Review of Scottish Power Energy Networks' uptake of flexibility services

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Contents

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Executive summary

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This report summarises the work that Scottish Power Energy Networks (SPEN) has commissioned Oxera to undertake in relation to the uptake of flexibility services in both of its regions. The purpose of this project is to understand the barriers that Flexibility Service Providers (FSPs) and domestic customers face when participating in distribution network operator (DNO) flexibility markets, and to provide recommendations in relation to the relative priorities of such barriers and how these may be overcome.

DNOs have a licence obligation under Condition 31E,[1] which describes when they can procure flexibility services. They are also incentivised to procure them under the Interruptions Incentive Scheme (IIS), which increases DNO revenues if the DNO reduces customer interruptions below a target level and reduces revenues if the customer interruptions target is exceeded.

Besides the small scale of the market relative to the wholesale and ESO markets, the DNO flexibility market (henceforth 'the DNO market' or 'the market') is fundamentally a locational and an inter-temporally transient market.

First, as regards the transience of the market: DNOs seek to procure flexible generation or demand in constraint locations) where they expect there may be grid constraints. Once a flexibility solution can no longer be used to defer reinforcement expenditure, the network will be upgraded, meaning that the market for the solution will disappear.

Second, the locational nature of the market means that DNOs that operate in areas where constraint locations have fewer flexible assets are likely to procure less flexibility. The pattern of auction results largely seems to support this, with WPD and UKPN both tendering for and contracting the largest capacities of flexibility, and also being located in the regions that have the largest numbers of electric vehicles (EVs).

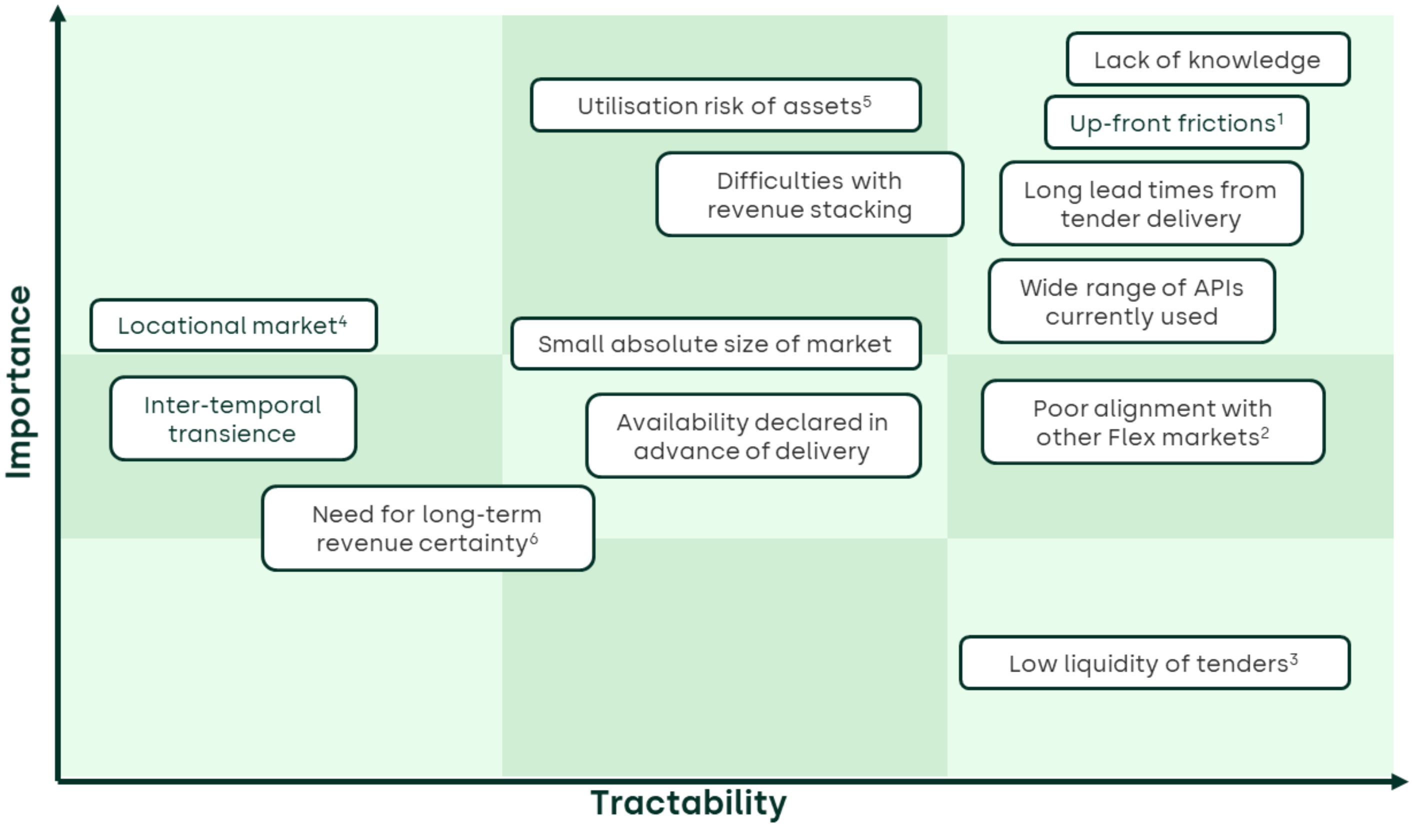
These fundamental characteristics of the DNO market are important because any solution to address barriers to uptake needs to respect these characteristics. Specifically, solutions should not unnecessarily encourage DNOs to procure flexibility in locations where it is unfeasible or disproportionately expensive to do so. Accordingly, in our review, we have first identified the barriers that FSPs and domestic customers face, then assessed which ones are the most tractable before focusing on developing solutions to overcome these.

In total, we have identified 19 barriers that FSPs and domestic customers face: 13 for FSPs and 6 for domestic customers. We have then outlined four main areas where we consider that SPEN, the DNO industry, and policymakers—i.e. Ofgem and the Department for Energy Security and Net Zero (DESNZ)—can focus their efforts to increase the numbers of FSPs bidding and then contracting with DNOs.

[1] Ofgem (2021), 'Electricity Distribution Standard Licence Condition 31E: Flexibility Procurement Statements 2021', available here, accessed on 30 March 2023.

