would be for the Aggregator to have some sort of contractual relationship with the supplier where they assume responsibility for the imbalance caused by flexibility so that the impact of this on the open supplier position can be taken into account. The volume could also be traded through this. This second possibility is depicted below:

In the UK market Aggregators could also take responsibility for the imbalance themselves by either directly participating in the balancing mechanism (through new BM Lite arrangements or otherwise) or contracting with a party with access to the balancing mechanism (either a second supplier or other). This is depicted below:



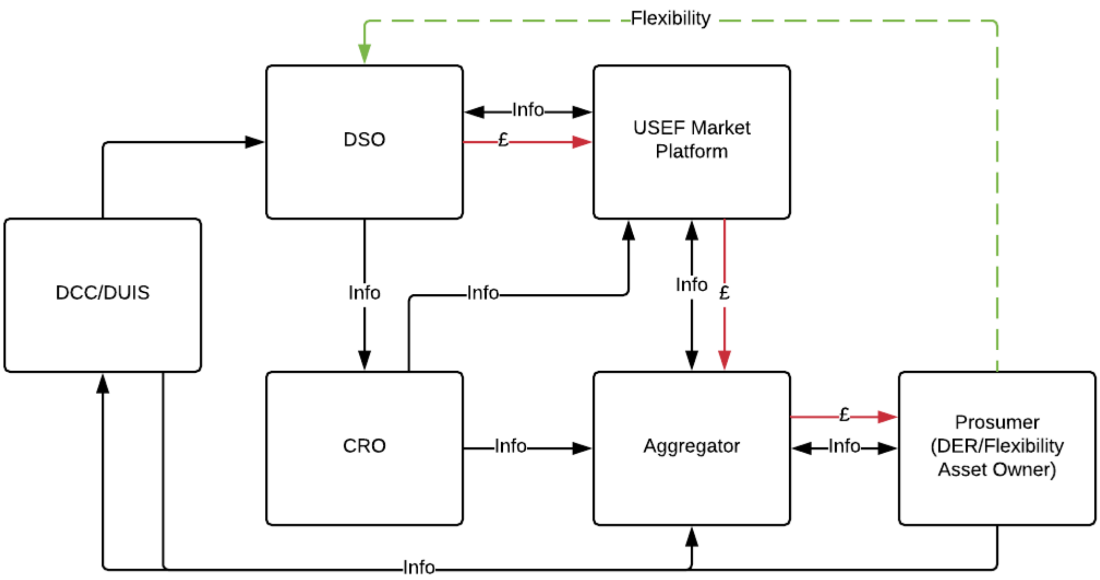
All configurations are possible but the most likely initially would be the 'uncorrected' implementation (particularly in local flexibility markets). Volume and balancing costs could still be taken into account passively by the Aggregator in this situation through the normal settlement of prosumer consumption (e.g. a dynamic time of use tariff).

In the following use cases we describe the operation of a local flexibility market with the 'uncorrected' Aggregator implementation. This reflects current arrangements and simplifies the initial market model. This could be extended at a later date.

4.3.2. High Level Use Cases

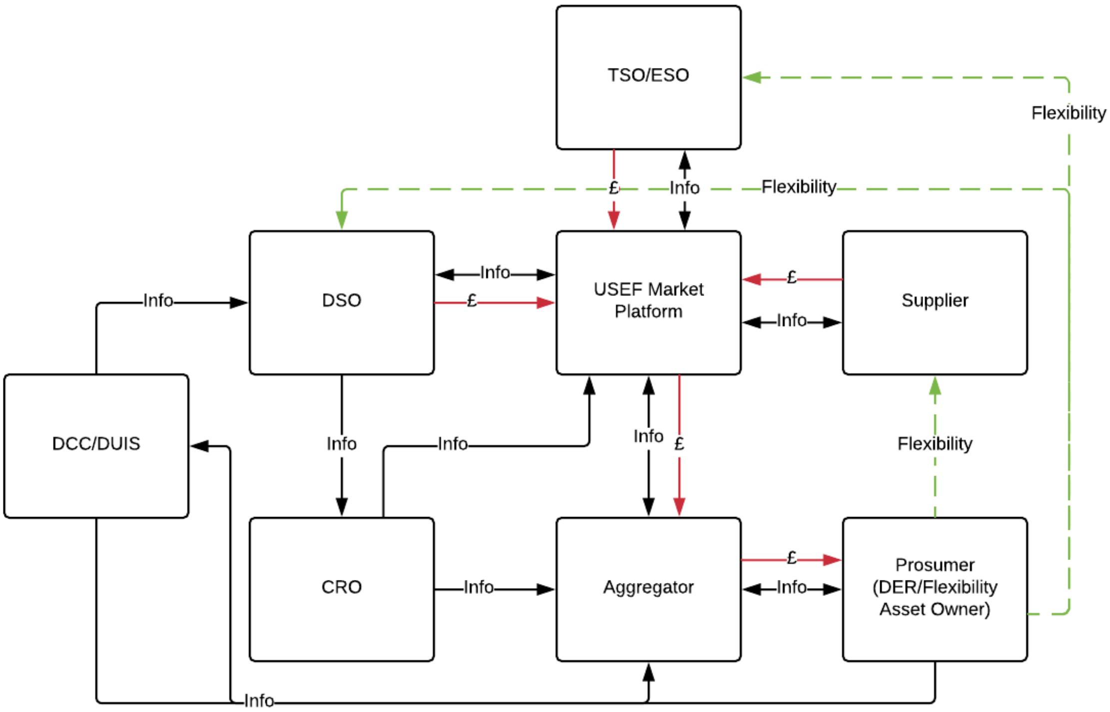
Two High Level Use Cases are presented below. The first is for an initial demonstrator and the second shows a commercial system with extensions for interacting with national flexibility markets.

3.10.1.2 HLUC 1: DSO Transition Local Flexibility Market



Objective	Procure flexibility for peak load reduction and capacity management using long term contracts
Actors	Prosumer, Aggregator,DSO,CRO, Market Platform Operator
Use Case Steps	1. USEF MCM 2. Audit/compliance (may fall within MCM)
Preconditions, assumptions, post conditions	● CRO maybe part of DSO. ● This doesn't reflect all payments/information exchange, only those relating to flexibility market (for example, network charges to DSO are not included).

3.10.1.3 HLUC 2: DSO local flexibility market extension to national flexibility market



Objective	In addition to HLUC 1, flexibility is procured by other actors for purposes such as secondary/tertiary system control and portfolio optimisation. An established local flexibility market is extended to provide flexibility to other actors. The system may be marketised with prices for each unit of flexibility.
Actors	Prosumer, Aggregator,DSO(s),ESO,Supplier(s),CRO,Market Platform Operator
Use Case Steps	1. USEF MCM. 2. Audit/compliance (may fall within MCM).
Preconditions, assumptions, post conditions	• CRO maybe part of DSO. • Aggregator implementation is uncorrected - otherwise there maybe payment/info exchanged between Aggregator and supplier. • This doesn't reflect all payments/information exchange, only those relating to flexibility market (for example, network charges to DSO are not included).

4.3.3. SGAM outline

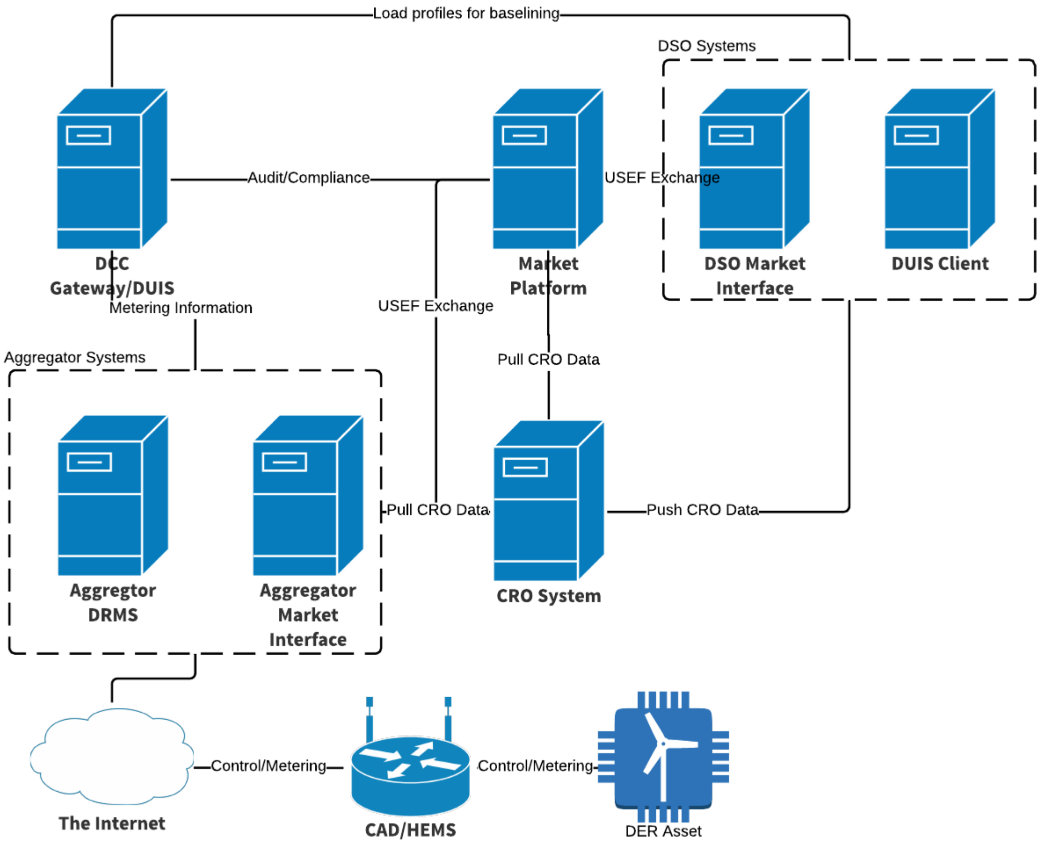
A local flexibility market such as ECAS will span multiple SGAM domains, zones, and interoperability layers.

