The changing electricity system provides opportunities for network operators to manage and develop the energy system in new ways. The transition to a Distribution System Operator (DSO) involves using flexible demand and generation to support the planning and operation of the smart grid. Through use of open and transparent local markets, we shall procure this flexibility to deliver reliable supplies at efficient cost for our customers.

In our DSO strategy consultation last year, Future Smart, we set out how technology innovation, decarbonisation and prosumers are driving change across the energy landscape. These changes have continued at pace in the short time since that consultation. We are continuing to see renewable generation and storage connecting across our high voltage networks, and the increased deployment of electric vehicles across our low voltage networks. We now have the highest number of electric vehicle charging points of all Distribution Network Operators and have received over 27 GW of applications for battery storage connections.

In our Future Smart consultation, we recognised the need to transition from a relatively passive network operator to an active Distribution System Operator. This transition provides us with the opportunities to use new tools to manage our networks, including using markets to procure flexible demand and generation. In our 2017 Flexibility Tender, we received a healthy level of interest from providers and we learned how to best utilise these types of market mechanisms to deliver cost savings for our customers.

DSOs as Neutral Market Facilitators
We firmly believe that our role is to be a neutral market facilitator. We want to use open and transparent market mechanisms to procure the flexibility we need to manage our network. Hence, we want to provide the information and transparency that allows market led innovation to flourish, whilst continuing to deliver the highest level of service to our consumers. Our Flexibility Roadmap sets out how we plan to achieve this.

Engaging With Stakeholders
In our Future Smart consultation, we noted how important it is that we listen, collaborate and share. This is still true. We constantly see the benefit of engagement across all facets of our business and will continue to work with industry peers to understand the role we need to play in the ongoing energy transition.

We are not alone on this journey. We are working with other network operators through the ENA’s Open Networks project to share learnings on how best to work with DER. As the market matures we may explore different paths, but ultimately we want a harmonised set of products that are simple to understand and can maximise flexibility’s potential.

We hope our Flexibility Roadmap will further your understanding of our flexibility needs and proposed approaches to using markets to manage our networks. We encourage you to provide us with feedback, give us your ideas and continue to challenge us.

Basil Scarsella
Chief Executive Officer
Executive Summary

The electricity system is going through a period of unprecedented change. Through the past decade we have seen a rapid deployment of renewable generation on our networks. More recently, we are also seeing the emergence of new distributed energy resources (DER) such as storage and electric vehicles (EVs), and changing electricity usage patterns of our customers. These fundamental system changes are challenging both how we maintain and operate our network today, as well as creating opportunities for us to do so more efficiently in the future.

To manage the changing electricity system we are transitioning from being a Distribution Network Operator (DNO) to a Distribution System Operator (DSO). In our Future Smart strategy, we described how as a DSO we will increasingly use flexibility from DER to deliver more energy with less network infrastructure, thus helping to keep costs down for our customers. This Flexibility Roadmap is designed to communicate our future flexibility needs to the market, allowing potential providers to assess the commercial opportunity, and to encourage them to participate in upcoming procurements for flexibility. We set out our flexibility needs across our network areas, how we will contract for flexibility services and how we will work with flexibility providers.

DER can provide flexibility to the system, directly or through a third party that aggregates multiple DER, by adjusting their demand or generation of electricity based on the needs of the system. The size and type of flexible DER may differ depending on their point of connection to the distribution network. Residential properties are connected onto our Low Voltage (LV) network at 400V and below, and can provide flexibility by changing their electricity consumption aided by small battery storage, solar PV and electric vehicles. Larger DER such as industrial and commercial loads, electric vehicle fleets, and larger generation and battery storage tend to be connected onto our Extra High Voltage (EHV) and High Voltage (HV) networks at up to 132kV.

In order to understand the most efficient solution in all cases, we plan to market test through flexibility all of our new EHV and HV load related reinforcement through the remainder of the current regulatory price control (to 2023). This makes up approximately 75% of our load related reinforcement programme. We estimate that our market for flexibility could be more than 200 MW for our load related reinforcement deferral use case by 2023.

We are exploring a range of commercial solutions for accessing flexibility on the LV networks. As a starting point, we plan to market test some LV reinforcement as part of our March 2019 tender. We will continue to develop our LV flexibility products with the aim to market test our LV load driven reinforcement requirements by the end of the regulatory price control period.

We are planning to launch a procurement event in September this year for our reinforcement deferral flexibility needs, starting a tender process in December with a tender to be held by March 2019. This will be for both 6 month ahead and 18 month ahead contracts. This will be designed to meet our flexibility needs from 2019/20 and 2020/21. We plan to repeat a similar tender process each year. Following the March 2019 tender, we will also contract for our planned maintenance and unplanned interruption use cases on a rolling basis as they are required.

We have identified three core use cases where DER flexibility can support us today to operate and manage our networks more efficiently: load related reinforcement deferral, managing planned maintenance, and responding to (unplanned) network outages.

1 http://futuresmart.ukpowernetworks.co.uk/
Using customer flexibility to plan our network

We plan to market test through flexibility all of our new EHV and HV level load related reinforcement. We estimate that our market for flexibility, to defer load related reinforcement, could be more than 200 MW by 2023.

To undertake market testing and ultimately contract for flexibility solutions, we will change our network planning, development and operating processes. This will require active engagement with our stakeholders and potential flexibility providers. We plan to undertake the following activities through 2018 and 2019.

- Publish heat maps showing areas of potential flexibility needs across our networks.
- Enable all DER, both existing and new, to register on a flexibility platform, providing details of their location and technical characteristics.
- Notify DER through a platform as and when market opportunities for flexibility emerge.
- Employ a common framework contract for all flexibility products in line with the terms used in our 2017 tender.
- Integrate flexibility solutions into our network planning processes so that our planning and network management teams have visibility of available flexibility in areas where they are considering network reinforcement and other works programmes.
- Establish clear and transparent protocols for appraising flexibility. We will make tender information publicly available, where it is commercially appropriate to do so.

Other flexibility use cases will likely materialise in the future. As yet, we have not seen the level of change on our low voltage networks as we have seen on our higher voltage networks.

We expect this to change rapidly as vehicles and heating loads are electrified at a domestic level. The future challenges on low voltage networks could be greater than the ones we are already managing on our HV and EHV networks.
Using customer flexibility to plan our network

We plan to market test through flexibility all of our new EHV and HV level load related reinforcement. We estimate that our market for flexibility, to defer load related reinforcement, could be more than 200 MW by 2023.

To undertake market testing and ultimately contract for flexibility solutions, we will change our network planning, development and operating processes. This will require active engagement with our stakeholders and potential flexibility providers. We plan to undertake the following activities through 2018 and 2019.

Visibility of market opportunities for DER

- Publish heat maps showing areas of potential flexibility needs across our networks.
- Enable all DER, both existing and new, to register on a flexibility platform, providing details of their location and technical characteristics.
- Notify DER through a platform as and when market opportunities for flexibility emerge.
- Employ a common framework contract for all flexibility products in line with the terms used in our 2017 tender.

Enhanced Processes

- Integrate flexibility solutions into our network planning processes so that our planning and network management teams have visibility of available flexibility in areas where they are considering network reinforcement and other works programmes.
- Enable all interested DER to enter into framework contracts with UK Power Networks, agreeing as many of the common contracting and product principles as possible, thus making participation in future procurement events as easy as possible.
- Get independent assurance of our internal procurement methodology and outcomes – this will be undertaken in 2019 with respect to the latest round of tenders we run and occur annually thereafter.

Fairness and Transparency

- Establish clear and transparent protocols for appraising flexibility. We will make tender information publicly available, where it is commercially appropriate to do so.
Our role is to be a neutral facilitator of market-based solutions, not to prescribe particular solutions. We will develop flexibility products that allow broad participation, encourage new entry, promote innovative solutions, and allow price discovery. This will help us to facilitate the transition to a more decentralised energy system, at lowest cost for our current and future customers.

In order to achieve the best outcomes for our customers, we will continue to work with other network operators through the Energy Network Association’s Open Networks project to share learnings and work towards a harmonised set of products, and contracting principles.

In order to maximise participation of DER in our flexibility programme, we are currently working with the Piclo Flex platform. As the first DSO adopter, we are planning to use the platform to provide greater transparency of needs and ease of contracting. This will include publishing flexibility requirements, allowing DER to register interest, and running flexibility tenders.

Our Flexibility Roadmap is the beginning of an enduring engagement with our stakeholders. We recognise that as this is a rapidly evolving market, all parties will benefit from transparency and engagement to ensure that our intentions and actions are fully understood and that learning is disseminated widely. We plan to use the feedback on this document to progress our work in this area, and have included a set of questions that we are keen to get your feedback on.