The figure below shows how we have mapped the 13 barriers that we identified for FSPs in accordance with their importance and tractability. The barriers in the top-right corner of the figure are those that are likely to be of highest priority. This is because removing them is likely to be easier than removing the others (they score high on the tractability dimension—i.e. how easy we think it might be to find a solution to them), and we hypothesise that their removal can have a big impact on the uptake of flexibility services (they score high on the importance dimension). We discuss these barriers in detail in section 3.

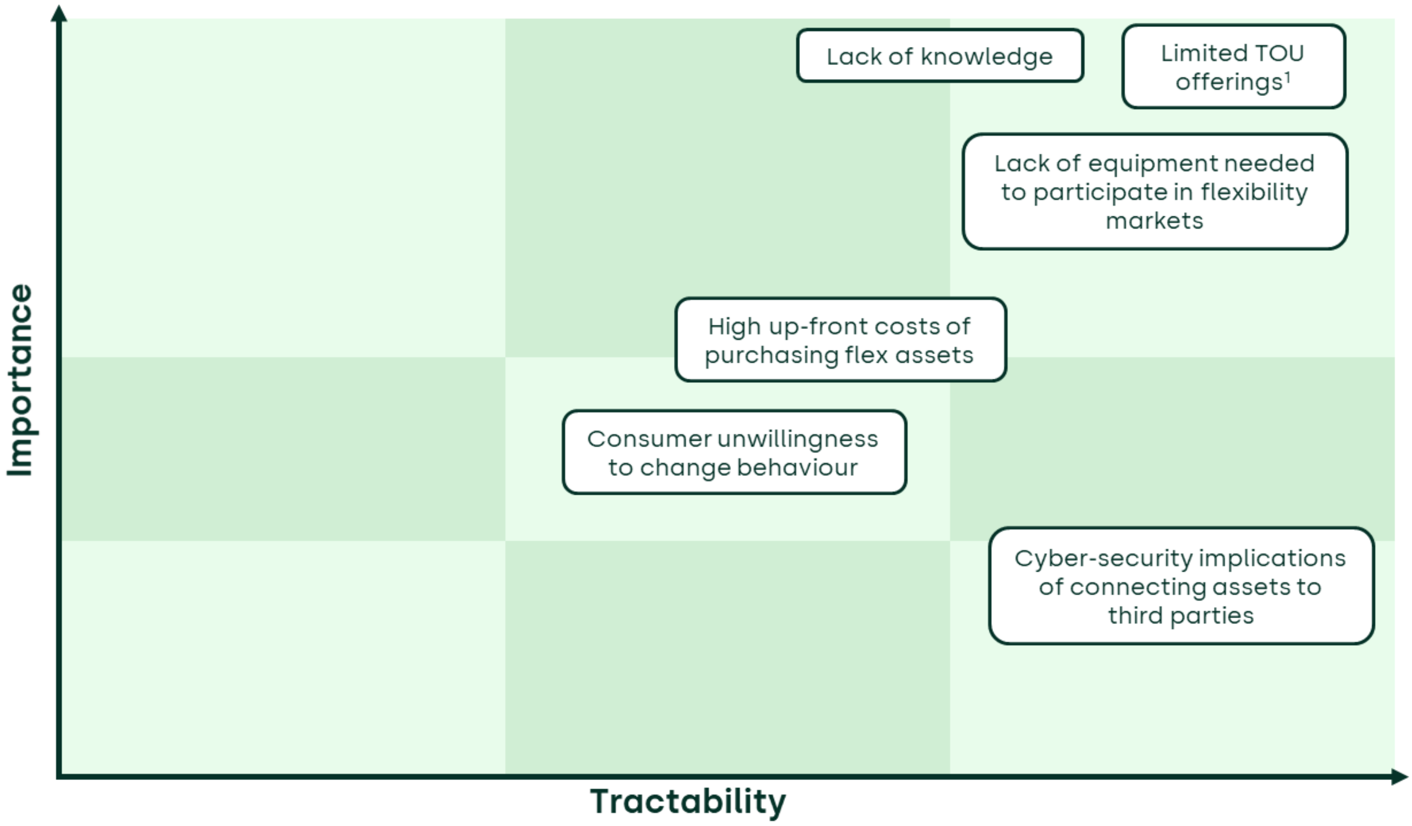
Stylised categorisation of barriers for FSPs, by importance and tractability



Note: [1] By 'up-front frictions' we mean issues such as the pre-qualification process that FSPs have to undertake and the fact that contracts can be long and complicated. We explain this in further detail in section 3.2. [2] These 'other' flex markets cover ESO, Wholesale and other DNO markets. [3] Low liquidity of tenders means that historical tender data may be inappropriate for future forecasting. [4] Due to the nature of the flexibility market, assets have to be located in a specific geographical location.
[5] Utilisation risk of assets means that committed assets may not be dispatched.
[6] Revenue certainty can be provided for small number of years but likely not for long (10+ years) periods of time, which may be a requirement for CAPEX-intensive technologies. This is due to the fact that, in the long term, networks are likely to be reinforced, thereby decreasing the need for local flexibility.
Source: Oxera.

The figure below shows how we have mapped the six barriers that we have identified for domestic customers in accordance with their importance and tractability. As with the figure above, the barriers in the top-right corner are those that are likely to be of highest priority: removing them is likely to be easier than removing the others and we hypothesise that their removal can have a big impact on the uptake of flexibility services. We discuss these barriers in detail in section 4.

Stylised categorisation of barriers for domestic customers, by importance and tractability



Note: [1] TOU stands for Time of Use and refers to a type of energy tariff where consumers face more than one price depending on the time of day.

Source: Oxera.

Having mapped the barriers, we then identified four different groups of solutions that stakeholders in DNO flexibility could focus on to reduce barriers to uptake of flexibility services. The figure below shows which barriers we consider each group of solutions would address. The dark green boxes list the groups of solutions, the light green boxes list the barriers faced by FSPs, and the blue boxes list the barriers faced by consumers.