Layer	Example of ECAS functions in this layer
Component Layer	These include the definition of different actors such as the Aggregator, Community Energy Service Company, Prosumer, Market Platform Provider, DSO, and ESO as well as their systems and associated devices, such as the Aggregator backend, market platform,
Communication Layer	ECAS uses primarily IP-based communication.
Information Layer	ECAS uses information structures specified in the SMETS (DLMS/COSEM for metering), OpenADR (for control, market information, sub-metering), and USEF (market information) specifications as well as custom formats.
Function Layer	High level use cases (such as described below).
Business Layer	Business models e.g. ECAS business model involving federation of community energy groups.

4.3.4. ECAS Technical Description

In this section we outline some of the key technical systems which distinguish ECAS. Other systems will be required, however where their operation is already defined (or implicit) in the USEF framework description they are not specified in detail.

3.10.1.4 High Level Architecture



4.3.4.1. CAD/HEMS

Central to the delivery of ECAS will be the use of a Home Energy Management System (HEMS) in the home to interface with flexibility assets. The functionality of this will be combined with a Consumer Access Device (CAD) which will pair into the smart meter home area network (HAN) thus providing a unified source of information about energy demand/generation and flexibility assets and a means of control for those assets which will be connected to the Aggregator DRMS system.

The way that CADs interact with smart metering system has not been fully determined at the current time, although it is already technically possible to undertake the required pairing procedure to connect CADs to the smart meter HANs on customer premises. Currently (with SMETS1 based metering systems) there is a reliance on suppliers and their meter equipment/operators to support this procedure, however SMETS2 metering equipment (and SMETS1 equipment which has been migrated to the DCC - a process which should begin at the end of 2018) can be provisioned by other DCC users (which maybe device manufacturers, system integrators, or Aggregators who have gone through the required DCC user entry process). This process of pairing devices will need to be streamlined to reduce costs and if large numbers of CAD devices are to be paired into HANs on consumer premises.

Some indicative explicit costs for this part of the system are presented below. These are based on quotes received from manufacturers and operational costs from similar existing systems. All costs are for a small scale demonstrator involving 100 - 500 participants.

Item	Cost
CAD/HEMS device	£50 per device (one-off)
Device management	£1 per device per year

4.3.4.2. Aggregator Demand Response Management System (DRMS)

The Aggregator demand response management system (DRMS) contains the business logic for the registration, commissioning, monitoring, management, and dispatch of flexibility assets (via the HEMS) and also communicates with the interfaces, and responds to requests from other business systems and customer applications.

An off-the-shelf USEF-compliant DRMS does not currently exist, but there are a large number of DRMS systems which could be developed to meet the requirements of USEF. We believe the development of OpenADR-based DRMS systems, which are made by a variety of vendors, as well as being available open source, is a viable route forward.

It is more difficult to estimate the development costs associated with such a system. Even an off-the-shelf or a vendor system will require integration with other business systems (e.g. CRM/billing).

4.3.4.3. Aggregator-DCC interface

The Aggregator DCC interface is required to validate and verify the actions taken to control flexibility assets and ensure that a unified view of settled electricity consumption/generation is accessible to all actors. The interface requires a DCC Gateway Connection and for the Aggregator to become a party to the SEC and a DCC User. This facility could also be used to pair the CAD/HEMS devices on behalf of users (and potentially also any Auxiliary Load Controllers) as a core business function of the Aggregator.

We present some indicative costs below.

Item	Cost
DCC Gateway Connection (Initial)	£400
DCC Gateway Connection (Ongoing)	£600 per year
Development of DUIS interface application	£30,000
Testing of DUIS interface application	£5000

4.3.4.4. Common Reference

The most important role of the system and actor providing the common reference is to map MPANs to USEF ‘congestion points’ based on a shared logical/graph representation of the distribution grid. In principle there are two operations associated with this, one is given an MPAN to determine which congestion points it is associated with; the other is given a congestion point to determine the MPANs associated with it. This functionality overlaps with that currently provided by the meter asset registry and this could be extended to include this information. Alternatively, given that the high degree of information sharing required with the DSO, it may make more sense for it to be operated by them or an associated independent organisation. This would be a reasonable application for blockchain technology as it is required to provide a single shared source of verifiable information for multiple actors (although it would likely need to be of the more restricted 'permissioned' and 'private' variety due to the sensitive nature of the MPAN information). We are seeing this role being played by market platforms currently like Piclo Flex, which connects DNOs requirements with flexibility providers. However, this information is valuable to the good operation of a marketplace for flexibility and should therefore not be monopolised by DSOs or single providers.

4.3.4.5. Market Platform

A market platform is seen as a key component of local energy and flexibility markets although its role is not explicit in the USEF framework. In a USEF context it can be seen as providing the compliant interfaces for different actors, hosting the market operation, and providing transparency/visibility to market information and operations, audit/compliance, and settlement of accounts. Based on this description it seems logical (and consistent with how the UK market currently operates) for this to be operated by an independent neutral party.

4.3.5. Analysis of ECAS

- Based on the above described use cases, it can be seen that the operation of local flexibility markets relies on a much higher level of information exchange than is currently the case. This underlines the need for standards in information models and interfaces supporting interoperability to manage the higher level of complexity.
- ECAS assumes Aggregators will have a high level of access to the UK smart metering system as (currently) non-licensed third parties under the 'Other User' role. This does not seem inconsistent with the Smart Energy Code however it does not represent an oft-discussed use case of the system (third-party access has mainly been discussed in relation to comparison services which only require occasional access). It maybe that an Aggregator user role should be added to the SEC/DCC definition. This may parallel efforts to license the operation of Aggregators.
- There is also a requirement to grant systematic access to large numbers of CADs to the Home Area Networks within the UK smart metering system. Whilst this is technically possible it may present certain operational and risk management issues.
- There is a specific requirement in ECAS for a common reference operator (CRO) role. Currently DSOs have total control over information taken from substations and other parts of their network and there is currently no shared belief or understanding that this information needs to be made accessible to meet the information requirements of future markets and smart grid systems.
- As discussed in a previous section, the activity of the Aggregator is 'uncorrected' i.e. it is not required to be reflected in settlement. This is not a desirable state of affairs as the impact on system imbalance falls unduly on the supplier as the balance responsible party. In other European countries Aggregators are responsible for imbalance and required to appoint a BRP.
- Certain actors do not have much of an incentive to adopt a standards based approach. Supply chain actors may attempt to monopolise the provision of ADS systems by promoting their own standards.

4.4. Conclusions and Recommendations

This report has reviewed the application of several technical standards and frameworks to the development of local flexibility markets in a UK context and proposed a concept local flexibility market 'ECAS' which implements these standards.

Based on the initial technical assessment of the system above we have concluded that an ECAS-style system is technically feasible (we make no comment on the business case for ECAS here) and could even be assembled by adapting existing products and services.

An analysis of the concept has highlighted some potential barriers to the implementation of such a system, and we base a set of recommendations on this:

- The role of Consumer Access Devices and their intended use cases within the UK smart metering system needs to be clarified by BEIS, Ofgem, and within the Smart Energy Code. These devices are essential in providing the "real time" data which is claimed to be one of the main products of the system and which are essential to the operation of the future smart grid and flexibility markets.
- Access to the DCC by an Aggregator may fall outside originally intended use cases even if it is technically permitted. There maybe a case to define an Aggregator user role within the SEC (which could also permit access to different functions than are currently available to the 'Other' user role).
- Whatever local flexibility market model maybe adopted, the historical and current operational status of distribution networks will be an essential tool to support planning and provision of flexibility and access to this information should be guaranteed, potentially by a neutral third-party performing the 'Common Reference Operator' role described in USEF (as well as any other functions required in the UK context). This role could be played by existing UK market actors such as the DCC or Elexon.
- There needs to be more recognition of the whole system impact of the activities of Aggregators, specifically how imbalance created by their activities should be taken into account. This has not been as important where Aggregators have provided services to support the ESO and therefore it is assumed their activities are benefit balancing, but where flexibility is provided to other actors this is not generally the case. This may need to be an area of focus in regulating Aggregators, potentially introducing a requirement to take responsibility for imbalance through the balancing mechanism (or otherwise) directly or by appointing a third party. Ofgem have indicated[73] that this is the direction of travel and P354 BSC modification proposal[74] will, when implemented, mean Suppliers are not penalised for imbalance caused by flexibility instructed by the ESO.
- With access to the balancing mechanism being granted to non-licensed parties and discussions around more access to wholesale markets there is an increasing case to review the supplier hub model. Separating the BRP and retail functions of suppliers (as is currently done in some EU markets) could promote further competition in both electricity supply and help stimulate domestic Aggregator activity.