To support DER and stakeholders’ engagement, we propose to:

**Hold a Flexibility Roadmap launch event**
The purpose of this event is to disseminate information, describe our Flexibility Roadmap, facilitate open debate and to get industry feedback on our Flexibility Roadmap. Our Flexibility Roadmap launch event will be held in October 2018.

**Set-up a bi-annual DSO Flexibility Forum**
The input from stakeholders will help shape the longer term development of DSO flexibility services. We plan an Autumn Forum to coincide with when we publish our flexibility needs (in the expression of interest) and an Spring Forum to feedback to stakeholders the results of the tender process.

**Request feedback from all interested stakeholders on this document**
We will summarise this feedback in a follow-on document to be published in Q4 2018.

In the coming months we will publish the list of sites where we require flexibility and undertake a procurement event to help meet our flexibility needs from 2019 onwards. This will provide the opportunity for flexibility providers to engage with us to sign up to specific products and specific locations as we deliver on our DSO strategy.
Executive Summary

Flexibility Timeline

<table>
<thead>
<tr>
<th>2018</th>
<th>2019</th>
<th>2020</th>
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### Market engagement

- Events and publications
  - Publish roadmap
  - Roadmap launch event
  - Roadmap consultation closes

- 6 month ahead tender
  - Publish sites for flexibility

- 18 month ahead tender
  - Sep 18: Expression of interest (EOI) for 2019/20 and 2020/21
  - Mar 19: Tender, delivery from 2019/20
  - Dec 18: Invitation to tender (ITT), Mar 19 Tender, delivery from 2020/21
  - Successful bidders notified
  - Publish sites for flexibility

### Market processes

- Develop framework contracts
- Make contracted DER registers on flexibility platform
- Design clear and transparent protocols
- Consult on transparent processes
- Independent assurance of internal procurement methodology and outcomes
- Review of tender process
- Independent assurance

### Transparency

- Review roadmap responses on LV flexibility products
- Publish update on plans for using flexibility at LV

### Market development

- On-going Electric Vehicle and Low-Voltage Flexibility Management project
- Oct 18: Include some priority LV sites in EOI
- Mar 19: Include some priority LV sites in tender
- Mar 20: 18 month ahead tender for 2021/22
- Mar 20: 6 month ahead tender for 2020/21
- Sep 19: Expression of interest (EOI) for 2020/21 and 2021/22
- Sep 20: Expression of interest (EOI) for 2021/22 and 2022/23

### Utilising contracted flexibility

- Successful bidders notified
- Publish sites for flexibility

### Short-term contracting

- 6 month ahead tender for 2020/21
- 18 month ahead tender for 2021/22
- Short term contracting for planned maintenance and unplanned interruptions

Market trials of LV flexibility
1.0 Introduction

In this section, we introduce UK Power Networks and outline the key objectives of our Flexibility Roadmap.
1.1

UK Power Networks

UK Power Networks owns, operates and manages 3 of the 14 regulated electricity distribution networks in Great Britain (GB) serving London, the South East and East of England. Our networks deliver electricity to 18 million people (8.2 million homes and businesses), representing 28% of the United Kingdom’s population.

Today, our regulated businesses are purely network operators, providing connectivity to customers. We do not generate or buy electricity, nor do we sell it to customers, but our networks are vital to ensuring the reliable supply of electricity.

Our responsibility is to ‘keep the lights on’ for the customers and communities connected to our network, and to do this as cost effectively as possible.

Where we operate
The area we serve covers more than 29,250 square kilometres from Cromer in the east to Brighton on the south coast.

- **London (LPN) – London Power Networks**
  We manage and maintain electricity network for inner London, with responsibility for delivering power to iconic buildings and businesses as well as high profile international events through the year.

- **South East (SPN) – South Eastern Power Networks**
  We serve South London, Surrey, Kent, East Sussex and part of West Sussex, covering a rich variety of customers and locations.

- **East (EPN) – Eastern Power Networks**
  We deliver power to North London and East Anglia, encompassing a diverse range of urban and rural areas as well as a huge coastline.

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**Energy distributed**
79,491 GWh

**Length of overhead network**
45,854km

**Length of underground network**
142,154km

**Distributed generation**
9.07 GW

**Peak Demand**
15,784 MW

**Number of people served**
18 million
1.2 The Flexibility Roadmap

The GB electricity system is going through a period of unprecedented change. Through the past decade we have seen a rapid deployment of renewable generation on our networks. We are also seeing the emergence of new distributed energy resources (DER) such as storage and electric vehicles (EVs), and changing electricity usage patterns of our customers. These fundamental system changes are both challenging how we maintain and operate our network, as well as creating opportunities for us to do so more efficiently in the future.

We now have over 9 GW of distributed generation connected on our networks, approximately one third of the total in GB. We expect this change to continue, with over 27 GW of storage enquiries already made across our networks. We also have the highest number of EV charging points of all Distribution Network Operators (DNOs) with considerable EV deployment potential across our low voltage networks.

Our Flexibility Roadmap builds on a long history of network innovation (see Appendix B) and valuable learnings from our 2017 Flexibility Tender. Our Flexibility Roadmap shows in a clear and transparent way our system needs, how we will work with DER to manage these system needs and how we will deliver on the Distribution System Operator (DSO) strategy we outlined in our Future Smart 2017 consultation\(^2\). We identify the key current use cases for flexibility, future needs and the principles we will use to procure flexibility. We will also make clear our proposed methods and timings for engaging with the market.

The Flexibility Roadmap will be the basis of an enduring engagement with our stakeholders and flexibility providers, beginning with the Flexibility Roadmap launch event in October 2018.

We will continue to work closely with other network operators to ensure commonality across DSO flexibility products being developed. The Energy Network Association’s (ENA) Open Networks project is leading in innovation and collaboration between network operators that will be critical to the long-term success of the DSO model. We will share our learnings from our Flexibility Roadmap with Open Networks, in particular to help achieve the common goals of the DER Services Procurement work stream\(^3\). We will also continue to utilise learning from the whole-system analysis, regional development programme we are running with National Grid and ongoing innovation projects, such as Power Potential\(^4\). In addition, we will continue to closely monitor global developments and adopt best practice to ensure that we remain in the vanguard of the DSO transition.

In the coming months we will publish the list of sites where we require flexibility and issue an expression of interest for flexibility providers to help meet our 2019 flexibility needs. This will provide the opportunity for flexibility providers to engage with us to sign up to specific products and specific locations as we deliver on our DSO strategy.

\(^2\) [http://futuresmart.ukpowernetworks.co.uk/](http://futuresmart.ukpowernetworks.co.uk/)
\(^3\) ENA, Open Networks, Work stream 1, Product 2
The Flexibility Roadmap describes:

What our current distribution network needs are.

How these DSO system needs might evolve in the future.

Why flexibility from DER can help us efficiently manage these system needs.

How we will work with DER to facilitate efficient contracting and maximum participation of all DER types.

What our proposed flexibility products and contracting principles are.

How we will engage with DER over the coming years in a fair and transparent manner.
2.0 The Importance of Flexibility in the Energy Transition

In this section, we describe how the energy landscape is changing and explain the value of flexibility in this transition.
The move to a low carbon economy and greater decentralisation is changing the way we and other DNOs need to plan, maintain and operate the distribution networks. At the same time, technological change and new market entrants are providing DNOs with new tools and opportunities to facilitate this transition. The new role of the DSO is emerging in response to this changing environment.

**Figure 1:** The changing nature of electricity generation, transmission, distribution and supply

### Old World

**Large scale generation**

- Small number of large generators connected on the transmission network
- Coal-fired and gas power stations
- One-way power flows
- Limited customer engagement

**Transmission**

**Local distribution**

**Customer**

### New World

**Wind farm**

**Solar farm**

**Battery storage**

**Connected living**

**Community Electric Vehicle Scheme**

**Large scale generation**

- Large number of generators connected on the distribution network, including behind-the-meter
- Two-way power flows
- Inclusion of renewables (such as, solar PV, wind turbines and biomass) and grid scale battery storage
- Proactive and active customer engagement

**Transmission**

**Local distribution**

**Customer**
Decentralisation of energy production to distribution networks

In recent years we have seen a rapid decentralisation of energy production. There is now almost 25 GW of solar and onshore wind capacity installed in Great Britain. The majority of this is connected to distribution networks and has a variable energy output. We are also seeing the direct participation of consumers in the electricity market, with this trend expected to continue. Prosumerism, where consumers take more control over how they use energy through on-site generation, storage or demand side response is a key component of the energy transition.

Electrification of transport and heat

We are already seeing the partial electrification of heat and transport. There has been a significant uptake in electric vehicles (EVs), including private vehicles and commercial fleets. The take up of load intensive devices like EV charging points is difficult to predict, in terms of both volume and location. Forecasting and managing this EV led load growth will be a key focus for our business over the next decade. As illustrated in Figure 2 below, by 2030, we are predicting close to 2 million EVs charging across our network under our ‘Business as Usual’ scenario.