Solution groups and the barriers they address

Reducing barriers to entry	Better integration between DNO and wholesale/ESO market	Adjustments to DNO flexibility architecture	Encouraging take-up of flexible assets
Utilisation risk of assets[1]	Difficulties with revenue stacking	Utilisation risk of assets[1]	Limited TOU offerings
Up-front frictions[2]	Up-front frictions[2]	Need for long-term (10+ years) revenue certainty[3]	High up-front costs of purchasing flex assets
Poor alignment with other Flex markets[4]	Poor alignment with other Flex markets[4]	Difficulties with revenue stacking	Consumer unwillingness to change behaviour
Wide range of APIs currently used	Wide range of APIs currently used	Long lead times from tender to delivery	Consumers lack the right equipment
Lack of knowledge		Availability declared in advance of delivery	Lack of knowledge
Concerns over data security/privacy			
Low liquidity of tenders[5]			

Note: Dark green shading represents solution groups; light green shading indicates barriers faced by FSPs; blue shading indicates barriers faced by domestic customers. The barrier 'inter-temporal nature of the market' is not included in this figure because it is a fundamental characteristic of the flexibility market that we do not think can be resolved. [1] Utilisation risk of assets means that committed assets may not be dispatched. [2] By 'up-front frictions' we mean issues such as the pre-qualification process that FSPs have to undertake and the fact that contracts are long and complicated. We explain this in further detail in section 3.1. [3] Revenue certainty can be provided for a small number of years but not for long (10+ years) periods of time, which may be a requirement for CAPEX-intensive technologies. This is due to the fact that, in the long term, networks may be reinforced, thereby decreasing the need for local flexibility. [4] Flex markets include ESO, Wholesale and DNO markets. [5] Low liquidity of tenders means that historical tender data may be inappropriate for future forecasting.
Source: Oxera.

In the figure above, note that we have not highlighted the barriers that have been identified as fundamental characteristics of the market—i.e. the small size of the DNO flexibility market relative to ESO and wholesale markets, the inter-temporal transience of the market, and the locational nature of the market. This is because:

- the size of the DNO flexibility market will increase over time, but always tend to remain smaller than ESO and wholesale markets;
- the inter-temporal transience of the provision of flexibility services to DNO markets is unlikely to change with the scale of the market;
- the locational nature of the market will tend to become less of a barrier as end-consumers within the constraint locations purchase more smart assets—however, the extent of flexibility that is feasible within different zones will always vary with sparsity and urbanity.

Thereby, the solutions that we consider in this report respect these fundamental characteristics.[2]

These four groups, listed in order of importance, are as follows.

Reducing administrative and procedural barriers to entry consists of standardising processes related to pre-qualification, contracting, and use of APIs (application programming interfaces) across all DNOs. It also covers making data on historical prices and utilisation rates (of FSP assets), as well as future utilisation rates and ceiling prices (or guide prices) for tenders, freely available from a single location.

Standardisation should reduce the 'transaction costs' that FSPs currently face when entering DNO markets. These transaction costs may have outsized effects on participation because the small size of the DNO market may mean that these transaction costs are perceived to outweigh the benefits of entering the market.

The provision of open data should make it easier for FSPs to assess opportunities from entering DNO markets. This should improve the transparency of DNO markets, reduce uncertainties that FSPs have about the size of the opportunity, and therefore increase participation rates.

Better integration between DNO and wholesale/ESO markets[3] includes extending the standardisation discussed above to also cover the wholesale and electricity system operator (ESO)[4] markets, as well as improving the DNO–ESO coordination on flexibility to allow for more revenue stacking, where feasible and desirable.

Extending standardisation to cover ESO markets should help increase tender participation rates because most FSPs are likely to see the wholesale and ESO markets as their primary sources of revenue. These FSPs will therefore already have submitted pre-qualification data to the ESO, set up the APIs required for integration with the ESO's

[2] We also note that two of the barriers that are fundamental characteristics of the market, specifically the locational nature and small size of the market, should be reduced by the growth of the DNO flexibility market over time.
[3] We distinguish between wholesale and ESO markets as follows. Wholesale markets are defined as covering any transactions that occur in futures/forward markets, the day ahead market, and the intra-day market. ESO markets cover the balancing market and all of the various Ancillary Services used by the ESO.
[4] We note that Ofgem and BEIS (now DESNZ) have been jointly consulting on the role of a future system operator (FSO). The FSO would take a more active role in managing not just the electricity network but also the gas network as well as potentially other parts of the energy supply chain. However, as the role of the FSO has not yet been defined, we refer to the procurement of flexibility services by the ESO throughout this report. BEIS and Ofgem (2022), 'Future System Operator: Government and Ofgem's response to consultation', available here, accessed on 30 March 2023.

systems, and be otherwise heavily integrated with the ESO. The aim of extending standardisation to cover the ESO is, among others, to allow for the submissions made by FSPs to the ESO to be automatically visible (if the FSP consents) by the DNOs and for any contracts signed with the ESO to be the same or similar to those that DNOs would expect to be signed. The effect of this would be a removal of, or at least a material reduction in, the amount of incremental engagement that is needed by FSPs when participating in DNO markets.

Improving ESO–DNO coordination on flexibility needs to be done carefully. There are two elements to this. The first is that revenue-stacking opportunities are likely to increase if balance responsible party (BRP)[5] imbalances are automatically adjusted to take account of deviations in their final physical positions due to DNO flexibility services. This would reduce the costs that BRPs have to incur (and potentially pass onto FSPs) as a result of DNO flexibility actions, thereby reducing the costs of participation in DNO flexibility markets to FSPs. The second is that the introduction of clear primacy rules, alongside any digital infrastructure that is needed to facilitate them (i.e. to allow the DNOs and ESO to communicate with each other) is likely to improve the DNOs' and ESO's confidence in using flexibility. This may in turn increase their willingness to tender for flexibility, or increase the ceiling prices that they are willing to pay for it.

Adjusting the DNO flexibility architecture covers providing a range of tenders with different time horizons and providing more clarity on the length of availability windows where possible.