[73] "Ofgem's views on the design of arrangements to accommodate ...." 24 Jul. 2017, https://www.ofgem.gov.uk/system/files/docs/2017/07/ofgem_s_views_on_the_design_of_arrangements_to_accomodate_independent_Aggregators_in_energy_markets.pdf. Accessed 12 Sep. 2018.

[74] "P354 - ELEXON." https://www.elexon.co.uk/mod-proposal/p354/. Accessed 12 Sep. 2018.

Future work on USEF and local flexibility markets is already underway. Both USEF and SGAM will be further examined as part of SP Energy Networks FUSION project[75] with a USEF demonstrator planned for 2020. This will involve further scrutiny of USEF and its applicability to the UK context as well as the development of USEF compatible systems able to test its feasibility.

[75] "Fusion - SP Energy Networks." https://www.spenergynetworks.co.uk/pages/fusion.aspx. Accessed 11 Sep. 2018.

5 WP5: Policy, Regulatory and Legal Considerations

Author: Ray Arrell, Regen

5.1 Related primary legislation

The need to decarbonise the UK's energy system is mandated by the Climate Change Act of 2008, which sets a statutory long-term target to reduce greenhouse gas emissions to 80% lower than 1990 levels, by the year 2050[76]. The purpose of the Act is to provide a clear legal framework for a long-term direction of travel in policy around economy-wide decarbonisation, with five-year carbon budgets[77], while also establishing the Committee on Climate Change (CCC) to ensure emissions targets are evidence-based and can be independently assessed[78]. The CCC has recommended to the Government that it should aim to reduce the carbon intensity of power generation from 350 gCO_2/kWh currently to 100 gCO_2/kWh by 2030. This mandate for decarbonisation of the energy system requires a greater share of renewable energy generation and supplementary low carbon technology to contribute to the UK's energy mix, especially if the UK is to meet its statutory fourth and fifth carbon budgets set under the Climate Change Act for the early 2020s and early 2030s[79].

The BEIS Clean Growth Strategy[80] was the Government's response to sections of the Climate Change Act. This strategy set out policies and proposals to deliver 'clean growth' (effectively increased economic growth coupled with decreased emissions[81]), with one of the key policy areas needed to meet the fifth carbon budget to deliver 'clean smart flexible power', with power accounting for 21% of UK emissions. Included was a proposal to invest £265 million in smart systems to reduce the cost of electricity storage, and to develop demand response technologies to help balance the grid[82]. This policy directive has been followed up in greater detail in BEIS and Ofgem's Smart Systems and Flexibility Plan[83].

This UK policy backdrop means that much more renewable energy generation needs to be added to the electricity network, simultaneously with the electrification of heat and transport, over the next decade to meet the UK's emissions targets. Due to the inherent intermittent nature of renewable energy generation, more flexibility with greater capability to balance the electricity network will be required to smooth out peaks in demand and generation and make the energy system operate more efficiently.

Poyry and Imperial College's report to the CCC estimated the required amount for additional capacity of flexible technology needed to meet 2030 carbon intensity targets[84] ranged from 3-15 GW. Storage, DSR, interconnectors and flexible generation will collectively enable more renewable generation to be added to the network, whilst either avoiding or deferring expensive network infrastructure upgrades.

Trajectories for EV, heat pumps and other disruptive sources of electricity demand will likely have a material effect on the amount of flexibility that is required in the future. National Grid's Future Energy

[76] https://www.legislation.gov.uk/ukpga/2008/27/pdfs/ukpga_20080027_en.pdf
[77] http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2018/04/10-years-of-UK-Climate-Change-Act-Summary-Policy-Brief.pdf
[78] https://www.theccc.org.uk/tackling-climate-change/the-legal-landscape/the-climate-change-act/
[79] http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2018/04/10-years-of-UK-Climate-Change-Act-Summary-Policy-Brief.pdf
[80] https://www.gov.uk/government/publications/clean-growth-strategy
[81] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700496/clean-growth-strategy-correction-april-2018.pdf
[82] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700496/clean-growth-strategy-correction-april-2018.pdf
[83] https://www.ofgem.gov.uk/system/files/docs/2017/07/upgrading_our_energy_system_-_smart_systems_and_flexibility_plan.pdf
[84] https://www.theccc.org.uk/wp-content/uploads/2017/06/Roadmap-for-flexibility-services-to-2030-Poyry-and-Imperial-College-London.pdf

Scenarios (FES)[85] analysis shows a wider range of outcomes for electricity generation, demand, storage as well as gas supply and fuel mix in the UK.

Table 11: Levels of additional flexibility-providing capacity required for 2030 carbon intensity targets
Source: Roadmap for Flexibility Services to 2030, Poyry and Imperial College London, May 2017

Flexible technology	By 2020 (GW)			By 2025 (GW)			By 2030 (GW)		
	Low	Central	High	Low	Central	High	Low	Central	High
New flexible generation	1	3	5	2	6	10	3	9	15
Storage	0.8	2.9	5	3.2	11.6	20	5.6	20.3	35
DSR	2.1	6.3	10.5	2.76	8.28	13.8	3.42	10.26	17.1
Interconnection	3.4	3.4	3.4	4.45	5.825	7.2	5.5	8.25	11

5.1.1 Considerations for domestic and community flexibility

A significant amount of flexibility needs to be added to the energy system and the flexibility potential from existing sources/assets must be exploited, to enable further decarbonisation progress to meet our legislative objectives. Research suggests that integrating new sources of flexibility will provide annual system-wide benefits equal to £3.2-£4.7 billion for an emissions target of 100 gCO_2/kWh in 2030[86]. This makes the case for stringent policy to support the growth, enabling markets and routes to those markets for flexibility at all scales. The potential scale of domestic and community flexibility is unknown, but almost certainty likely to rapidly increase moving forward. Models such as ECAS could potentially act as a link between smaller entrants into network flexibility markets with the right policies and regulatory supporting framework. A firmer and more rapid approach to rolling out smart meters, home batteries, smart appliances and controlling software could unlock this untapped source of flexibility, by allowing greater aggregation of distributed resources, helped by the potential increased uptake of EVs, increasing more readily accessible flexible loads at the domestic level.

5.1.2 Enabling factors

Some of the enabling factors to overcoming key barriers and improving access to flexibility[87] include:

- Increased consumer engagement around energy use and energy behaviour
- Increased uptake of second generation smart meters
- Increased deployment of domestic energy storage
- Increased deployment of EVs with smart home charging/control infrastructure
- Accessible domestic demand-side energy management services and systems

For effective domestic demand-side energy management to work, an engaged customer base, coupled with tangible flexible technologies and policy driven smart metering provision, is essential.

Local energy stakeholders, such as community energy groups[88], could potentially have a key role to play in engaging and coordinating flexibility at a more regional/localised level. Engaging individuals through

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[85] https://www.legislation.gov.uk/ukpga/2008/
27/pdfs/ukpga_20080027_en.pdf
[86] http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2018/04/10-years-of-UK-Climate-Change-Act-Summary-Policy-Brief.pdf
[86] https://www.theccc.org.uk/tackling-climate-change/the-legal-landscape/the-climate-change-act/
[86] http://www.lse.ac.uk/Grantha
mInstitute/wp-content/uploads/2018/04/10-years-of-UK-Climate-Change-Act-Summary-Policy-Brief.pdf
[87] https://www.gov.uk/government/publications/clean-growth-strategy
[87] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700496/clean-growth-strategy-correction-april-2018.pdf

their supplier is one method but being approached by a local agent such as a community energy group (as a more trusted intermediary), could potentially be more fruitful.