Figure 2: Actual and forecast EV take-up in our regions out to 2030

*The forecast shown is our ‘Business as Usual’ scenario – where no new policies or incentives are introduced to encourage EV uptake, and targets within the government’s Road to Zero strategy are not met (if Road to Zero targets are met, there could be upwards of 4 million EVs within our regions by 2030).*
2.2 Our DSO Vision

Building on our successful innovation portfolio\(^6\), we launched our consultation on our DSO vision and strategy – Future Smart\(^7\) in July 2017. This document sets out how we will adapt our business over the coming years in order to continue to provide a high quality service to our customers, amid the changing energy landscape.

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**Figure 3: DSO role in a future energy system**

- **Keeping the lights on**
  Secure and reliable supplies taking into account two way flows and greater intermittency.

- **Providing great customer service**
  Facilitating cheaper and quicker connections using proven innovation.

- **Lowering our costs**
  Optimising network investment decisions using alternative flexible solutions.

- **Support whole system optimisation**
  Collaborating with the ETSO to deliver ‘whole system’ outcomes that are best for customers.

- **Enabling markets**
  Enabling market solutions for DER to provide flexibility to the local and wider system.

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\(^6\) [http://innovation.ukpowernetworks.co.uk/innovation/en/]
\(^7\) [http://futuresmart.ukpowernetworks.co.uk/]
2.3 The Benefits of Using Flexibility

Using flexibility to help manage our network can benefit our customers and DER, while helping to facilitate Government policy.

We believe that efficient, well-functioning flexibility markets can facilitate:

**Efficient network operation**
- Provide a lower cost solution to conventional reinforcement.
- Manage load uncertainty and avoid the risk of stranded assets.
- Promote competition in providing network solutions.
- Support more efficient maintenance and operation of the network.

**DER to help meet decarbonisation targets**
- Stimulate new markets to attract DER to connect.
- Provide the means to connect new DER without delays associated with reinforcement.

**Whole system benefits**
- Provide transparency on the distribution value of flexibility and the locations where it has value.
- Allow DER providers to ‘stack’ revenue opportunities in other markets, such as the wholesale and balancing services markets, so that the value of their flexibility to the system as a whole is maximised.
- Support the wider electricity system, e.g. by managing the load during peak demand periods through coordination with other transmission/distribution system operators.
2.4 Flexibility Tenders

In August 2017, we launched our first Flexibility Tender. We issued an expression of interest for flexibility providers to help us defer reinforcement at 10 sites across our network. We then ran an open and transparent tender process for services delivering in 2017/18 and 2018/19. This led to two successful contracts signed with flexibility providers to help meet our needs.

This first tender and stakeholders' feedback provided the following important learnings:

- The need for a longer notification of upcoming tenders.
- A preference for longer contract lengths.
- The benefit of being able to ‘stack’ revenues from the flexibility tender with services provided to other parties.
- These learnings and market feedback have been considered in the contract and tendering principles proposed in this document.

*https://ukpowernetworks.co.uk/internet/en/have-your-say/listening-to-our-connections-customers/flexibility-services.HTML*
3.0 DSO Flexibility Needs and Products

In this section, we provide stakeholders with a detailed view of the flexibility products we plan to procure to help address our network needs over the coming years.
3.1 Current DSO Flexibility Needs

We have identified three current DSO flexibility needs, where DER can provide services:

**Reinforcement Deferral**
Allowing us to delay the need to reinforce our load related EHV and HV network assets, until it is clear that reinforcement is required.

**Managing Planned Maintenance**
Helping us to carry out planned maintenance, asset replacement, and connection works more efficiently.

**Dealing with Unplanned Interruptions**
Mitigating the effect of network outages when they occur, minimising the impact on our customers.

### 3.1.1 Reinforcement Deferral

**Network need**
In order to maintain reliable supplies for our customers we must ensure that there is sufficient network capacity. We proactively forecast demand and generation growth across our network to anticipate reinforcement requirements and plan accordingly. Historically, this planning has been undertaken against the backdrop of very stable demand growth, with only limited amounts of generation connecting to our networks.

As highlighted in Section 2, the rate and scale of distributed energy uptake, alongside electricity intensive low carbon technologies (such as EVs), means there is increased uncertainty over when and where we will need to reinforce the network.

Reinforcing is a significant investment, with the impact of demand driven reinforcement contributing to customer bills over a number of decades. The increased uncertainty around future load growth means that we need to ensure any investment undertaken addresses the need in an efficient and economic manner. Hence, delaying investment can reduce that risk, ensuring that network assets are utilised as efficiently as possible until reinforcement is needed.

**Flexibility application**
Rather than reinforcing the network in all cases, we plan to use flexible DER to maintain the network within its operational limits. Our aim is to market test all new EHV and HV load related reinforcement (LRR) prior to deciding whether to install new assets. Our network is roughly categorised according to the following voltage levels:

- **Extra-High voltage (EHV)** – 132kV and 33kV assets
- **High voltage (HV)** – 11kV and 6.6kV
- **Low voltage (LV)** – 400V and below

In March 2019, we plan to run two concurrent tenders for EHV and HV reinforcement deferral, 6 month ahead for 2019/20 and 18 month ahead for 2020/21. The reinforcement needs at LV are more complex and the market for residential level flexibility is still developing. As a starting point, we plan to market test some LV reinforcement as part of our March 2019 tender. We will continue to develop our LV flexibility products with the aim to market test our LV load driven reinforcement requirements by the end of the ED1 period (2023). We outline in Section 4 how we see this market evolving and what our needs in this area could look like.

Table 1 highlights the general needs from flexibility providers to help us defer EHV and HV reinforcement.
Flexibility demand and value

The value of this flexibility is derived from the financial value of deferring investment. To provide a sense of this, we have used the LRR expenditure included in our RIIO-ED1 business plan to estimate the flexibility potential. We describe our approach for each category of reinforcement below.

Table 1: EHV and HV reinforcement deferral flexibility system needs

<table>
<thead>
<tr>
<th>Illustrative Requirements</th>
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<tr>
<td><strong>Value Drivers</strong></td>
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<tr>
<td><strong>Reinforcement Deferral</strong></td>
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</tbody>
</table>

Table 2: Market engagement for different load related reinforcement categories

<table>
<thead>
<tr>
<th>Description</th>
<th>Role of flexibility</th>
<th>Plan to engage the market</th>
<th>% of LRR spend ¹⁰</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EHV and HV reinforcement</strong></td>
<td>Includes all assets downstream from the 132kV busbar up to and including the secondary substation transformer</td>
<td>Flexibility can help reduce the needs for EHV and HV reinforcement</td>
<td>Using open and transparent tenders for multi-year contracts</td>
</tr>
<tr>
<td><strong>LV reinforcement (including circuits and voltage)</strong></td>
<td>Includes all assets downstream of the 400V busbars</td>
<td>Flexibility at the right location can help defer the need for LV reinforcement, or buy time to maintain quality of service while reinforcement is undertaken</td>
<td>Market test some LV reinforcement in 2019/20 and continue to develop our LV flexibility proposals discussed further in Section 4</td>
</tr>
<tr>
<td><strong>Diversions (EHV, HV and LV)</strong></td>
<td>Where existing assets need to be moved to accommodate new buildings or developments</td>
<td>Limited – flexibility cannot remove the need to divert the assets. In a small number of cases, it may help reduce the costs of the redesigned network</td>
<td>Ad-hoc as needs arise</td>
</tr>
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⁹ In our 2017 Flexibility Tender we relaxed this requirement to 45 minutes to facilitate increased participation. Whilst we are minded to revert towards shorter timeframes as above, we will take into consideration the work undertaken through the ENA Open Networks project. Additionally, we will consider how this helps address the specific locational need.

¹⁰ These are based on our original load related business plan to Ofgem in 2014. While this plan will have had amendments made and some schemes will already have been undertaken, it still provides an indication of the scale of the market.
The remainder of this section focuses on the value of the EHV and HV reinforcement. In order to estimate the flexibility market potential, we have assessed the number of substations which are expected to require reinforcement before the end of the ED1 period based on long-term development statement (LTDS)\(^1\) data of substation capacities and updated load estimates. This illustrates the potential market opportunities to the end of this price control period (2023).

The LTDS contains the vast majority of our EHV and HV reinforcement needs, based on our latest planning estimates\(^2\). Our published LTDS does not go beyond 2023, as this will be a new price control period where Ofgem will need to approve our business case assumptions. However, we expect there will be an enduring need for flexibility on the EHV and HV network, of comparable scale to that in our ED1 plans.