We expect that adjusting the time horizons of tenders will increase FSP participation because some FSPs are better-suited to bidding into longer-term tenders, while others (largely those with planned assets[6]) are better-suited to bidding into shorter-term tenders. By providing a range of tender time horizons, some FSPs that currently do not participate in the market may enter the tender that is more suited to them. Similarly, FSPs with planned assets that already participate in the market will be able to increase participation because they will be able to top up their longer-term bids (which may be conservative due to the difficulty of forecasting asset availability long into the future) with shorter-term bids when they have better visibility of their future asset pipeline. When implementing this solution, however, care should be taken to ensure that the number of time frames for tenders does not increase unnecessarily, as there is a risk that this could make participation in the market more complicated, and that some tender time frames would end up being under-subscribed. We therefore suggest that, initially, DNOs experiment with only two different time frames.

Providing more clarity on the length of availability windows refers to DNOs either reducing the length of availability windows or providing

[5] The BRP is the party that is responsible for maintaining the balance of supply and demand for electricity of all generation and demand assets included in its portfolio.
[6] Planned assets refer to assets that are not yet available to FSPs. These could refer to generators or storage units that are not yet constructed but typically refer to EVs that Aggregators have not yet contracted with (because end-customers have not yet purchased them, or have purchased them but not contracted with an Aggregator).

FSPs with more clarity on the extent to which they will need to be available during the entirety of a tendered availability window.[7] Either of these actions should increase FSP participation in DNO markets because they either increase the amount of time that FSPs can spend competing in non-DNO markets, or provide more clarity to FSPs about when they can compete in non-DNO markets. Of course, it may not always be technically desirable or feasible from the networks' perspective to reduce availability windows, which is why we consider that this should only be done where possible.

Encouraging take-up of flexible assets is targeted at growing the total market for flexibility. This will make it easier for FSPs that are Aggregators to recruit more end-consumers in the locations where DNOs are tendering for flexibility. While the primary reason for encouraging the growth of the market in flexible assets is decarbonisation—the largest flexible assets are likely to be EVs, heat pumps, and behind-the-meter batteries—the benefits that making these assets smart can provide should also be recognised.

[7] In this report we distinguish between tendered availability windows, which are the availability windows that DNOs tender for, and actual availability windows which are the actual windows that FSPs have to commit to closer to real-time.

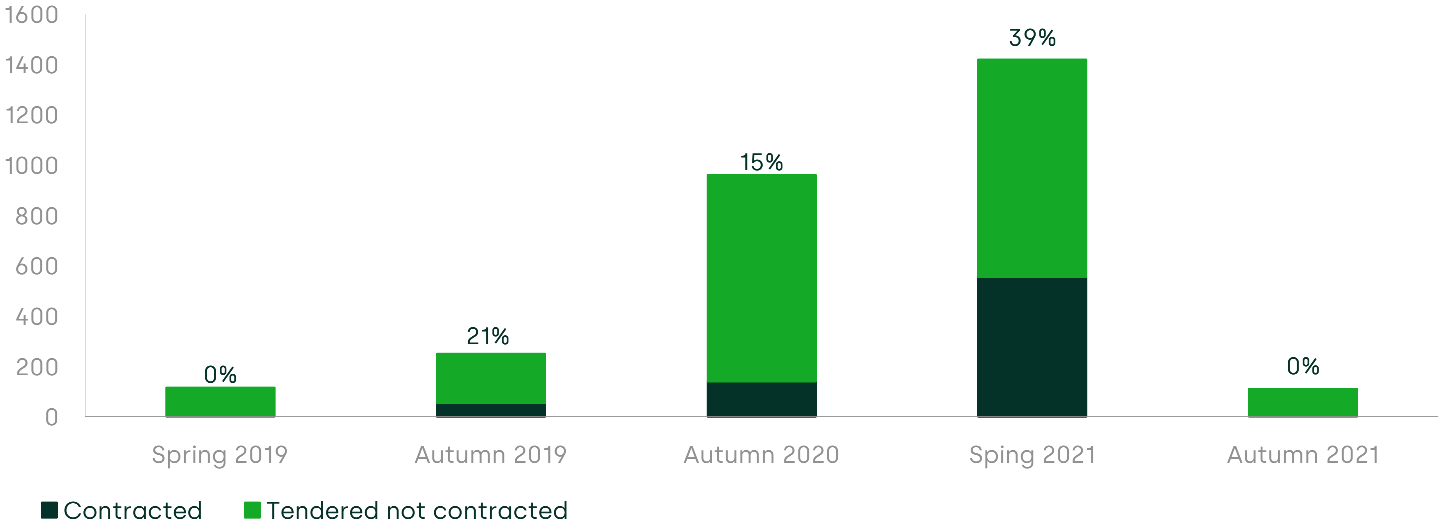
1 Introduction

Through the RIIO framework and licence condition under which DNOs are regulated, all DNOs are required to consider whether the procurement of flexibility can be undertaken in order to reduce the needs for network reinforcement.[8] To help achieve this aim, UK DNOs have gradually started tendering for flexibility services since 2018, with SPEN doing so since spring 2019.[9]

SPEN's success in securing the levels of flexibility that it requires has varied over time. Figure 1.1 shows that the total amounts of capacity tendered for have increased over time (except for autumn 2021, but this was a tender for top-up volumes to cover 2022–24). The proportion of successful bids has also broadly increased, but remained low at below 50% of required capacity.

In autumn 2021, SPEN tendered for 110MW of capacity but received only 220kW of bids, none of which it accepted.[10] We understand from SPEN that the reason for only receiving 220kW of bids was that FSPs were not in a position where they could recruit sufficient assets for FY2022/23 and FY 2023/24. For FY2023/24, FSPs could not offer more assets than had already been offered in previous tenders. .

Figure 1.1 Capacity tendered and MW awarded in each of SPEN's tenders from 2019 to 2021



Note: Percentages represent capacity contracted as a percentage of total capacity tendered.
Source: Scottish Power Energy Networks (2022), 'April 2022 – Procurement Report', p. 5, available here, accessed on 30 March 2023.

We understand from discussion with SPEN that due to the difficulties that SPEN experienced in getting sufficient, competent bids, and then converting these bids into contracts (particularly in the autumn 2021

[8] Ofgem (2022), 'RIIO-ED2 Final Determinations Overview document', para. 7.1, available here, accessed on 30 March 2023. Scottish Power Energy Networks (2022), 'April 2022 – Procurement Report', p. 5, available here, accessed on 30 March 2023.
[9] For more details, see the ENA website available here, accessed 30 March 2023.
[10] Scottish Power Energy Networks (2022), 'April 2022 – Procurement Report', p. 5, available here, accessed on 30 March 2023

tender),, SPEN has decided to postpone any further flexibility tenders until April 2023[11] and wants to understand why both the capacities bidding into flexibility tenders and then subsequently contracting with SPEN are lower than hoped for. In order to do this, SPEN has commissioned Oxera to identify the barriers that FSPs and domestic customers face in both SPEN regions when participating in flexibility markets, and the solutions that SPEN, the industry, and policymakers can consider in order to reduce these barriers.