5.2 Wider policy considerations for local flexibility

5.2.1 Smart Systems and Flexibility Plan - considerations

BEIS, together with Ofgem, set out a number of policy and regulatory actions in the Smart Systems and Flexibility Plan, part of the Clean Growth Strategy[89]. Together with the ENA and DNOs, the plan aims to upgrade the UK's regulatory and market framework and aid the transition to a smarter, more flexible energy system by:

- Removing the barriers to smart technologies such as DSR and storage
- Enabling smart homes and businesses
- Improving the access to energy markets for new technologies and business models

Outlined in the plan are some key policy directives around storage, specifically around licensing, planning, connections and charging (such as use of system charges etc.). The plan itself is supplemented by an Action Tracker detailing outputs, progress and organisations that are taking the lead on each area. Some of the actions from the plan are directly relevant for the feasibility of domestic scale flexibility aggregation. See examples in Table 12:

Table 12: Smart System and Flexibility Action Tracker - key points relating to domestic flexibility aggregation

Action	Relevance, Progress and Future Consideration
The flexibility markets feasibility study competition (that this research falls under) Domestic DSR innovation competition	Seeing innovation funded research to explore business models, as well as tangible control assets in the home. Outcomes of these innovation funded trials and research projects may be vital in understanding why domestic flexibility won't work now but may do in the future under more developed scenarios.
Changes to storage regulation that demonstrates how storage benefits the network and wider energy system	Adjustments to network charging was a positive change for storage projects. However classifying storage as a subset of generation is considered to be a short-term position, whilst storage seeks to have its own classification and/or licence.
Planning and location frameworks to enable storage to be located on the same site as renewable generation	Ofgem has recently released guidance on the co-location of storage with FIT or RO accredited generation[90]. BEIS are continuing to explore the issue of how storage is to be treated in regard to planning. This may become a technology specific consideration, with the site footprint and site-specific variation between solid state battery storage, pumped hydro and liquid air storage technologies, for example.
Smart metering rollout programme	Placing the obligation to install smart meters on electricity suppliers and BEIS having a role in reporting on progress, Ofgem monitoring and incentivising suppliers to achieve their targets (and penalising those who do not).

88 https://assets.publishing.service.gov.uk/gove
rnment/uploads/system/uploads/attachment_data/file/700496/clean-growth-strategy-correction-april-2018.pdf
89 https://www.ofgem.gov.uk/system/files/docs/2017/07/upgrading_our_energy_system_-
_smart_systems_and_flexibility_plan.pdf
ems_and_flexibility_plan.pdf
90 See Ofgem guidance (June 2018): https://www.ofgem.gov.uk/publications-and-updates/guidance-generators-co-location-electricity-storage-facilities-renewable-generation-supported-under-renewables-obligation-or-feed-tariff-schemes-version-1

Enabling Aggregators to access the Balancing Mechanism	This has effectively come to fruition, with LimeJump announcing[91] its entry into the BM.
Network access reform – Ofgem will look into changing the existing structure of network charging costs to reflect real benefits to the system as part of its Targeted Charging Review[92]	A lot of work has been undertaken by Ofgem to review the way consumers (and generators) are charged to connect to, use and pay towards the upkeep of the electricity network. Commencing with the Targeted Charge Review in early 2017, where Ofgem set up the Charging Futures Forum. More recently, Ofgem has consulted on specific charging areas of access and forward-looking charges[93]. This consultation proposed a number of changes under the following arrangements: i) Shallow connection charges for distributed generation (DG), effectively proposing to echo the connection charging arrangement on the transmission network, by not requiring DG to have to pay for all the upstream network reinforcement related to their project connecting, as is currently the arrangement. ii) A tougher set of use of system charges for generators, seeing DG contributing towards transmission network use of system charges and potentially an increase in equivalent regional charges on the distribution network. iii) The current transmission network demand peak penalty mechanism (Triad charges) may be removed, thus changing the business case for behind the meter storage and industrial energy management strategies. iv) EV related charging tariffs, smart or managed 'at home' EV charging arrangements

Many of these reforms are seeking to encourage 'smart and flexible' technologies to connect and add value to the network. The potential for these policy and regulatory actions to level the playing field and make it easier for small-scale generation and storage to connect to the network is still to be seen.

In terms of some of the specific policy enablers we identified in section 5.1.2, some additional detail around progress in some of these areas is outlined in the sections that follow, namely:

- Smart meter rollout progress
- Faraday Battery Challenge
- EV uptake trajectories
- Smart appliances

[91] See LimeJump press release, Aug 2018: http://www.limejump.com/limejump-enters-balancing-market/
[92] https://www.ofgem.gov.uk/publications-and-updates/targeted-charging-review-consultation
[93] See Ofgem consultation, July 2018: https://www.ofgem.gov.uk/system/files/docs/2018/07/network_access_consultation_july_2018_-_final.pdf

5.2.2 Smart Meter Rollout progress

The smart meter rollout is a key part of the Smart Systems and Flexibility Plan, with domestic smart metering being a vital component of enabling and aggregating domestic households in local flexibility markets. As of March 2018, 12.3 million smart and advanced meters have been installed in total and just over 11 million of these are now in operation in homes and businesses across Great Britain[94]. See breakdown in Table 13. The Government's Smart Metering Programme aims to ensure every home and business is offered a smart meter by the end of 2020, rolling out over 50 million meters to approximately 30 million premises; all domestic properties and smaller non-domestic sites.

Table 13: UK Smart meter rollout progress (source: BEIS Smart Meters Quarterly Report, to end of March 2018)

Meter Type	Installed & Operating as of end of March 2018 (millions)		
	Domestic	**Non-domestic**	**All Meters**
Smart Meters	10.02	0.06	10.06
Advanced Meters	-	1.00	1.00
Total	**10.02**	**1.05**	**11.06**

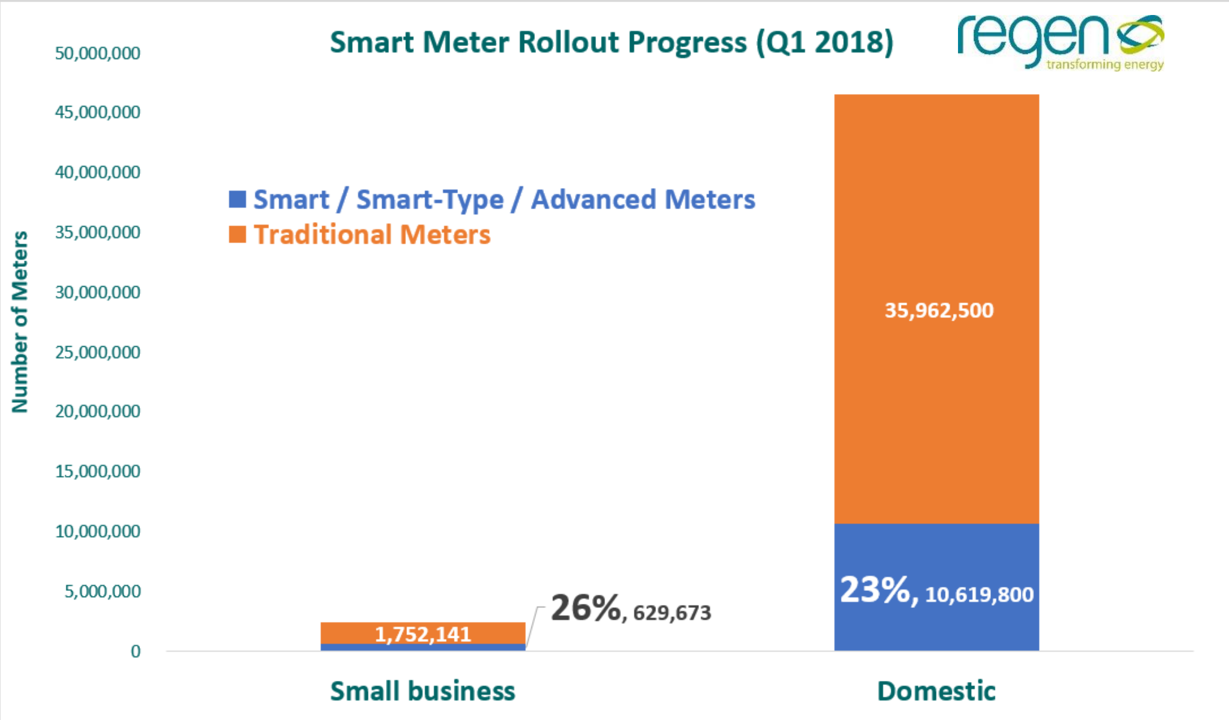
The Smart Metering Programme is being delivered in two phases:

- The foundation stage starting in 2011, developed the commercial and regulatory frameworks to support smart metering through engagement with the energy industry, consumer groups and other stakeholders, learning lessons from early installations and trial systems
- The main installation stage began in November 2016 and goes through to the end of 2020. The aim is for most households and small businesses to have smart meters installed by their supplier and that national smart meter data and communications infrastructure will be fully functioning.

Unfortunately, as it stands, the main installation stage is some way off meeting its 2020 target, as can be seen in the relatively low percentage of overall premises, that the above smart meter installations represent. See Figure 28.

[94] See BEIS Smart Meters Quarterly Report to End of March 2018: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/712151/2018_Q1_Smart_Meters_Report_.pdf

Figure 28: Smart Meter Rollout Progress to end of March 2018 (Source: BEIS, Analysis: Regen)



The smart meter rollout is currently poor, as energy suppliers fall notably behind their required installation government targets[95]. There are recent examples of some suppliers missing their obligated targets, with EDF being fined £350,000 by Ofgem in June 2018[96] for missing its 2017 smart meter target and Npower being fined £2.4 million in August 2018[97] for falling short of their non-domestic advanced meter target.