Figure 4 highlights the number of substations which are currently forecast to have a potential need for reinforcement in the remaining years of ED1, across our three networks. The years in the chart represent the year of procurement 18 months ahead of service delivery.

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\(^1\)\text{https://www.ukpowernetworks.co.uk/internet/en/about-us/regulatory-information/long-term-development-statement.html. The data within the LTDS can be provided in excel format upon request.}

\(^2\)\text{Some HV substation schemes may not be included in the data set as they fall outside the definition of assets included in the LTDS. This category of schemes constituted around 5\% of our load related reinforcement expenditure included in our RIIO-ED1 business plan. So it would not have a material impact on the figures quoted.}

\(^3\)\text{EPN, SPN and LPN describe our three networks, Eastern Power Networks, South Eastern Power Networks and London Power Networks.}

\(^4\)\text{These and all other figures show the total flexibility potential per year, not new additive flexibility potential in each year.}
In addition, in Figure 5 we have set out the flexibility need (MW) which would be required to defer all the reinforcement schemes detailed in Figure 4.

Of these reinforcement needs, over two thirds will be on the HV networks, with the remainder on the EHV networks. HV and LV connected parties will also be able to provide flexibility to support EHV substations. Figure 6 provides a more complete breakdown of the split across voltage levels.

**Figure 5:** Flexibility market potential for EHV and HV reinforcement needs

**Figure 6:** Breakdown on potential flexibility needs by voltage level
These should be seen as an indication of the opportunities for flexibility providers until the end of the ED1 price control period based on current forecasts. It will not be practicable to use flexibility in all these cases, for example:

- There may be insufficient flexibility available at all locations.
- Network reconfiguration such as load transfer from other parts of the network might be the most economical solution.
- Reinforcement might be the most efficient long-term option.

To establish the value of flexibility we are estimating the value created by deferring the capital expenditure to a later date. The higher the value of the specific reinforcement scheme and the longer it can be deferred for, the higher the potential value of flexibility.

As an indicative example, Figure 7 illustrates that using flexibility services with an approximate cost of £30,000/year can help us defer a reinforcement cost of £2m for 4 years.

**Future demand**

The potential market opportunities we have presented in this section are based on our current load and generation growth projections out to 2023 which are regularly updated. During the next price control period (2023–28), there is the potential for load and generation growth to increase further, beyond our current forecasts. This could be driven by EV costs reaching a point where mass take-up is feasible, along with further falls in technology costs for solar PV and/or batteries.
3.1.2 Planned Maintenance

Network need
We are constantly monitoring, upgrading and replacing assets on our networks. These maintenance regimes are critical to ensuring the long-term reliability and security of the network for our customers.

The foresight, duration and requirements of planned maintenance events vary considerably, depending on the asset type and category of maintenance we require. Some maintenance projects will be agreed 12–36 months ahead of time, others are managed on a rolling maintenance basis, and some are reactionary to continuous monitoring of asset health. Similarly, some maintenance regimes can be years in duration, while others can be efficiently completed in hours.

Currently, we manage planned maintenance through:

- **Network outages**
  We may have to temporarily de-energise portions of the network to allow for safe planned network improvements. These are scheduled to ensure minimal inconvenience to customers.

- **Temporary generators**
  To bring the local net loading on the network within acceptable parameters, typically post fault.

- **Network redundancy**
  We use the redundancy arrangements of the meshed network to carry out maintenance activities without de-energising sections of the network. We foresee the possibility to use flexibility where available in relevant locations to assist in our maintenance programme.

Flexibility application
When carrying out necessary maintenance on the network, we plan to seek to use flexibility to increase network resilience and manage any unexpected increases in load, from June 2019. This will be based on the DER resources which have registered on the flexibility platform for reinforcement deferral, at designated locations. These flexible resources could also allow for more efficient and flexible scheduling of maintenance, potentially allowing maintenance events to be completed without a need for planned interruptions.

Flexibility demand and value
The value of flexibility for this service would be comparable to the rental and utilisation cost of temporary generation, increased resilience, and efficient scheduling.

Future Demand
We are constantly investing in improving the health of our network assets. Consequently, we expect that maintenance regimes will continue at a steady rate through the remainder of this price control.

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This includes planned maintenance, asset replacement and connection works
3.1.3 Unplanned Interruptions

Network need

We have improved the reliability of our network dramatically over recent years, with the number of customer interruptions falling by 42% between 2010/11 to 2017/18. Unplanned interruptions can be caused by severe weather events, infrastructure failures or accidents, which are a major inconvenience to customers with significant customer welfare, economic and social impacts.

From June 2019, we want to use flexibility both pre and post fault to reduce the number and duration of unplanned interruptions that our customers experience.

• **Pre fault** flexibility could help provide additional resilience to the network. On occasions we may be required to operate the network closer to its technical limits which makes the likelihood of faults higher. To mitigate for this risk, we could deploy flexibility to provide additional resilience during these periods.

• **Post-fault** flexibility would reduce load or allow network reconfigurations to reduce the impact of faults on our network. Some network faults do not immediately result in customer interruptions but, if left unchecked, may do so over a period of hours or days. Flexibility could be used to reduce the risk of customer interruption until such time as longer term remediation measures are put in place.

In the future, we may explore the ability of flexibility services to provide sub 3 min response to help us reduce our customer interruptions (CIs).

Table 3: Planned maintenance flexibility system needs

<table>
<thead>
<tr>
<th>Value Drivers</th>
<th>Location Specific</th>
<th>Response Time</th>
<th>DER Type</th>
<th>Exclusive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planned Maintenance</td>
<td>Managing unplanned interruption risk through planned maintenance</td>
<td>Yes (post code and connection level)</td>
<td>30 mins max</td>
<td>All eligible DER (generation, storage and load reduction)</td>
</tr>
</tbody>
</table>

* Other flexibility services can be provided. The only restriction would be on providing demand turn up during availability windows.
Flexibility demand and value

Under the RIIO price control framework, we have specific targets for the number of CIs on our network and the overall number of customer minutes lost (CML). These targets are subject to the ‘Interruption Incentive Scheme’ (IIS) which provides us with rewards if service levels for interruptions are lower than the target, and penalties if they are higher. The value of the IIS is based on consumer research into the value they place on lost load.

The value of these incentives set the value we can see in using flexibility to reduce the number of unplanned customer interruptions and their duration.

Future demand

As a distribution company we use our allowances to improve network resilience through flood mitigation investments, tree cutting and other physical security measures, which help reduce unplanned interruptions. Therefore, while unplanned outages will continue to be strongly weather dependent, on average it is expected that unplanned interruptions will reduce in the future through continued investment in resilience measures. This reduction in outages is expected to be in line with target performance improvement rates, resulting in a steady forward looking outlook for the need and value of this use case.

Table 4: Unplanned interruption flexibility system needs

<table>
<thead>
<tr>
<th>Illustrative Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value Drivers</td>
</tr>
<tr>
<td>Pre-Fault Response</td>
</tr>
<tr>
<td>Post-Fault Response</td>
</tr>
</tbody>
</table>

Other flexibility services can be provided. The only restriction would be on providing demand turn up during availability windows.
3.2 Product Strategy

We recognise that the market is rapidly evolving and that a set of rigid products and pricing structures could stifle competition and price discovery. Our role is to act as a neutral facilitator of market-based solutions, not to prescribe any particular solutions. As such, we want it to be as easy as possible for flexibility providers to ‘do business’ with us. Hence, we are proposing a standard set of contracting and product principles that we will operate within to give flexibility providers some clarity, whilst retaining the ability to tailor individual procurements to our specific needs.

We are proposing two ‘Flexibility Product Structures’. These align to our flexibility needs and are comparable in design to other flexibility products in GB and the ENA Open Networks Project.

We are also proposing a set of eight ‘Common Product Principles’. We use these to describe a set of common criteria that will apply to all flexibility products (e.g. de-minimis volume, proof of delivery, performance, transparency). We will agree these in standard framework contracts with all DER providers as a prerequisite to contracting for flexibility. These framework contracts will help facilitate efficient and frictionless contracting.

Additionally, we are proposing a set of three ‘Contracting Principles’ which set the framework around contract term, eligibility, and contract lead times. We expect that these will vary by product and in some instances on a case-by-case basis. For example, the demand profile in an area might require a longer or shorter availability window. As such, in this section we discuss the expected form of these contracting principles, but note that these could change both on a case-by-case basis and as the market matures.

We are structuring our products and contracting process in this way to create an environment where we can explore further DSO use cases and products within a common contracting framework.

3.2.1 Flexibility Products Structures

Our flexibility needs align to two core product structures:

- An availability and utilisation payment product for the Reinforcement Deferral and Planned Maintenance use cases.
- A utilisation only product for the Unplanned Interruptions use case.