In order to produce this report, we have conducted interviews with SPEN, different types of FSPs, and other stakeholders in the DNO market including Ofgem. We have reviewed a range of relevant literature in relation to the development of the DNO flexibility market, including reports that have been produced as part of the Open Networks Project undertaken by the Energy Networks Association (ENA) and Ofgem's recent Call for Input on the Future of Distributed Flexibility (henceforth 'Ofgem's Call for Input').[12]

The remainder of this report is structured as follows:

- section 2 contains information on the market background, explaining how DNOs including SPEN procure flexibility and how they are incentivised to do so under the current regulatory and licensing regimes;
- section 3 contains the barriers we have identified to the uptake of flexibility for FSPs;
- section 4 contains the barriers we have identified to the uptake of flexibility for domestic customers;
- section 5 contains the solutions that we consider could be introduced in order to alleviate the barriers discussed in sections 3 and 4.

It is important to note that the purpose of this report is to identify how barriers can be reduced for FSPs. Therefore, when discussing potential solutions, we focus on the benefits they have on FSP participation rather than consumer or social welfare. In the vast majority of cases, the two should be aligned, but the focus in this report is on the former rather than the latter.

[11] Scottish Power Energy Networks (2022), 'April 2022 – Procurement Report', p. 5, available here, accessed on 30 March 2023.
[12] Ofgem (2023), 'Call for Input: The Future of Distributed Flexibility', available here, accessed on 30 March 2023.

2 Market background

The purpose of this section is to set out how DNO flexibility markets work and who the main participants in these markets are. This forms the relevant market context for our analysis of barriers in the uptake of flexibility services. Specifically, this section explains:

- the different flexibility services procured by DNOs, including SPEN (section 2.1);
- the ways in which domestic customers can participate in flexibility markets (section 2.2);
- the different types of FSPs (section 2.3);
- the recent trends in the purchase of flexibility services by DNOs (section 2.4);
- how DNOs are incentivised to procure flexibility services (section 2.5).

2.1 Flexibility services procured by DNOs

This subsection explains the various flexibility services that are procured by UK-based DNOs.

Standard Licence Condition 31E explains the circumstances under which DNOs can procure flexibility, and the obligations that they have for reporting on the flexibility that they procure.[13] UK DNOs procure four main types of flexibility products: Sustain, Secure, Dynamic and Restore, all of which have standardised definitions given to them as part of the ENA's Open Networks project.[14] In practice, we understand from interviews with FSPs and SPEN that different DNOs use these products differently. This means that a given product is likely to have similar, but not identical, technical and commercial characteristics[15] when procured and implemented by different DNOs. This may arise from the fact that the definitions provided by the ENA are very broad, and do not specify the technical and commercial characteristics that each product should have.[16]

All four flexibility products are active power services, i.e. they increase or decrease the quantities of electricity on the network that are convertible into other forms of useable energy (after accounting for resistive losses). This contrasts with reactive power services, which are currently only tendered by SPEN,[17] the purpose of which is to

[13] Ofgem (2021), 'Electricity Distribution Standard Licence Condition 31E: Flexibility Procurement Statements 2021', available here, accessed on 30 March 2023.
[14] Energy Networks Association (2020), 'Open Networks 2020 Final Implementation Plan', p. 11, available here.
[15] Technical characteristics refer to parameters such as the minimum capacity required for a bid, response times, ramping times, etc. Commercial characteristics relate to whether an asset bidding into a particular tender for a particular DNO flex product can also participate in tenders for other products at the same time, the mix of availability and utilisation payments that are provided, penalties for non-delivery, etc.
[16] Energy Networks Association (2020), 'Open Networks 2020 Final Implementation Plan', p. 11, available here.
[17] For more details, see the SP Energy Networks website, available here, accessed on 30 March 2023.

maintain the voltage of the distribution system between certain bounds.

Flexibility products are primarily remunerated through either a combination of availability and utilisation payments or only utilisation payments.[18] Utilisation payments are paid per megawatt hour (MWh) and are only paid when a service is activated. Availability payments are paid per megawatt (MW) per period of time and are paid to compensate flexibility providers for the fact that they set aside their assets to be available for provision of DNO flexibility services in certain time windows.

While these four products may evolve over time, with various DNOs trialling alternative specifications (e.g. breaking down one of the four products into sub-products),[19] the DSO flexibility market is currently structured under the following four product names.[20]

- **Sustain**: this is a pre-fault, scheduled, constraint management service where the DNO procures, ahead of time, a scheduled change in generation or demand over a defined time period (i.e. some number of hours on a given set of days). We understand from SPEN that the precise time when this schedule is determined differs between DNOs, but in principle is intended to be established well in advance (potentially even at contracting stage).[21] The product is typically used to manage congestion on the network during times and in locations where excess demand can be reliably forecast. Due to the fact that the dispatch schedule is agreed in advance of the service being required (i.e. there is near-certainty about dispatch), it is typically remunerated exclusively through a utilisation fee, although UKPN remunerates this through an availability payment.[22]
- **Secure**: as with Sustain, this is a pre-fault constraint management service where the DNO procures, ahead of time, the ability to call upon an FSP to either increase or decrease its demand/generation based on network conditions. Unlike Sustain, the availability window for this product is scheduled closer to real-time, although we have observed one DNO declares the availability window a year in advance.[23] As there is no guarantee of activation, both an availability and utilisation payment is provided. Due to this, in all