Other than purely the low number of installations, a further issue arises from the lack of interoperability of first generation smart meters as their data and communication systems vary from supplier to supplier. To resolve this issue the government is consulting on proposals to require energy suppliers to bring first generation smart meters under the national Data Communications Company, or failing that, mandate suppliers to replace first generation smart meters with second generation models which operate a universal communication system. BEIS issued a consultation on proposals regarding smart appliances and interaction with smart meters, which is covered in more detail later in this report.

5.2.3 Faraday Battery Challenge

The launch of the Faraday Battery Challenge, as part of the Industrial Strategy Challenge Fund[98], sees some £246 million of funding available to support the development of new battery technologies. This is partly focussed on the preparation for the electrification of transport but is also an opportunity to improve the effectiveness of static battery storage at varying levels. The fund aims to connect university research to businesses and to increase R&D more generally, with an aim to take the latest technologies closer to market and commercial feasibility[99]. The end goal of the Faraday Challenge is to develop

95 https://www.current-news.co.uk/news/smart-meter-roll-out-offering-all-the-signs-of-a-car-crash-agree-mps
96 See Ofgem press release, June 2018: https://www.ofgem.gov.uk/publications-and-updates/edf-energy-pays-350000-after-missing-smart-meter-targets
97 See Ofgem press release, August 2018: https://www.ofgem.gov.uk/publications-and-updates/ofgem-fines-npower-24-million-failing-meet-advanced-meter-deadline
98 https://www.gov.uk/government/collections/industrial-strategy-challenge-fund-joint-research-and-innovation
99 https://www.gov.uk/government/collections/faraday-battery-challenge-industrial-strategy-challenge-fund

batteries that are cheaper and more cost-effective, more durable and last longer, safer and lighter, and recyclable at the end of their life.

It is hoped that in making better batteries more widely available, the cost of EVs, home batteries and large storage plants will come down, as well as making assets more practical and more attractive to customers, reducing emissions and using storage to manage intermittency. Low-cost, high-performance batteries would also make domestic battery storage more widespread, increasing the amount of one of the more readily dispatchable flexible loads at the household level.

Related to the launch of this fund, was the creation of the UK's first independent institute for electrochemical energy storage technology – the Faraday Institution. This institute aims to drive research, training and analysis of (predominantly) electrochemical battery technology. See Figure 29.

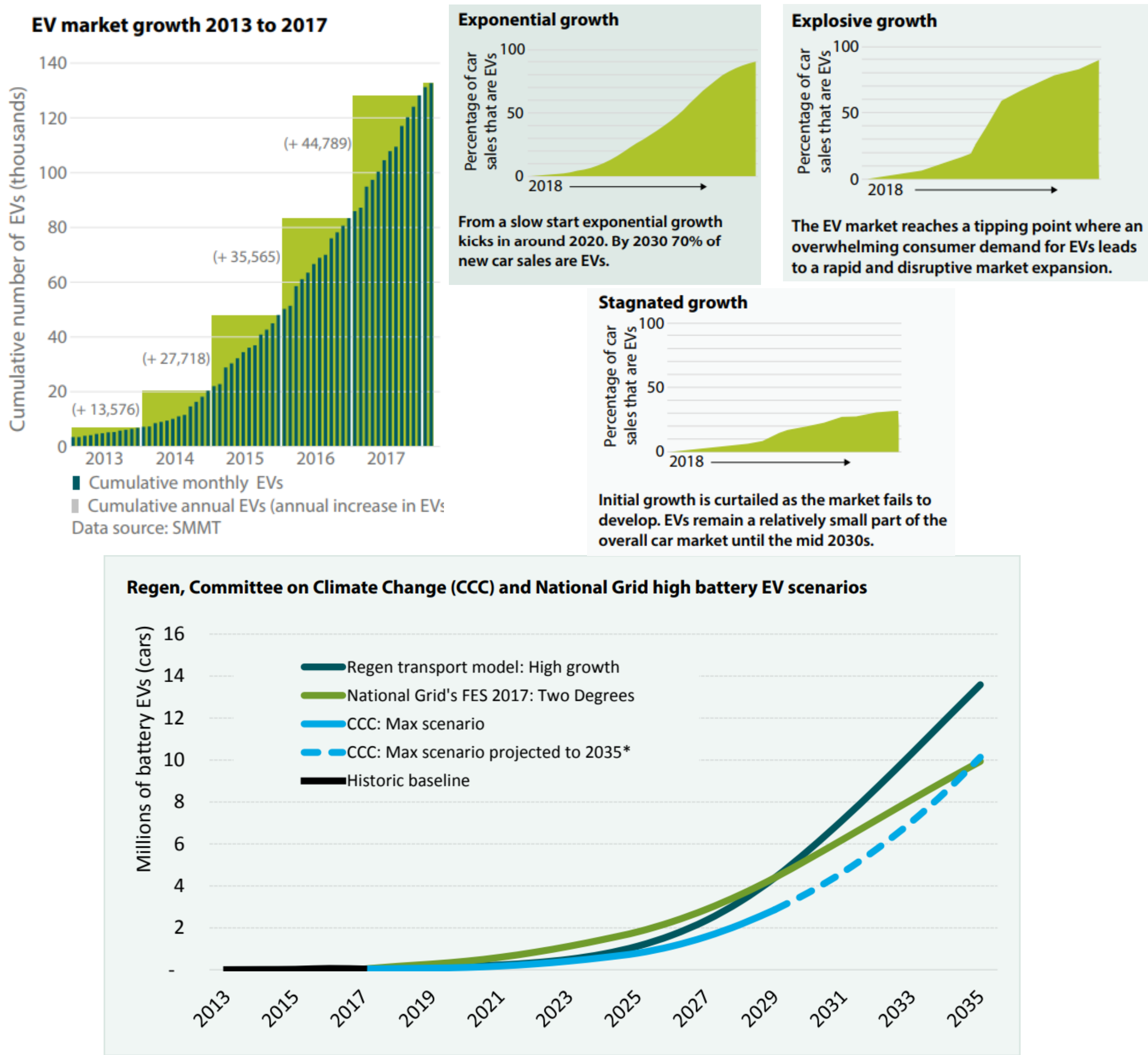
THE FARADAY INSTITUTION

Figure 29: Faraday Institution - Faraday Battery Challenge programme stages
(Source and credit: The Faraday Institution, https://faraday.ac.uk/)

5.2.4 EV uptake projections

Regen's analysis in April 2018[100] showed that EV uptake could take a number of different trajectories. Building on the 2017 baseline position of c.120,000 (see Figure 30), the number of EVs on the road could vary significantly out to 2035. But Regen, National Grid, Committee on Climate Change and many other industry organisations are aligned that EVs will be into the millions within the 2030s (see Figure 30).

Figure 30: Regen baseline and growth analysis for EVs, source: [Harnessing the Electric Vehicle Revolution](https://www.regen.co.uk/wp-content/uploads/Harnessing_the_electric_vehicle_revolution_-_Regen_market_insight_series_-FINAL_2_pages-3.pdf), Regen



The nature of charging EVs at home is also an evolving area, with smart charging control systems, managed charging arrangements being proposed by DNOs[101] and electricity tariffs aimed to shift EV

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[100] See Regen market insight paper, 'Harnessing The Electric Vehicle Revolution', April 2018: https://www.regen.co.uk/wp-content/uploads/Harnessing_the_electric_vehicle_revolution_-_Regen_market_insight_series_-FINAL_2_pages-3.pdf

[101] See SSEN consultation on managed EV charging, March 2018: http://news.ssen.co.uk/news/all-articles/2018/march/smart-ev/

charging out of times of peak demand[102]. The potential for EV owners to flex their import/export power from their EV is potentially uncertain and the role EVs can play in local flexibility markets is potentially significant, but unclear.

5.2.5 Smart Appliances consultation

In March 2018, BEIS launched a consultation on introducing primary legislation to set standards for smart appliances[103]. Government wants to introduce legislation to ensure minimal functional standards, stimulate investment in product development, and make the UK a pioneer in the emerging sector with regulation that can help overcome market failure, manage risks and align with international standards. The standards proposed in the consultation follow these principles:

- **Interoperability**: so that all devices can understand the same language and communicate with multiple interfaces
- **Grid stability**: to ensure there are no sudden unexpected drops in demand or unintended shifting of peak demand
- **Cyber security**: for all devices to have minimal access points, with secure control systems that are regularly penetration tested
- **Data privacy**: covered by the Data Protection Act 2018[104], consumers to have the choice over who their data gets shared with

BEIS is pursuing primary powers to regulate these standards for UK smart appliances, with the consultation seeking views on:

- Whether BEIS having regulatory powers is appropriate,
- Whether the proposed labelling of appliances is the best method to communicate standards,
- Whether the need to mandate that all appliances are/should eventually be smart,
- BEIS' impact assessment,
- Whether proposed functionality is appropriate,
- Other areas around consumer protection.