These product structures are well understood by DER and commonly used across Electricity Transmission System Operator (ETSO) and other DSO products.
3.2.2 Common Product Principles

In addition to the Core Flexibility Products, we are proposing a set of Common Product Principles that will apply across all Core Flexibility Products.

These terms will be agreed with DER through the standard framework agreements as a pre-requisite to contracting for flexibility:

**Fairness and Transparency**

- We want flexibility to be procured in a fair and transparent manner, with all parties confident in the fairness of the tendering, contract award and dispatch of flexibility contracts.

- This fairness and transparency needs to be balanced with appropriate handling of commercial and personal data, as well as mitigating the potential for tender outcomes to be manipulated.

- The first step to facilitating fairness and transparency is to disseminate information and clearly describe the DSO’s flexibility needs. This is a core goal of this Flexibility Roadmap.

- Tender award criteria will be made publicly available, as will ex-post commercial and technical data of all successful contracts, when commercially appropriate to do so.

**Minimum Capacity (De-Minimis) Threshold: 100 kW**

- We used a 100 kW threshold in our 2017 Flexibility Tender. This received broad support from participants and stakeholders, as it facilitates increased participation. Hence, the 100 kW De-Minimis threshold will apply to our Core Flexibility Products.

- Parties can aggregate DER assets to reach this De-Minimis threshold, subject to meeting other framework, tendering and verification requirements.

- It may be that our flexibility needs require a minimum volume of aggregated flexibility to be viable. For example, if 1 MW of flexibility is needed to avoid conventional reinforcement in an area, and only 500 kW is available, then flexibility cannot meet the DSO’s needs. This will be applied as a ‘Minimum Aggregate Volume’ where flexibility will only be used if this threshold is met.

- In some cases we could build up to the Minimum Aggregate Volume through successive tender rounds, to facilitate new flexibility providers where economically efficient.

- DER will be notified of any such Minimum Aggregate Volume thresholds in advance.

**Dispatch**

- DER will be dispatched on instruction from the DSO during a contracted availability window, or as requested under a framework agreement. Instruction notification periods will be prescribed in advance.

- In some cases we may contract for a service to dispatch continuously through the contracted availability window.

- Dispatch of DER will evolve as the market and technology matures.

**Stacking Revenues (Mutual Exclusivity)**

Revenue stacking (contracting with multiple other services) will be allowed for all Core Flexibility Products, but not for other services that requires DER to increase active load unless outside contracted availability windows.

- The Core Flexibility Products all reduce active load on our network, rather than ETSO type balancing needs, which often require a turn-up response. As such, DER that reduce load on the network be that at the DSO’s instruction or another party’s instruction, meets the DSO’s needs.
• However, DER increasing load while under a flexibility product, for demand turn-up, high frequency response or Balancing Mechanism bids for example, would work counter to our network needs.

• As such, we are proposing that our DSO flexibility contracts can be contracted alongside all other services, but not for those that will require an increase in active load within availability windows.

• We recognise that future use cases could require active load increases (a demand turn up type service). These would be handled as new Flexibility Product structures.

**Performance**
Where DER does not deliver on the terms of their flexibility contract their payments are reduced pro-rata to a pre-agreed maximum penalty that will not exceed the value of the contract.

• Performance mechanisms are necessary to incentivise DER to deliver and for DSOs to have confidence in using flexibility as an alternative to conventional means of network management.

• The structures proposed are intentionally similar to those applied to Balancing Services, Capacity Market contracts and other DSO services.

• Where a DER asset cannot meet the response duration requirements of a specific contract then availability payments will be reduced pro-rata.

**Proof of Delivery**
DER will provide metered data ex-post to validate contract delivery.

• Proof of delivery is key. As in our 2017 Flexibility Tender, we propose that DER provides us with their meter data ex-post to confirm delivery.

• In the long term, a more efficient solution might be for DER meter data to be reported to DSOs through industry standard settlement processes to allow for automatic verification of delivery and availability.

• Baselining – as in our 2017 Flexibility Tender, we will use historical meter data to build baseline customer usage profiles that can be used ex-post to verify delivery.

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*DER contracted for flexibility will play a key role in the security and reliability of the distribution network. At the same time, we acknowledge that the change in the load of contracted DER may have an impact on the wider system. Hence, we are working with ETSO to capture the benefits of coordinating how we contract and dispatch DER.*

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**3.2.3 Contracting Principles**

Our flexibility needs will be specific to individual use cases. As such, some flexibility contract specifics such as term and procurement lead-time will vary depending on the particular requirement.

For example, a contract with a term of 1 year for summer evening availability might be required on one site, or a seasonal contract for an evening peak 4 to 7pm availability might be required on another. Similarly, there might only be DER of a certain type in a given area, and we may need to structure flexibility products accordingly.

The ability to adapt our approach will allow us to structure tenders which are likely to give the best outcomes in the context of our requirement in each location, and the types of DER that exist or might be deployed there. It will also allow us to evolve contract terms as the market and our understanding of the flexibility potential matures, facilitating market discovery and not limiting innovation through overly prescriptive product and pricing structures. We believe that this flexibility can be achieved while still giving confidence and signals to DER by maintaining the core underlying product structures and principles.

**Procurement Lead Times**

Procurement lead times will align with our internal network planning and decision making processes, where flexibility will be considered as an alternative to conventional means of network management. We will endeavour to give DER as much foresight as possible of upcoming flexibility tenders.

We are proposing an 18-month procurement lead-time to enable flexibility providers to develop their solutions to meet our network needs, and a 6-month procurement lead-time to facilitate the participation of providers that may become available in shorter time frames.
Contract Terms

Contract terms will vary by use case and requirement for each location, with a mixture of long term (multi-season) and short (week) contract terms.

- For the reinforcement deferral use case we will consider multi-year contracts initially. At this stage, we are proposing contracts up to 4 years in duration.
- We recognise the efficiency of short term, frequent contracting, and the general market theme towards the procurement of flexibility in shorter timescales. However, in the case of reinforcement deferral in particular, we are postponing the upgrade of a portion of the network for a period using flexibility to manage increasing customer load. As such, we will need a robust guarantee that flexibility can be used for the duration of the reinforcement deferral. This is most easily achieved through long-term contracting.
- In the case of planned maintenance, these will likely be seasonal contracts, managing summer and shoulder month maintenance programmes. For this use case, contracts could be up to 6 months in duration.
- In the long term, as liquidity increases and markets mature, we may transition to closer to real time procurement of flexibility for some products, similar to the evolution of the ETSO balancing products.

Pricing

When there is likely to be sufficient liquidity, we will use competitive tenders, wherever possible. In cases where we believe there is insufficient competition, we may revert to the use of administered prices.

- To align with other GB energy markets, and to achieve the most efficient outcome for consumers, we will competitively tender flexibility contracts in all cases where it is appropriate to do so.
- We recognise that competitive tenders might not always give the best outcome. In these cases we may use a set of administered prices, with these prices publicly available and periodically updated. For example, we may choose to update these administered prices to reflect price discovery through competitive tender.
- Administered prices would not be changed through the term of a contract, rather these may be updated for future contracts on a periodic basis.
- For each flexibility need we will undertake liquidity (competition) checks. Where liquidity provisions are not met, we could revert to the administered prices.
3.3 Current DSO Flexibility Products

3.3.1 Reinforcement Deferral Product
When we go to market to seek flexible solutions for our reinforcement deferral use case, we will define the availability windows when the flexibility is likely to be needed. This will allow DER to maximise other revenue opportunities outside of these availability windows. This will be based on the load profile of the network asset and when it is forecast to exceed network limits. This will be different for each asset.

Figure 8 below is the yearly load profile of one of our sites. It illustrates that the substations in question has ten spikes of demand which exceed the network limit. These types of load profiles are well suited to using flexibility to defer reinforcement

In the illustrative example, the duration of the peaks are 1–3 hours. This type of requirement would be well suited to a contract that provides availability payments during the winter peaks, to ensure that the flexible DER is available to us, and utilisation payments to compensate the DER for its short run costs (additional generation costs, or opportunity cost of reduced process output) when we require the response.

Table 5 provides a summary of the type of flexibility products for reinforcement deferral which we will be going to market for the 2019/20 and 2020/21 winter periods.
3.3.2 Planned Maintenance Product

For the planned maintenance product, procurement lead times would vary depending on the maintenance type. Some multi-year maintenance events could be identified and planned 24-36 months ahead of delivery, with flexibility potentially procured around similar timelines. However, the majority of maintenance programmes are finalised closer to the event, supporting short procurement timeframes (month ahead) in most cases.

Payments would be for both availability and utilisation, tailored with availability windows set to the peak load profile of the particular area or the specific need of that maintenance event. The length of the maintenance event would set the contract term, potentially with a buffer either side of the maintenance window to allow for early start or over-runs. These could be multi-year in duration, but in most cases would be contracted seasonally, or through peak daily demand windows. For example, a tender for flexibility providing summer daytime peak availability to manage increasing summer air-conditioning load on planned maintenance regimes in built-up areas.