[18] UKPN's Secure product is the only product that we are aware of which is remunerated through an availability payment, referred to as an (annual) service fee. UKPN (2022), 'Participation Guidance Winter 2022 Flexibility Tender', p. 7, available here. Piclo (2022), 'Piclo Flex UK Competitions', last downloaded on 22 March 2022, available here.
[19] Origami Energy (2021), 'Fusion-Transition Service Description Report, v6.0', available here, accessed on 30 March 2023.
[20] Energy Networks Association (2020), 'Open Networks 2020 Final Implementation Plan', p. 11, available here. See also the Flexible Power website, available here, accessed on 30 March 2023. Origami Energy (2021), 'Fusion-Transition Service Description Report, v6.0', pp. 9–10, available here, accessed on 30 March 2023. For more details, see the SP Energy Networks website, available here, accessed 30 March 2023.
[21] Energy Networks Association (2022), 'Active Power Products Review', p.10, available here.
[22] Piclo (2022), 'Piclo Flex UK Competitions', last downloaded on 30 March 2023, available here.
[23] Energy Networks Association (2022), 'Active Power Products Review', p.11, available here.

cases that we are aware of, this product is remunerated with both an availability and a utilisation fee.[24]

- **Dynamic**: this is a post-fault constraint management service where the DNO procures, ahead of time, the availability of an FSP to deliver a change in output following an unplanned network fault. This service is typically compensated either through a mixture of availability and utilisation payments, or utilisation payments only.[25]
- **Restore**: this is a restoration support management service where the DNO instructs an FSP to either draw no power from the network, to reconnect with lower demand, or to reconnect and supply generation to support increased and faster load restoration under depleted network conditions. Due to the fact that the probability and duration of utilisation is very low, DNOs only offer a utilisation payment for this service.[26] This payment is typically made at a premium to other products, and we understand from SPEN that this is because DNOs generally do not expect to use this service often, and can therefore afford to pay a relatively high price once utilised (for example, we understand from SPEN that in some cases it is willing to spend £1,000/MWh).

An important feature that is not necessarily standardised across the industry is that DNOs can choose when assets need to declare their availability. In our FSP interviews, we heard that these declarations need to be made one week in advance, and we note that this is the approach that is taken by the Flexible Power platform[27] used by SSE, SPEN, NPg, and WPD for dispatch and settlement.

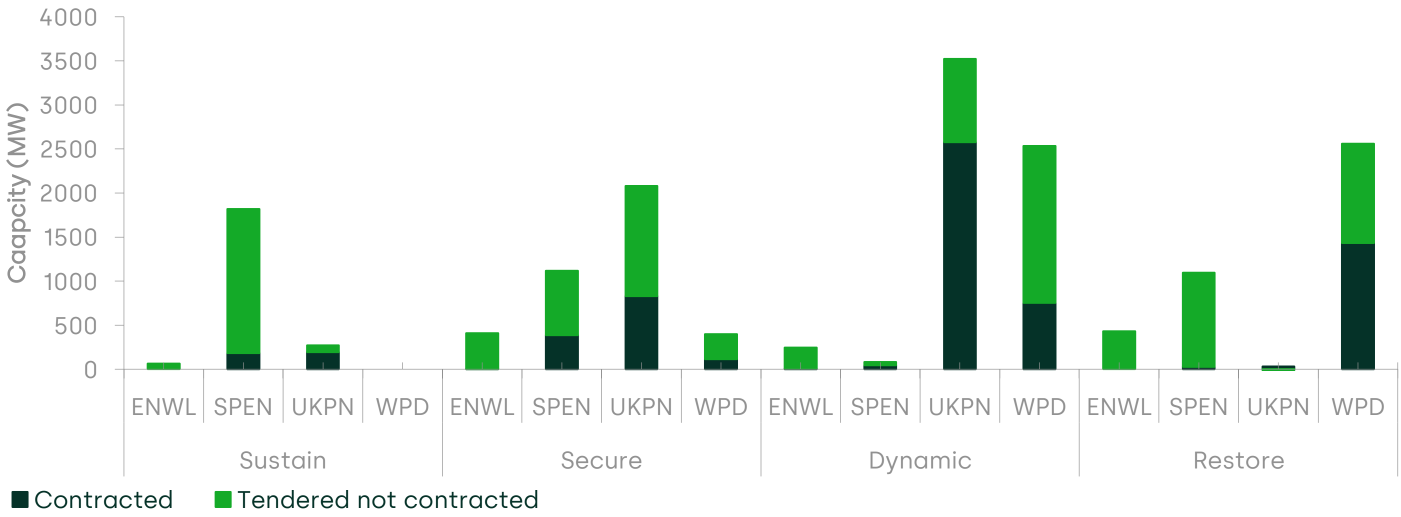
As mentioned above, in practice the DNOs may define the technical and commercial characteristics of the products differently. For example, some may allow FSPs to bid in at smaller capacity increments, or some might use a mixture of capacity and utilisation payments for the same products that other DNOs only use utilisation payments for. Notwithstanding, we understand that the categorisation of flexibility products under the four categories above will generally respect the following differences:

- the Sustain and Secure services are pre-fault;
- the Sustain service is the most likely to be dispatched in a given availability window, followed by Secure and then Dynamic with the lowest probability of dispatch; this is why Sustain tends not to have an availability payment while Secure and Dynamic do. Restore does not have any official availability windows, with FSPs instead being called upon at short notice to provide flexibility services;
- The Sustain and Restore services are typically remunerated through utilisation payments only, while Secure and Dynamic are remunerated through a mix of availability and utilisation.

[24] Piclo (2022), 'Piclo Flex UK Competitions', available here, last downloaded on 30 March 2023.
[25] Piclo (2022), 'Piclo Flex UK Competitions', available here, last downloaded on 30 March 2023.
[26] Piclo (2022), 'Piclo Flex UK Competitions', available here, last downloaded on 30 March 2023.
[27] Please see the Flexible Power website for more information, available here, accessed on 31 March 2023.

The flexible capacity tendered for and contracted varies significantly by product and by DNO (we discuss the differences by DNO in section 2.3). The Dynamic product has the highest amount of capacity both tendered and contracted, with over 6.5GW tendered and over 3.2GW contracted across the period 2020–27. This is driven by the fact that Dynamic is the product that is predominantly tendered and contracted by UKPN and WPD, which are the DNOs that have procured the most flexibility over the period. There are also some notable differences between DNOs in relation to the types of product procured. For example, we note that SPEN is the only DNO that has tendered (but not contracted) material quantities of Sustain,[28] UKPN tenders and contracts for more Secure than other DNOs, and WPD tenders and contracts for more Restore than other DNOs.