It is largely accepted that regulatory frameworks around consumer protection and data protection are needed for widespread consumer acceptance[105]. Therefore, an ECAS model might stand to benefit from an increased uptake of smart appliances with universal data and interoperability standards, brought about if the regulation proposed in the consultation document is agreed and enacted. In short, if smart appliances are mandated to be, standardised and sold with the protection of consumers and consumers' data at its core, it is likely that there could be a surge in smart appliances that flexibility aggregation platforms might seek to access and control.

It is advised that Aggregators should look to be involved in future processes developing updated standards, so as to have their voice heard and ensure regulation is not introduced which harms their business model or prevents flexibility service type operability. One danger identified, which has the potential to hinder the development of a functioning local flexibility market, is that mandatory standards could drive prices of appliances up, deterring early adopters, meaning less load is available for aggregation at the domestic level.

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[102] Octopus launched the first time of use tariff tailored to EV owners, see Zap Map article, June 2018: https://www.zap-map.com/octopus-energy-launches-ev-driver-tailored-tariff/

[103] See BEIS Consultation on Proposals regarding Smart Appliances, March 2018: https://www.gov.uk/government/consultations/proposals-regarding-setting-standards-for-smart-appliances

[104] See Data Protection Act 2018: http://www.legislation.gov.uk/ukpga/2018/12/contents/enacted

[105] Referenced by Committee on Climate Change: https://www.theccc.org.uk/wp-content/uploads/2017/06/Roadmap-for-flexibility-services-to-2030-Poyry-and-Imperial-College-London.pdf

A more fundamental consideration is that regardless of how well regulated, standardised and comms-enabled smart appliances may become, it does not negate the fact that the potential for appliances to provide real energy flexibility benefits to the system is low. Appliances in themselves are becoming more energy efficient, either from using less instantaneous power (fridges, cookers) or run-times (washing machine/dishwasher cycles), thus the amount of demand reduction is likely to be relatively small. In addition, the alignment of dispatching flexibility at a time when appliances are not being used, coupled with the likely need to set baselines using sampling periods, will mean that the availability of smart appliances to provide useful response to flexibility markets (local or national) is again low.

5.2.6 Key policy considerations and conclusions for the ECAS model

The Smart Systems and Flexibility Plan lays out the Government's vision and provides a roadmap to a future smart and flexible energy system, complete with markets in which an ECAS could operate. Removing barriers to smart technologies, enabling smart homes and businesses and improving access to energy markets for new business models and technologies are all hugely promising for the development of an ECAS. However, to ensure that smaller loads can participate in local flexibility markets in the near term, innovation trials and feasibility studies such as this one must continue, with key learnings taken forward, to ensure that the technology and business models can be replicated and scaled up. The outcome of the domestic DSR trials should look to focus on responding to 'real' system flexibility needs, as well as exploring non-system flexibility, such as co-operating demand or generation with storage/DSR. Similarly the local flexibility feasibility studies and domestic DSR projects should look to target non-sandbox arrangements or bespoke/special case arrangements. If a domestic flexibility business model is to work, it needs to be replicable and scalable and not in 'special case' regulatory circumstances.

The rollout of smart meters is a vital component for the feasibility of ECAS. Smart meters are key to verifying domestic DSR and to aggregating loads at the community level. Current progress is slow, with the government seemingly way off its targeted number of installations to be complete by the end of 2020, and there are additional issues around the functionality of first generation smart meters. We need to see a drastic increase in the uptake of second generation smart meters over the next few years in order to keep up with other developments in the market. In addition to this, standardisation and regulation of smart meters, and the method to interrogate the data generated by them, is key to ensuring the value and role that smart meters can genuinely play. Fundamentally, without a smart meter and a robust supporting structure to access the data, cost-effective participation in flexibility at the domestic level is likely to be very challenging, and the technical ability to interface with network operators, Aggregator platforms or the ESO likely becomes unachievable.

The ongoing development of battery technology under the Faraday Challenge, specifically at home battery and EV scales, is another positive policy area, hopefully boosting the round-trip efficiency, capability, shelf life and overall deployment of domestic batteries and take-up of EVs. Alongside controllable electrified heating (heat pumps or electric hot water boilers), EVs and home batteries are the two core technologies that could make flexibility at the domestic and community level viable.

5.3 Regulation of local flexibility

As widely discussed in the industry, Ofgem has required that all six DNOs transition to become DSOs. Ofgem's core function is to protect the interests of energy consumers in GB. This remains a fundamental aspect of their forward-looking work to enable the transition to a decarbonised and decentralised[106] energy system. The DSO, therefore, represents an evolutionary role of the DNO for this future system, in which it "*operates and develops an active distribution system comprising networks, demand, generation and other DERs*"[107].

Ofgem's regulatory framework surrounding the future energy system is to stimulate innovation, support the low carbon transformation and, in keeping with their primary role, to deliver sustainable, resilient and affordable services to all energy consumers in Britain. Many of Ofgem's regulatory objectives lend themselves to developing more specific regulation around the facilitation of local flexibility markets. Specific areas include balancing supply and demand nationally, locational operability of the energy system and to support innovation. As part of their strategy[108] for regulating this future energy system, Ofgem's priorities fall under the following key principles:

- Aligning the ESO's and DSOs' interests with those of consumers, with clear obligations, objectives and incentives
- Ensuring that regulation is non-discriminatory towards technologies, systems or business models,
- Setting regulation that encourages new entrants and innovation, creates a level playing field between entrants and incumbents and between network reinforcement and alternative solutions,
- Providing a reliable regulatory regime which supports efficient investment and risk allocation,
- Promoting competition and harnessing market-based approaches when in the interest of consumers.

The focus of Ofgem's future regulatory framework is concerned with embracing new technologies and services in ways that benefit consumers, while avoiding network upgrade costs, where possible. This approach can be seen as positive for the feasibility of an ECAS model, suggesting that regulation of services will be designed to':

- Maximise existing flexibility opportunities,
- Promote the participation of new and innovative sources of flexibility,
- Look to share financial benefits with consumers, (which is at the heart of the ECAS model).

[106] Referenced in Smart Systems and Flexibility Plan, July 2017: https://www.ofgem.gov.uk/system/files/docs/2017/07/upgrading_our_energy_system_-_smart_systems_and_flexibility_plan.pdf

[107] See ENA Open Networks Project – Workstream 3: DSO Transition, DSO Definition 2018 Product, June 2018: http://www.energynetworks.org/assets/files/electricity/futures/Open_Networks/ON-WS3-DSO%20Definition%20(updated)%20-%20published%20v1.pdf

[108] See Ofgem 'Our strategy for regulating the future energy system, August 2017: https://www.ofgem.gov.uk/system/files/docs/2017/08/our_strategy_for_regulating_the_future_energy_system.pdf

5.4 Industry-led developments

5.4.1 BEIS and DNO engagement workshop

Regen facilitated a meeting with some of the leading DNOs and ministerial advisors. The meeting focused on the DNO to DSO transition, local flexibility markets and how broader participation and neutral markets could feed into BEIS funded local flexibility work and research. In attendance were:

- **Charlie Ogilvie**, Special Adviser to Claire Perry (Minister of State for Energy & Clean Growth),
- **Guy Newey**, Special Adviser to Greg Clark (Secretary of State for BEIS),
- **Nigel Turvey**, Network Strategy and Innovation Manager, WPD,
- **Sotiris Georgiopoulos**, Head of Smart Grid Development, UKPN,
- **Steve Atkins**, DSO Transition Manager, SSEN.

A key theme was that there is still a lot of debate around the roles of National Grid ESO and the DSOs in procuring flexibility. From a community/domestic perspective, it seems likely that a DSO will be a more viable counterparty and BEIS enabling DSOs to work directly with flexibility providers, rather than increasing the role of the ESO, was seemingly encouraged.

The key message from BEIS at the meeting was that they want to see open markets for local flexibility and clear evidence that DNOs are not favouring investment in infrastructure over third-party providers. We can, therefore, expect some action from BEIS to clear external scrutiny of the decision by a DNO to use local flexibility rather than invest in infrastructure and to ensure this is neutral.

There is less focus from BEIS on the type of flexibility providers and potential role of communities/ households. The impression here is that BEIS are focussed more on the role of Aggregators.

5.4.2 Open Networks project

Led by the Energy Networks Association (ENA), the Open Networks project sets out different future models for operation of the electricity system. This project effectively sees the ENA + DNOs acting on the direction of travel from BEIS & Ofgem's Smart Systems & Flexibility Plan. The various models were also discussed with BEIS, UKPN, WPD and SSEN. A summary of the discussion was:

ESO led
The ESO would have the direct relationship with DERs, facilitated by DNOs.

- **Pro:** the ESO has extensive experience of system balancing.
- **Con:** the ESO deals with around 6,000 customers. There are millions of DERs. It would be a major shift for them to have the skills and relationships to coordinate flexibility at a street by street level

DSO led
DSOs would coordinate all DERs and provide an 'aggregated' response at the GSP level

- **Pro:** Clear division of responsibilities, DNO has contractual relationship with millions of customers.
- **Con:** Could lead to competition between DSO and Aggregators to provide services to the ESO. Lack of expertise in system balancing at DNO level.