Tendering for contracts would be done as needed, considering the availability of DER registered on the flexibility platform at the required area.

*Other flexibility services can be provided. The only restriction would be on providing demand turn up during availability windows.*
3.0 DSO flexibility needs and products

Table 6: Planned maintenance product

<table>
<thead>
<tr>
<th>Product Principles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Procurement Type</strong></td>
</tr>
<tr>
<td>Planned Maintenance</td>
</tr>
</tbody>
</table>

3.3.3 Unplanned Interruptions Product

Our need for flexibility under the unplanned interruptions use case will be infrequent and difficult to forecast. Consequently, we propose that the flexibility product is a utilisation based payment mechanism with contracted utilisation prices. This would be accessible to all eligible DER providers.

Registered flexibility providers could adjust utilisation prices, as well as availability status. This could be done on a rolling fixed term basis, with standing framework agreements. In the case of new connections we may consider if flexibility provision could be included in new connection agreements.

Table 7: Unplanned interruption product

<table>
<thead>
<tr>
<th>Product Principles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Procurement Type</strong></td>
</tr>
<tr>
<td>Unplanned Interruptions</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

20 Other flexibility services can be provided. The only restriction would be on providing demand turn up during availability windows
### 3.4 Flexibility Need and Product Summary

Table 8 below summarises the key characteristics of the flexibility products we are looking to procure from DER.

<table>
<thead>
<tr>
<th>Flexibility Products</th>
<th>Reinforcement Deferral</th>
<th>Planned Maintenance</th>
<th>Unplanned Interruptions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Value Drivers</strong></td>
<td>The present value of deferring capital expenditure</td>
<td>Managing unplanned interruption risk during planned maintenance</td>
<td>Customer Interruption (CI) and Minutes Lost (CML) incentives</td>
</tr>
<tr>
<td><strong>2023 Flexibility Potential (MW)</strong></td>
<td>206</td>
<td>Available to eligible DER capacity</td>
<td></td>
</tr>
<tr>
<td><strong>High-Level Requirements</strong></td>
<td>Location Specific</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>Response Time</strong></td>
<td>30 mins maximum</td>
<td>&lt;10 mins preferred, 30 mins maximum</td>
<td></td>
</tr>
<tr>
<td><strong>Response Duration</strong></td>
<td>Full availability window – case dependent. Pro-rated payment if available for part of window</td>
<td>3 hours. Pro-rated payment if available for part of window</td>
<td></td>
</tr>
<tr>
<td><strong>DER Type</strong></td>
<td>Generation, Storage and Load Reduction</td>
<td>Generation and Storage</td>
<td></td>
</tr>
<tr>
<td><strong>Contracting Principles</strong></td>
<td>Procurement Type</td>
<td>Competitive tenders or administratively set prices if low liquidity</td>
<td>Framework agreement. Optional updating of pricing through contract</td>
</tr>
<tr>
<td><strong>Procurement Lead Time</strong></td>
<td>6 months ahead and 18 months ahead</td>
<td>Case specific 1~12 months</td>
<td>DER applies if eligible</td>
</tr>
<tr>
<td><strong>Payment</strong></td>
<td>Availability and Utilisation</td>
<td>Utilisation only</td>
<td></td>
</tr>
<tr>
<td><strong>Contract Term</strong></td>
<td>1~4 years</td>
<td>Monthly or seasonal</td>
<td>Framework agreement</td>
</tr>
</tbody>
</table>
This section explores what types of flexibility we might need in the future, in addition to our core use cases. We then share early thinking on the range of ways in which we could engage with the market to enable DER provision.
4.1 Low Voltage Flexibility Products

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.

To manage the needs of the future network, there are a range of different products which we may require. We have outlined our emerging views on what these products could look like below. This is not designed to be an exhaustive list, as there may be other additional technologies which can meet our needs and new business models may emerge over the next few years.

<table>
<thead>
<tr>
<th>Reinforcement need</th>
<th>Our flexibility requirements</th>
<th>Flexibility products or services</th>
<th>Potential providers</th>
</tr>
</thead>
<tbody>
<tr>
<td>LV substation/ circuits reinforcement</td>
<td>Demand turn down or generation turn up at specific location</td>
<td>Smart EV charging tariffs, Commit to follow set load profiles, Payments to operate appliances in restricted hours, Generation turn up, Vehicle to grid flexibility services, Energy efficiency</td>
<td>Aggregated residential and commercial consumers with EVs, generation and/or battery storage, Small scale generation connected at LV (including community energy), Commercial storage developers</td>
</tr>
<tr>
<td>LV voltage management</td>
<td>Demand turn down or generation turn up at specific location (typically winter peak)</td>
<td>Smart EV charging tariffs, Demand turn up/down, Generation turn up/down, Vehicle to grid flexibility services, Reactive power</td>
<td>Aggregated residential and commercial consumers with EVs, generation or in-home storage, Small scale generation connected at LV (including community energy), Commercial storage developers</td>
</tr>
<tr>
<td>LV losses</td>
<td>Generally demand turn down or generation turn up at specific locations</td>
<td>Similar to LV voltage management</td>
<td></td>
</tr>
</tbody>
</table>

Table 9: Future LV flexibility needs and products
Engaging the market for future flexibility products

The way we engage the market for LV flexibility services may need to be different from the core services we outline in Section 3. We want to ensure that we use competition to drive the lowest possible costs for our consumers, as we are doing for EHV and HV reinforcement needs. However, this may not be possible for some of our future LV flexibility services due to the following factors:

- **Highly locational nature of the market:** Our LV reinforcement needs will be highly locational. This means that the total market size for potential flexibility providers may be limited to a few consumers in urban areas and even fewer in rural areas. There is a question on whether there will be sufficient participants (or liquidity) at this local level to run open market tenders for flexibility services.

- **The unpredictability of need:** At LV, the sudden clustering of a handful of EVs or heat pumps can drive reinforcement of a previously moderately loaded asset. As highlighted above, this makes it difficult to predict where reinforcement needs will emerge at an LV level. The time we have to proactively respond to emerging network developments at LV is far less than for primary substations where there is a clearer line of sight of load growth. Our experience to date has been that an open tender process can take multiple months from start to finish.

- **Higher volumes/lower value:** The cost of reinforcement of a single LV substation is far lower than a primary substation. This means that the value of individual flexibility services will be lower – albeit that there could be high volumes required (depending on how DER take-up drives reinforcement needs). There are obviously costs involved in participating and running a tender process and it may not be efficient to do this for individual LV assets.

These factors mean that we may need to consider how a more administered price approach could work for LV flexibility (at least initially). While this will not be able to use markets to discover the most efficient costs of flexibility, it can still act as a lower cost alternative to reinforcement in some cases.

There are a number of options on how an administered price could work. We have set out some initial thoughts on these below.

### Postage Stamp
A single, static payment for utilisation across all our networks.

### Location price
A utilisation payment which varies depending on the value of the individual asset and the cost to reinforce. This price could be communicated to market participant as needs arise.

### Locational zones
A utilisation payment which varies per LV zone.

### Dynamic prices
A dynamic utilisation payment which can vary by time of day or season.

For LV reinforcement, the time window available to find a solution is likely to be weeks rather than months, requiring us to refine our approach to market engagement.
We are also conscious that Ofgem is currently undertaking a review of network access and forward looking charging. This work has the potential to introduce new, more granular price signals to LV customers that reflect some of the value of flexibility. This could allow consumers to see the value of flexibility within their network charges, without the need to contract through a flexibility provider for specific services. Such reform still appear a few years away from implementation. Consequently, we are continuing to plan on the basis that LV flexibility will need to be contracted for outside of network charging arrangements.

There are some important trade-offs when considering these types of options for LV flexibility products:

- **Cost reflectiveness and simplicity for flexibility providers:** Providers of flexibility want to be rewarded for the actual value of their actions. However, they also need to have a product which is simple to understand and where the value to them is clear.

- **Efficiency of procurement and certainty for flexibility providers:** We want to procure flexibility at the lowest cost we can in order to reduce bills for our customers. This would suit a product which only paid for LV flexibility when needed (utilisation only). However, we are conscious that flexibility providers need to ‘sign up’ customers and show them the flexibility value. Therefore, we will need to ensure that the utilisation only products provides sufficient certainty for flexibility providers to make it attractive.

As we look to expand out use of flexibility through the three core use cases in Section 3, we want to ensure that the policies, processes and procedures we embed into our business can be easily adapted to cover our future flexibility needs. This will allow us to bring these new products to market quickly. Section 5 outlines the steps we will be taking to do this, alongside implementation of our core use cases.
4.0 Future DSO System Needs

4.2 Whole System Products

A whole system co-ordination of flexibility needs and procurement will be crucial as the energy system becomes more integrated and interdependent. We plan to work with the ETSO and other network operators to jointly develop and procure flexibility in the future.