Figure 2.1 Flexible capacity tendered and procured by product by DNO, 2021/22–2027/28



Note: We have excluded SSEN and NPG from the figure as the dataset is missing tendered and contracted values for these companies from 2021/22.
Source: Oxera analysis of ENA data. Energy Networks Association (2021), 'ON22-WS1A-P0 Flexibility Figures 2022/23', available here, accessed on 24 March 2023.

In order to provide these products to DNOs, FSPs need to go through:

- a company pre-qualification phase, where DNOs gather information on company characteristics such as solvency in order to ensure that the company entering the tenders meets certain minimum criteria;[29]
- an asset pre-qualification phase, where the technical characteristics, such as geographical boundaries, voltage compatibility and capacity of the asset are assessed in order to ensure they can provide the flexibility service being tendered;[30]
- a tendering process;
- a contract-signing process.

The tendering process is organised around constraint locations , which are geographical areas within a particular DNO's network area, in

[28] On a point of detail, we understand that the majority of SPEN's Sustain services have been tendered at the low-voltage network level.
[29] For more details see Piclo company qualification, available here, accessed on 31 March 2023.
[30] For more details see Piclo asset qualification criteria, available here, accessed on 27 March 2023.

which it expects that there will be grid constraints. As the DNO is interested in securing access to assets that are located within these constraint locations , the assets bidding into the auction must be able to provide services within the zones by being connected to the right part of the network. The auctions also specify the flexibility product that is being procured and whether the requirement is to: (i) turn up generation / turn down consumption; (ii) turn down generation / turn up consumption.

After the tendering process is complete, the FSP can decide whether to sign a contract. Based on interviews with industry participants, this process can last several months. In principle, the DNOs and FSPs sign the standardised ENA contracts, but in practice some FSPs will request that the terms and conditions are adjusted, such that there will be a contractual negotiation. Furthermore, some DNOs may choose to depart from the standard contract.

Once the contract is signed, the next steps depend on the service that has been procured.

In the case of **Sustain**, the dispatch schedule is agreed on well in advance, potentially as early as at the contracting stage, although in many cases this schedule is agreed closer to real time.[31] The FSP then makes an availability commitment (as mentioned above, this is often but not always done on a week ahead basis), which can either be accepted or rejected by the DNO.[32] If the DNO accepts the FSP's availability then the FSP will be dispatched, at which point the FSP will receive its utilisation payment.

In the case of **Secure** and **Dynamic**, unlike with **Sustain**, the dispatch schedule is not agreed in advance. However, the FSP still chooses whether to make its assets available to provide a particular service, and this is often done one week in advance.[33] We understand from SPEN that there is no penalty if the FSP declares an asset to be unavailable. If the FSP does make its assets available, and the DNO accepts its declaration, it will receive an availability payment. If the FSP is called upon to dispatch during the availability window, it will then receive a further utilisation payment.

In the case of **Restore**, the FSP will receive a premium utilisation payment if activated (as mentioned above, we understand from SPEN that this could be as much as £1,000/MWh).

If the FSP fails to deliver a service when called upon, there is no penalty, although any availability payments which were made by the DNO can be clawed back[34]—this would therefore apply mainly to the Secure and Dynamic products.

[31] Energy Networks Association (2020), 'Open Networks 2020 Final Implementation Plan', p. 13, available here, accessed on 31 March 2023.
[32] For more details, see the Flexible Power website, available here, accessed on 30 March 2023.
[33] Ibid.
[34] We understand from SPEN that this clawback results in 100% of the availability and utilisation payments being returned to the DNO if less than 63% of contracted capacity is delivered in the availability window. If the quantities delivered are between 63% and

2.2 Participation of domestic customers in flexibility markets

Domestic customers can participate in DNO flexibility markets by joining an Aggregator,[35] either directly or indirectly, that bids to provide one of the flexibility products cited above. Directly joining an Aggregator would consist of a domestic customer signing a contract with the Aggregator, then responding to signals sent by the Aggregator to either increase or decrease electricity demand. By contrast, indirectly joining an Aggregator could happen if a customer already subscribes to a TOU tariff with an energy Supplier, then the Aggregator contracts with the Supplier to provide additional flexibility signals through the contract that the customer already has with their Supplier.[36] A consumer could also interact directly with both an Aggregator and a Supplier, with the Aggregator adjusting its consumption in response to price signals that are sent either by the markets that the Aggregator is involved in, or the tariffs that the Supplier charges to the customer.

The primary benefit for domestic consumers is that they receive lower energy bills through providing flexible demand (in response to the price signals received both from TOU tariffs and flexibility markets, including those run by the ESO as well as the DNO) or receive additional benefits, such as vouchers.[37] The reduction to energy bills can only happen if the Aggregator is an energy Supplier, or has a contract with a Supplier, while all Aggregators can offer benefits outside of energy bills.

In practice, most Aggregators are likely to primarily aggregate domestic consumers' EV assets, as (i) they are large and controllable sources of load (as compared to other appliances such as TVs and other small electronic devices), and (ii) they are typically 'smart', i.e. they can communicate with the grid through smart chargers and therefore charge or discharge the EV's battery depending on grid requirements. However, in future, Aggregators may also optimise across other larger assets such as heat pumps and refrigeration units in order to increase the size of the load that they control.

When offering an energy bill saving, Aggregators optimise the energy consumption of domestic customers so that they use electricity when the end-use electricity price (the sum of the wholesale price and

100%, only a proportion of the repayment is made. Further details on this are available on slide 4 of the following Flexible Power document—although we understand that the axis labels have been incorrectly transposed in that slide. See: Flexible Power (2020), 'Payment Mechanism V1 December 2020', available here.

[35] An Aggregator is a business that combines a large quantity of Distributed Energy Resources (DER) and then controls the generation or energy usage of these resources remotely. This remote control allows the Aggregator to turn the demand of the DER that are connected to it up or down, depending on what is needed on the grid. The reason for aggregating individual DER is that individual DER levels are likely to be too small to provide much value to the grid, but when combined, the DER can have a material impact either on the load (if the DER is on the demand side) or the quantity of electricity generated (if the DER is on the supply side).