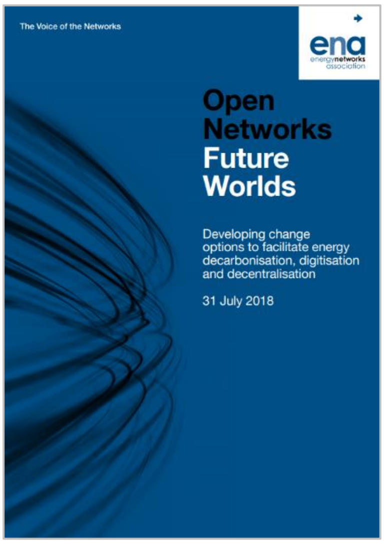
Hybrid/Market led
DERs can provide services to the ESO and the DSO as they choose. ESO and DSO need mechanisms to manage any conflicts that might arise.

- **Pro:** enables market led competition.
- **Con:** could lead to inefficient outcomes.

The clear signal at the meeting was that we are moving to a hybrid/market led approach. DERs, therefore, will need to consider the services they provide at a distribution and transmission level.

5.4.3 ENA Future Worlds Consultation

As part of Workstream 3 of the Open Networks programme, the ENA has published a consultation[109] called 'Future Worlds', which is seeking to share the thinking around how to develop 'change options' to facilitate decarbonisation, decentralisation and digitisation.



The consultation includes:

- A description of five 'Future Worlds',
- A summary of the methodology to build the Smart Grid Architecture Models (SGAMs),
- An overview of why the principle of neutral market facilitation is important,
- Key stakeholder insights for each of the 23 actors described in the models,
- ENA's intended approach to impact assessment modelling of the worlds inviting views,
- A description of the key enablers needed to deliver these future worlds,
- A summary of the ENA's proposed next steps including their work on 'least regrets' analysis

Building on the themes of the Open Networks models, these 5 future worlds develops the types of interactions that might take place between the various actors, and the requirements of facilitating a neutral market. The worlds are outlined in Figure 31, showing how flexibility is to be coordinated.

Figure 31: ENA Future Worlds (source and credit: ENA)

[109] See ENA website: http://www.energynetworks.org/electricity/futures/open-networks-project/future-worlds/future-worlds-consultation.html

- **World A: DSO Coordinates** – a World where the DSO takes a central role for all distribution connected parties acting as the neutral market facilitator for all DER and provides services on a locational basis to the ESO
- **World B: Coordinated DSO-ESO Procurement and Dispatch** – ESO procurement and dispatch – a World where DSO and ESO work together to efficiently manage networks through coordinated procurement and dispatch of flexibility resource
- **World C: Price-Driven Flexibility** – a World where changes developed through Ofgem's reform of electricity network access and forward-looking charges have improved access arrangements and forward-looking signals for Customers. This World has been built with flexibility arrangements as described in World B, but it is recognised that charging and access developments could be similarly progressed in other Worlds
- **World D: ESO Coordinate(s)** – a World where the ESO takes a central role in the procurement and dispatch of flexibility services as the neutral market facilitator for DER with DSO's informing the ESO of their requirements
- **World E: Flexibility Coordinator(s)** – a World where a national (or potentially regional) third-party acts as the neutral market for DER providing efficient services to the ESO and/or DSO as required.

These five worlds represent a wide range of potential options for the future. It would appear that 'World C' looks overall the most likely pathway for a flexibility market as it currently stands, given the proposals outlined in the Smart Systems and Flexibility Plan. This would involve market-led competition and likely a hybrid approach with both the ESO and DSOs coordinating DER-led flexibility services.

Essentially this could be seen as an assessment of the conflict between the ESO and DNOs, over how national and local balancing needs are coordinated and by who. The variety across the five worlds questions whether the ESO is set to be in control of coordinating all DERs or if DNOs (DSOs) are set to essentially manage everything below the Grid Supply Point (GSP).

The ability for the ESO to coordinate and deal more directly with millions of local customers is potentially a difficult concept. Equally all flexibility procurement passing through the DSOs is likely not a favourable option for Ofgem or BEIS, with the potential for it to be locally too sewn-up. The answer may therefore be a form of price-driven market, where ESO and DSO set out their needs, the market responds and both parties have to coordinate behind the scenes to avoid any conflicts. It is also essential that this coordination avoids unintended consequences, such as the ESO wanting a turn-down and DSO wanting a turn-up response simultaneously.

On the whole, smaller decentralised generators and storage companies would naturally liaise with their local DSO, but if the market signal is clear, the responding DER asset/party probably isn't too concerned with who they are providing the operational benefit to, as long as the benefit is realised.

5.4.4 European distribution network standards around flexibility

The Council of European Energy Regulators (CEER) set out its views of the DSO's role in accessing flexibility services and fostering a suitable environment for the provision of flexibility, following on from its public consultation on Guidelines for Good Practice for Flexibility Use at Distribution Level[110]. A position echoed and stated by Ofgem, CEER's guiding principles stress that DSOs should be non-discriminatory towards technology when procuring sources of flexibility that benefit the network, and they should be able to use flexibility services provided by network users (i.e. DERs) to help manage the distribution network, effectively driving the creation of flexibility markets in the European countries.

CEER has also developed a set of high-level guiding principles for National Regulatory Authorities (NRAs), resulting from this consultation. These guiding principles can be summarised as follows:

[110] See CEER consultation, Spring 2017: https://www.ceer.eu/flexibility-use-at-distribution-level

- The regulatory framework for DSOs should be non-discriminatory and not hinder DSOs from facilitating the development of flexibility and markets therein. Specifically, all sources of flexibility that benefit the grid, including generators, storage, and DSR, should be treated in a non-discriminatory manner when procured by network operators – regulatory incentives should avoid any bias towards specific technologies that deliver flexibility
- The regulatory framework should enable the development of a full range of possible flexibility services, while also ensuring that the framework is sufficiently robust deliver the best outcomes for consumers and the system as a whole
- NRAs should ensure that no options are prematurely ruled out
- DSOs should be able to, under the relevant regulatory frameworks, access and use flexibility services provided by grid users for managing the distribution network, where the use of this flexibility is considered to be the most economical solution and avoids undue distortion to markets and competition
- Within the framework set by the relevant European legislation, the details on the roles and responsibilities of DSOs should be determined at national level, given the diversity of situations, legislation and needs across EU Member States and the variation of DSOs in size and location
- It is vital to differentiate between the use of flexibility by market actors and the use of flexibility that benefits the grid by the DSO. Due to their different competitive, technical and regulatory conditions, the source of flexibility may be the same, but the purpose is different
- Intensify the discussion on principles and roles and responsibilities regarding DSO-ESO coordination in the field of flexibility.

As with Ofgem's own regulatory framework principles, these guidelines give explicit mention to an 'agnostic' approach to procuring flexibility at the distribution level. Such a principle is nominally positive for a model such as ECAS seeking to enter local flexibility markets, especially with one of the core roles of the ECAS model to share/provide financial benefit with/to end domestic consumers.

5.4.5 The regulation of Aggregators

5.4.5.1 Ofgem consultation

Ofgem's view is that permitting independent Aggregators (i.e. those not also acting as suppliers) to gain access to additional markets like the BM, can deliver benefits to the consumer, provided it's under carefully designed regulation[111]. This will be made easier by ensuring a level playing field in the access to markets for participants, leading to increased competition, while the Aggregator bears the balancing costs and delivery risks as opposed to the customer. Ofgem also state that payments for sold-on energy should be agreed in the retail contract between the supplier and the end consumer. They do anticipate lessons to be learned once these arrangements become more widespread as the market grows.

5.4.5.2 Aggregators entering the Balancing Mechanism

Ofgem granted derogation to Limejump[112], allowing it to participate in the BM, by submitting aggregated data at the GSP level, rather than individual assets within a GSP. In practice, LimeJump have entered the BM by firstly becoming a licenced supplier and creating a Virtual Power Plant (VPP), aggregating distributed renewable energy generation, battery and DSR assets[113]. Within LimeJump's VPP

[111] See Ofgem letter regarding allowing Aggregators to enter additional energy markets, July 2017: https://www.ofgem.gov.uk/system/files/docs/2017/07/ofgem_s_views_on_the_design_of_arrangements_to_accomodate_independent_Aggregators_in_energy_markets.pdf
[112] See Ofgem decision letter in regards to LimeJump derogation, July 2018: https://www.ofgem.gov.uk/system/files/docs/2018/07/limejump_grid_code_derogation.pdf
[113] See LimeJump press release: http://www.limejump.com/limejump-enters-balancing-market/

is also the first battery storage site that has entered the BM, a 10 MW battery operated by Anesco in Derbyshire. Whilst very positive precedents, other organisations acting in a similar role of an Aggregator with a supply licence are also actively trading in the BM, such as Flexitricity[114], who targets DSR aggregation specifically. These organisations are evidently blazing a trail for aggregated flexible energy assets, accessing value from more than one energy market. This provides a positive landscape for smaller entrants into these markets, with Aggregators once more providing a potential route to market.