DER contracted for flexibility will play a key role in the safety and reliability of the distribution network. At the same time, we acknowledge that the change in the load of contracted DER may have an impact on the wider system. Hence, we are exploring through ongoing work at the ENA to capture the benefits of coordination between the DSOs and ETSO.

Through the Power Potential project we are already working with National Grid to trial how DER on our network can help National Grid resolve constraints on the Transmission network21.

<table>
<thead>
<tr>
<th>Reinforcement need</th>
<th>Our flexibility requirements</th>
<th>Role of flexibility</th>
<th>Flexibility products or services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactive power constraints at Distribution and Transmission (whole system services)</td>
<td>Delivery of reactive and active power at specific network locations</td>
<td>Availability and Utilisation (purchased day ahead)</td>
<td>LV and HV connected generators and storage providers (&gt;100kW)</td>
</tr>
</tbody>
</table>

4.3 Demand Turn-up

As discussed in Section 3, all of the Core flexibility products we intend to procure in the short-term require providers to reduce the active load on the network, whether by reducing their consumption or increasing their export onto the network. In the future, it may be necessary for us to procure demand turn-up services, which would involve participants either increasing their demand or reducing their output.

This behaviour is already seen in the case of generation customers under Flexible Connections. These generators have connected in a constrained region of the distribution network. Rather than contributing to the cost of reinforcement, they have instead opted to accept a degree of curtailment during periods of constraints.

UK Power Networks have already begun to investigate ways to manage this curtailment more efficiently, creating a form of flexibility market that would allow generators to trade their curtailment obligations with each other. This market could also involve storage assets and demand turn-up providers, increasing efficiency further and avoiding the need to curtail often low-carbon forms of generation. We are looking to trial such an approach in the near future.

In the short-term, such Flexible Connection markets will be targeted at specific constraints, and will be for the benefit of customers with Flexible Connection agreements. UK Power Network’s role will be to facilitate such markets, but we would not be the beneficiary of the flexibility services.

In the longer-term, however, we anticipate that there may be a value in developing a demand turn-up service to be used for our own purposes as shown below.

Whilst we do not intend to develop a specific demand turn-up product in the short-term, we expect that our development of flexibility markets for Flexible Connection customers will provide a solid foundation if and when such a product is required.

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1. There are instances in which networks reach their export limits without there being an identified connecting party causing the constraint. For example, reduced demand (whether through demand efficiencies or the closure of a large consumption site) can introduce an export constraint. In this case, the DSO is responsible for funding any reinforcement.

2. Under current charging arrangements, the connecting customer is responsible either for funding the reinforcement of the local network (up to one voltage level above the Point of Connection) or accepting the risk of curtailment under a Flexible Connection. However, where the connection has an impact further upstream, it may be beneficial for the DSO to procure demand turn-up rather than incurring the cost of reinforcement.

3. There is a possibility that connection charging will move to ‘shallower’ charging arrangements, which would place more of the reinforcement costs on the DSO and Distribution Use of System (DUoS) customers. Ofgem is consulting on such an option in its Access and Charging review.22

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5.0 Maximising DER Participation

In this section, we describe how we propose to maximise DER participation. We then set our key areas of focus for 2018 and 2019. Finally, we set out our timings for our key flexibility commitments.
5.0 Maximising DER Participation

We recognise the importance of giving DER visibility of our needs and putting in place the tools and processes that will allow us to work efficiently with high volumes of DER assets on a frequent basis. Flexibility platforms are the obvious vehicles for DSOs to maximise participation of DER, through greater transparency of needs and ease of contracting.

There is a large amount of innovation in the areas of emerging flexibility platforms, optimisation tools, and network management software. We have pioneered this space by working with the Piclo Flex platform to allow DER assets to register their interest in providing flexibility services. Also, we are working closely with our stakeholders and new entrant technology companies to be at the forefront of this innovation. This is allowing us to contribute to the development of technology solutions that meet our needs and the needs of our customers. This innovation is critical to us delivering on our DSO vision of the future.

We see platforms as the long-term solution to run and settle tenders and shorter-term markets. The dispatch of DER flexibility may also involve proprietary control software, which may ultimately be integrated into the flexibility platforms, or vice versa.

We have had detailed conversation and feedback from stakeholders on what actions can maximise DER participation in flexibility markets. This feedback was received through our Future Smart consultation, our 2017 Flexibility Tender, and in preparing our Flexibility Roadmap. Overall, our stakeholders supported our objectives and approach to facilitate increased DER participation.

The key areas we have identified in our Flexibility Roadmap are:

- **Visibility of market opportunities for DER**
  - Publish heat maps showing areas of potential flexibility needs across our networks.
  - Enable all DER, both existing and new, to register on a flexibility platform, providing details of their location and technical characteristics.
  - Enable all interested DER to enter into framework contracts with UK Power Networks, agreeing as many of the common contracting and product principles as possible, thus making participation in future procurement events as easy as possible.

- **Enhanced Processes**
  - Integrate flexibility solutions into our network planning processes so that our planning and network management teams have visibility of available flexibility in areas where they are considering network reinforcement and other works programmes.
  - Employ a common framework contract for all flexibility products in line with the terms used in our 2017 tender.
  - Notify DER through a platform as and when market opportunities for flexibility emerge. In the longer term, we will seek to contract and settle DER through a platform.

- **Fairness and Transparency**
  - Establish clear and transparent protocols for appraising flexibility. We will make tender information publicly available, where it is commercially appropriate to do so.
  - Get independent assurance of our internal procurement methodology and outcomes – this will be undertaken in 2019 with respect to the latest round of tenders we run and occur annually thereafter.
### Figure 9: Flexibility Timeline

<table>
<thead>
<tr>
<th>2018</th>
<th></th>
<th>2019</th>
<th></th>
<th>2020</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Q3</td>
<td>Q4</td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
<td>Q4</td>
</tr>
<tr>
<td><strong>Events and publications</strong></td>
<td><strong>Roadmap launch event</strong></td>
<td><strong>Spring forum</strong></td>
<td><strong>Autumn forum</strong></td>
<td><strong>Spring forum</strong></td>
<td><strong>Autumn forum</strong></td>
</tr>
<tr>
<td>Publish roadmap</td>
<td>Roadmap consultation closes</td>
<td>Successful bidders notified</td>
<td>Publish sites for flexibility</td>
<td>Successful bidders notified</td>
<td>Publish sites for flexibility</td>
</tr>
<tr>
<td><strong>6 month ahead tender</strong></td>
<td><strong>Dec 18</strong></td>
<td><strong>Spring forum</strong></td>
<td><strong>Autumn forum</strong></td>
<td><strong>Spring forum</strong></td>
<td><strong>Autumn forum</strong></td>
</tr>
<tr>
<td>Publish sites for flexibility</td>
<td><strong>Expression of interest (EOI) for 2019/20 and 2020/21</strong></td>
<td><strong>Successful bidders notified</strong></td>
<td><strong>Utilising contracted DER on flexibility platform</strong></td>
<td><strong>Successful bidders notified</strong></td>
<td><strong>Utilising contracted DER on flexibility platform</strong></td>
</tr>
<tr>
<td><strong>18 month ahead tender</strong></td>
<td><strong>Dec 18</strong></td>
<td><strong>Spring forum</strong></td>
<td><strong>Autumn forum</strong></td>
<td><strong>Spring forum</strong></td>
<td><strong>Autumn forum</strong></td>
</tr>
<tr>
<td>Publish sites for flexibility</td>
<td><strong>Expression of interest (EOI) for 2020/21 and 2021/22</strong></td>
<td><strong>Successful bidders notified</strong></td>
<td><strong>Utilising contracted DER on flexibility platform</strong></td>
<td><strong>Successful bidders notified</strong></td>
<td><strong>Utilising contracted DER on flexibility platform</strong></td>
</tr>
<tr>
<td><strong>Short-term contracting</strong></td>
<td><strong>Dec 18</strong></td>
<td><strong>Spring forum</strong></td>
<td><strong>Autumn forum</strong></td>
<td><strong>Spring forum</strong></td>
<td><strong>Autumn forum</strong></td>
</tr>
<tr>
<td>Publish sites for flexibility</td>
<td><strong>Invitation to Tender (ITT), Mar 19 Tender, delivery from 2019/20</strong></td>
<td><strong>Successful bidders notified</strong></td>
<td><strong>Utilising contracted DER on flexibility platform</strong></td>
<td><strong>Successful bidders notified</strong></td>
<td><strong>Utilising contracted DER on flexibility platform</strong></td>
</tr>
<tr>
<td><strong>Market processes</strong></td>
<td><strong>Invitation to Tender (ITT), Mar 19 Tender, delivery from 2020/21</strong></td>
<td><strong>Successful bidders notified</strong></td>
<td><strong>Utilising contracted DER on flexibility platform</strong></td>
<td><strong>Successful bidders notified</strong></td>
<td><strong>Utilising contracted DER on flexibility platform</strong></td>
</tr>
<tr>
<td><strong>Develop framework contracts</strong></td>
<td><strong>Make contracted DER registers on flexibility platform</strong></td>
<td><strong>Consult on transparent processes</strong></td>
<td><strong>Independent assurance of internal procurement methodology and outcomes</strong></td>
<td><strong>Independent assurance</strong></td>
<td><strong>Independent assurance</strong></td>
</tr>
<tr>
<td><strong>Transparency</strong></td>
<td><strong>Design clear and transparent protocols</strong></td>
<td><strong>Independent assurance of internal procurement methodology and outcomes</strong></td>
<td><strong>Independent assurance of internal procurement methodology and outcomes</strong></td>
<td><strong>Independent assurance of internal procurement methodology and outcomes</strong></td>
<td><strong>Independent assurance of internal procurement methodology and outcomes</strong></td>
</tr>
<tr>
<td><strong>Market development</strong></td>
<td><strong>Review roadmap responses on LV flexibility products</strong></td>
<td><strong>Consult on transparent processes</strong></td>
<td><strong>Independent assurance of internal procurement methodology and outcomes</strong></td>
<td><strong>Independent assurance of internal procurement methodology and outcomes</strong></td>
<td><strong>Independent assurance of internal procurement methodology and outcomes</strong></td>
</tr>
<tr>
<td><strong>On-going Electric Vehicle and Low-Voltage Flexibility Management project</strong></td>
<td><strong>Development of transparent protocols</strong></td>
<td><strong>Consult on transparent processes</strong></td>
<td><strong>Independent assurance of internal procurement methodology and outcomes</strong></td>
<td><strong>Independent assurance of internal procurement methodology and outcomes</strong></td>
<td><strong>Independent assurance of internal procurement methodology and outcomes</strong></td>
</tr>
<tr>
<td><strong>Market trials of LV flexibility</strong></td>
<td><strong>Review of tender processes</strong></td>
<td><strong>Independent assurance of internal procurement methodology and outcomes</strong></td>
<td><strong>Independent assurance of internal procurement methodology and outcomes</strong></td>
<td><strong>Independent assurance of internal procurement methodology and outcomes</strong></td>
<td><strong>Independent assurance of internal procurement methodology and outcomes</strong></td>
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</tbody>
</table>
6.0 Future Engagement

In this section, we describe how we will engage with stakeholders and ask for feedback on this document.
6.1 Continuous Engagement

We want this document to be the beginning of an enduring engagement with our stakeholders. We recognise that as this is a rapidly evolving market, all parties will benefit from transparency and engagement.

To support this transparency and engagement, in our role as a neutral market facilitator, we propose to:

**Hold a Flexibility Roadmap launch event:**
The purpose of this event is to disseminate information, describe our Flexibility Roadmap, facilitate open debate and to get industry feedback on our Flexibility Roadmap. Our Flexibility Roadmap launch event will be held in October 2018.

**Set-up a bi-annual DSO Flexibility Forum:**
The input from stakeholders will help shape the longer term development of DSO flexibility services. We plan an Autumn Forum to coincide with when we publish our flexibility needs (in the expression of interest) and a Spring Forum to feedback to stakeholder the results of the tender process.

**Request feedback from all interested stakeholders on this document:**
We will summarise this feedback in a follow-on document to be published in Q4 2018.
6.2 Feedback on Document

We are keen to get your feedback on our Flexibility Roadmap. Below is a set of questions to support the feedback process.

1. Has the Flexibility Roadmap improved your understanding of our flexibility needs?
   - [ ] Strongly Agree  [ ] Agree  [ ] Neutral  [ ] Disagree  [ ] Strongly Disagree

2. Has the Flexibility Roadmap increased the likelihood of you participating in future tenders?
   - [ ] Strongly Agree  [ ] Agree  [ ] Neutral  [ ] Disagree  [ ] Strongly Disagree

3. What additional areas do we need to consider, or areas we need to clarify, to maximise participation?

4. Do you agree with our proposed ways of working with DER?
   - [ ] Strongly Agree  [ ] Agree  [ ] Neutral  [ ] Disagree  [ ] Strongly Disagree

5. Please provide feedback, proposed improvements or clarifications on:
   - A. The proposed Core Flexibility Product Structures
   - B. The proposed Common Product Principles
   - C. The proposed Contracting Principles

6. Please provide feedback on our future low voltage flexibility products:
   - A. The administered pricing options being considered
   - B. Alternative approaches to enabling flexibility on low voltage networks

7. Do the Flexibility Roadmap timelines sufficiently progress our DSO strategy and in the right direction?
   - [ ] Strongly Agree  [ ] Agree  [ ] Neutral  [ ] Disagree  [ ] Strongly Disagree

We are keen to get your feedback on these questions and any other feedback you may have using the form at [http://futuresmart.ukpowernetworks.co.uk](http://futuresmart.ukpowernetworks.co.uk), and emailing us your response to flexibility@ukpowernetworks.co.uk by 8th October 2018.
Appendices
## Appendix A
### Glossary of Terms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANM</td>
<td>Active Network Management</td>
</tr>
<tr>
<td>CI</td>
<td>Customer Interruption (the number of customer interruptions per 100 customers)</td>
</tr>
<tr>
<td>CML</td>
<td>Customer Minutes Lost</td>
</tr>
<tr>
<td>DER</td>
<td>Distributed Energy Resource</td>
</tr>
<tr>
<td>DG</td>
<td>Distributed Generation</td>
</tr>
<tr>
<td>DNO</td>
<td>Distribution Network Operator</td>
</tr>
<tr>
<td>DSO</td>
<td>Distribution System Operator</td>
</tr>
<tr>
<td>DUoS</td>
<td>Distribution Use of System</td>
</tr>
<tr>
<td>ED1</td>
<td>RIIO-ED1</td>
</tr>
<tr>
<td>EHV</td>
<td>Extra High Voltage</td>
</tr>
<tr>
<td>ENA</td>
<td>Energy Networks Association</td>
</tr>
<tr>
<td>EPN</td>
<td>Eastern Power Network</td>
</tr>
<tr>
<td>ETSO</td>
<td>Electricity Transmission System Operator</td>
</tr>
<tr>
<td>EV</td>
<td>Electric Vehicle</td>
</tr>
<tr>
<td>HV</td>
<td>High Voltage</td>
</tr>
<tr>
<td>IIS</td>
<td>Interruption Incentive Scheme</td>
</tr>
<tr>
<td>KASM</td>
<td>Kent Active System Management</td>
</tr>
<tr>
<td>LPN</td>
<td>London Power Network</td>
</tr>
<tr>
<td>LRR</td>
<td>Load Related Reinforcement</td>
</tr>
<tr>
<td>LTDS</td>
<td>Long Term Development Statement</td>
</tr>
<tr>
<td>LV</td>
<td>Low Voltage</td>
</tr>
<tr>
<td>RIIO-ED1</td>
<td>Revenue = Incentives + Innovation + Outputs, Electricity Distribution (price control)</td>
</tr>
<tr>
<td>SPN</td>
<td>South Eastern Power Network</td>
</tr>
</tbody>
</table>
Appendix B
Innovation Projects

In anticipation of this changing energy landscape we have worked with our customers, fellow Network Operators, technology providers and Ofgem continuously over the past decade on a range of discussions, studies, trials and real-world projects investigating the use of flexibility on our networks.

Through these projects, and learning from other network companies, we have developed a greater understanding of the needs of our network, and tested how flexibility can be efficiently used to meet these needs to achieve better outcomes for our customers. These innovation projects therefore underpin much of the thinking laid out in this Flexibility Roadmap.

The trials have built upon each other’s learnings, over time.

- **Network Visibility**: We started by gaining greater visibility of our network (through Distribution Network Visibility project and the early stages of Low Carbon London).
- **Consumer flexibility**: We went on to investigate whether customers would respond to price signals to provide flexibility. More recently, our work on smart EV charging is seeking to understand systems required to support the market procurement of flexibility from EVs.
- **Flexible Generation**: Our Flexible Plug and Play project introduced flexible connection arrangements for generators to help avoid network reinforcement. We have been trialling the use of more market-based mechanisms in the market based flexible DG project.
- **Vulnerable Customers**: Our Energywise project is seeking to understand the opportunities for fuel poor to help reduce their bills.

![Figure 10: The path to Flexibility Services](image-url)