However, whilst likely a lucrative market to be in, the entry and operating requirements of BM are almost certainly more stringent and restrictive than even National Grid's Power Responsive programmes or the local flexibility services that we have discussed here. This therefore means that the potential for domestic loads being able to enter the BM may be a technically challenging prospect.

With the right aggregation platform interfaces, the right 'readily dispatchable' technologies (such as home batteries or EV charging equipment), the potential for ECAS to access the BM could be explored further. Alternatively, ECAS could potentially be better placed to aggregate domestic/community level flexibility, then offer that to a licenced Aggregator such as LimeJump, Flexitricity or Upside to operate within the BM. The added commercial arrangement and related contracts would need to be considered carefully, alongside the division of risk and value.

5.4.5.3 Aggregator Code of Conduct

The Association for Decentralised Energy (ADE) is in the process of developing a 'Code of Conduct' for Aggregators to help build confidence amongst DSR providers and advance flexibility opportunities[115]. The Code of Conduct will be mainly targeting these following areas:

- **Sales and marketing** - ensuring an honest and technically proficient relationship between Aggregators and customers, allowing customers to make decisions based on accurate information to promote high performance in the industry
- **Technical due diligence and site visits** - ensuring the best practices to protect data and assets from cybercrime, as well as requiring that member installations be built to ensure protection of employees and liability coverage in the event of an accident
- **Proposals and contracts** - ensuring that tenders are fair and accurate, with benefits and risks clearly laid out, so as not to deceive customers into signing up for services they do not want or need and enabling Aggregators and customers to enter into mutually beneficial agreements
- **Complaint handling** - requiring members to give continued support to customers after a contract has been signed, helping disputes to be resolved in a timely and attentive manner.

The code has been developed by a committee of Aggregators, suppliers and industrial customers. It will be voluntary and industry-led and is due to be implemented later this year[116].

5.4.6 Considerations for the ECAS model

These industry-led consultations stress the ever-increasingly important role of the DSO, coordinating with the ESO, in facilitating a suitable environment for a range of flexibility services. This role must include procuring flexibility at the community level when it is practical and economically viable to do so.

For the ECAS model, the DSO remains one of the most likely counterparties when providing flexibility services aggregated from the domestic/community scale. From an industry perspective, it seems the direction of travel for the procurement of flexibility is to continue to be driven by markets, with

[114] See Flexitricity DSR in the BM: https://www.flexitricity.com/en-gb/energy-supply/balancing-mechanism/
[115] Code of Conduct referenced as a wider initiative in National Grid's Demand Side Flexibility Annual Report 2017: http://powerresponsive.com/wp-content/uploads/2018/02/Power-Responsive-Annual-Report-2017.pdf
[116] See ADE Code of Conduct consultation, July 2017: https://www.theade.co.uk/news/ade-news/ade-demand-side-response-code-of-conduct-consultation

individual sites and Aggregators bidding to provide services to both the DSO and ESO. Who takes on the mantle of coordination may have a material effect on the ability for smaller participants to enter and operate in flexibility markets. If successful, Ofgem's proposed network access reforms could act as an enabling factor to improve the viability of ECAS.

It is promising that both Ofgem and CEER acknowledge the need for regulatory and market arrangements that enable consumers to benefit from innovation and new services, as this is a key principle which an effective ECAS should deliver. Regulatory framework principles from Ofgem and CEER stress the protection of consumer interests if DSOs are to use flexibility to manage their networks. If there is a truly level playing field that enables small-scale and new technologies to access the local flex markets alongside larger incumbents, ECAS ought to be a feasible flexibility option for DSOs to turn to.

The ADE code of conduct, when released, is an opportunity for Aggregator parties to standardise approaches and gain credibility with potential entrants to flexibility markets. If successfully implemented, this code of conduct is something an ECAS may wish to voluntarily adhere to as a form of reputational or quality standard. In contrast, this may be more of an 'upward-facing' standard for an ECAS potentially intending to interface or offer flexibility to other Aggregators. The average domestic householder or community energy group may have little interest or awareness of this code of conduct.

Regulation to ensure minimum standards for smart appliances should advance their uptake in households, in turn giving an ECAS access to a greater portfolio of aggregated assets. However, smart appliances are likely to remain a low or limited source of flexible capacity in the home.

5.5 Legal considerations and barriers

5.5.1 DNO to DSO transition:

A community Aggregator flexibility provider may incur licence issues, in regards to sourcing DNO income streams and providing services to domestic and non-domestic end users. DNO income streams are also still quite uncertain at present, given the current pruning/simplification of the services sought.

Initially, Ofgem legislated against DSO holding storage assets. This could create a regulatory barrier in the DSO not being permitted to hold small-scale storage contracts with the ECAS (see Ofgem 2017). However, alternative grid connections and ANM can pave the way for some flexibility in that the DNOs are permitted to engage in ANM through regulation and have guidance for participation written by the ENA. This could also be seen as a barrier due to the DNO being able to constrain through own measures without procuring flexibility services.

Work by the Smart Grids Forum concluded that the regulatory framework does not prevent commercial arrangements in the market. Including DNOs using third parties to help provide services, work on flexibility is looking at what more needs to be done to support efficient use of flexible resources across the system (both RIIO-ED1 and ED2).

In addition to this, as referenced by Ofgem under RIIO, DNOs are permitted to recover 1% of revenue, by offering small-scale reward services such as flexibility which they do themselves, rather than open to the market. ENW's innovation project 'Customer Load Active System Services (CLASS) is an example where a DNO could potentially bid into the ancillary services market. This project is therefore a revenue-deriving project for ENW, but they will be unable to offer it on an open market as they will have reached the 1% cap and because there is no need if it is a success on its own as a revenue provider to the DNO.

Historically, DNOs were incentivised through capex pricing to deliver a large-scale network and not to provide localised services, except through innovation. This incentivisation is changing as part of the transition to a DSO, with cheaper, more localised solutions being incentivised. The regulatory position still exists in which DNOs have to calculate their expenditure in building and operating large networks.

5.5.2 Licence conditions and codes

A review of the National Electricity System Security and Quality of Supply Standard, SQSS, and other relevant standards and codes should be undertaken to determine if changes were required for ECAS. Engagement with licensed suppliers would also be a key area of focus, assessing the need for 'licence lite' or no licence at all. In addition to this, understanding what future market supply arrangements need to be considered, the contracts for multiple suppliers and what obligations would be on the ECAS facilitating company, should be considered.

5.5.3 Smart metering

The smart metering system is not yet uniform with a number of considerations around SMETS1 vs SMETS2 and compliant software interfaces and interaction with in-the-home devices and appliances. Related to this are the issues around suppliers not meeting their rollout targets and how this will be addressed by Ofgem, BEIS as the rollout targets move closer. Regulatory dangers of changes to roll out and the type of smart meter may cause any proprietary control devices installed as part of the ECAS model, to need to be future proofed against these mandated changes.

Similarly, the consideration around elective or mandatory half hourly settlement (HHS), and who can access the HH data, will also need to be considered. Mandatory HHS can be seen as a positive thing for flexibility markets and Ofgem are trying to bring this forward for domestic consumers. At present it is not mandatory and discussion from Ofgem suggests that there is some concern that domestic consumers, when given the option through smart meters, are not taking it up. If mandatory HHS becomes legislation this will drive the benefit, but it may be that Ofgem decide it is not in the consumers' interest. The position on mandatory HHS and smart meter regulation is another area that is very unclear. Barriers exist through both the lack of regulation or legislative commitment, but also mostly in consumer distrust of both electricity suppliers and what HHS will mean for customer bills.

5.5.4 Power Purchase Agreements (PPAs) and customer contracts

In relation to flexibility services being provided to ECAS, the consideration of a corresponding PPA between the domestic users and ECAS being required would need to be factored in, as some services would require individuals to become energy exporters (EVs, storage discharge, time-shifted rooftop PV generation etc.).

As part of the participation contract between ECAS and individuals, would penalties for non-compliance/performance (from any flexibility contracts) be passed on to individual non-responders? Or would this be soaked up as part of the ECAS risk profile, from i.e. oversubscribing compared to flexibility bid. This is again similar to existing Aggregator models and the arrangements they have with the ESO (or soon-to-be DSO) and thus the corresponding arrangement between Aggregator and provider.

5.5.5 Other legal considerations

- Employment law issues may crop up as the community group may need to employ front line staff to deal with end-user support and consultants/traders to deal with the flexibility market interactions and contractual operations.
- Consent requirements under GDPR in relation to the data involved, potential difficulties with GDPR and access to meter data.
- The uncertainty of Brexit and what effect this will have on regulation, single energy market, UK participation in decarbonisation programmes such as the Emissions Trading Scheme etc.