[36] Examples of the different ways in which Aggregators and Suppliers interact can be seen in USEF (2021), 'USEF: The Framework Explained', pp. 31–32, available here.

[37] For example, EV.Energy provides Amazon gift cards to customers, alongside other benefits. For more details, see EV.Energy website, available here, accessed on 30 March 2023.

network charges) is low, and reduce their demand when it is high. The saving that the consumer makes is shared between the consumer (giving them a reason to contract with the Aggregator) and the Aggregator (giving them revenues).

When offering customers additional revenues, Aggregators use their customers' assets to bid into either ESO or DNO flexibility markets.[38] When bidding into ESO flexibility markets, we understand from conversations with Aggregators that this primarily consists of bidding into the balancing mechanism, and the revenues from this are shared with customers. By contrast, the DNO flexibility markets provide relatively little revenue. For example, we understand from SPEN that in the ED1 period (2015–23[39]), it spent c.£26k on DNO flexibility markets. By contrast, the ESO spent £129m on Dynamic Containment in 2022.[40]

Domestic customers can also provide flexibility services by signing up to TOU tariffs for their energy consumption. All TOU tariffs encourage load shifting by providing lower prices during off-peak hours, but the extent to which the pricing tracks changes in wholesale market prices and Distribution Use of System (DUoS) tariffs can vary depending on the tariff. At one end of the spectrum are tariffs that have two prices, one for peak and the other for off-peak energy usage. An example of such a tariff is the Intelligent Octopus tariff (which is specifically for EVs), and which provides one fixed price between 23.30 and 05.30, and another fixed price at all other times of day (albeit one that varies by region).[41] At the other end of the spectrum are tariffs that track the half-hourly movements of electricity prices in the wholesale market, such as the Octopus Agile tariff.[42] All TOU tariffs require domestic customers to agree to install smart meters.[43]

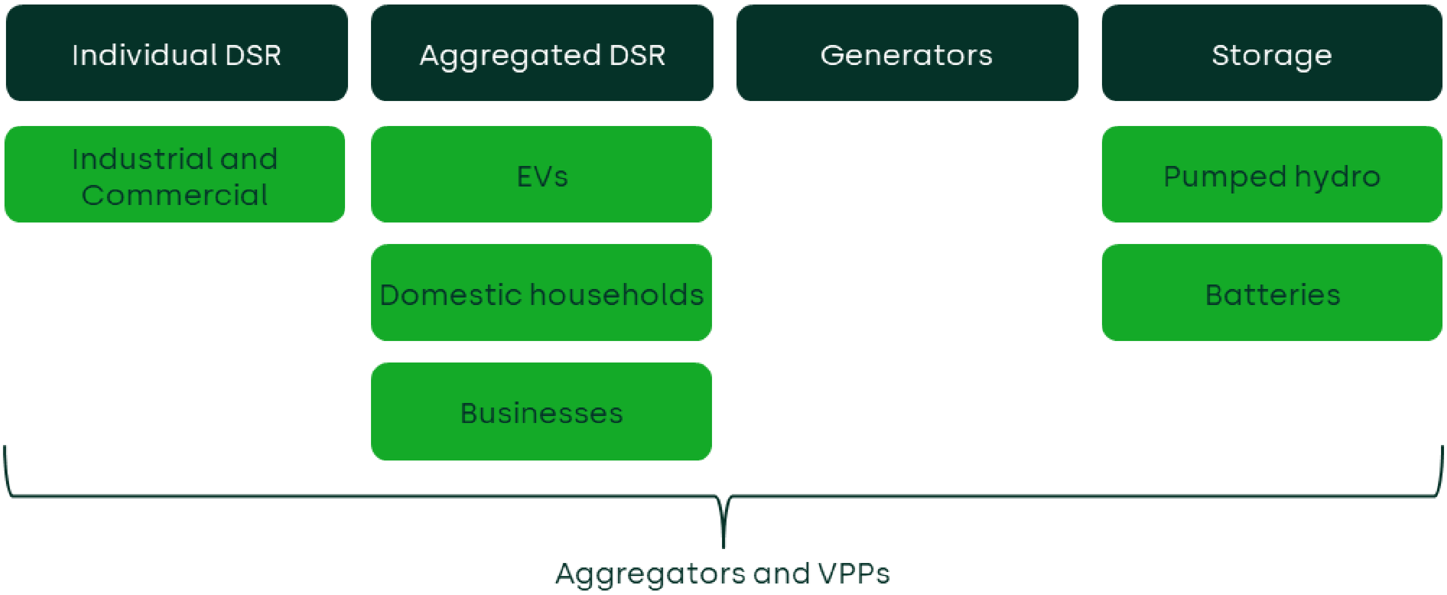
It is important to note that, when bidding their customers' assets into flexibility markets, Aggregators will rely on the price signal being sufficiently strong and dynamic (i.e. responding to and accurately reflecting real-time changes in market prices) to encourage the domestic customer to take an action that is consistent with the service that the Aggregator will provide. If the price signal is not sufficiently strong then domestic customers may face incentives to either override any automated control of their assets or, if they have not given the Aggregator automated control over their assets, they may disregard the price signal and not adjust their demand. Therefore it is in the interest of the Aggregator to combine as many different revenue streams as possible—not just so that it can retain those revenues but also so that it can send more pronounced price signals to domestic customers, to induce higher levels of demand response.

[38] Further information on Aggregator business models can be found in USEF (2021), 'USEF: The Framework Explained', available here.
[39] As mentioned earlier, the ENA website shows that SPEN only tendered for flexibility services from 2019, with the earliest DNO flexibility tenders starting in 2018. See the ENA website available here, accessed 30 March 2023.
[40] For more details, see National Grid ESO data, available here, accessed on 24 March 2023.
[41] For more details, see the FAQs on Octopus Energy website, available here, accessed on 30 March 2023.
[42] For more details, see the Octopus Energy website, available here, accessed on 30 March 2023.
[43] For more details, see Energy Saving Trust here.

2.3 Types of FSP

Based on our review of different types of FSP that participate in electricity markets, we have categorised them into four main groups, each of which uses different types of asset to provide flexibility to the market. The four types are: Individual Demand Side Response (DSR), Aggregated DSR, Generation, and Storage. They are shown in Figure 2.2 below.

Figure 2.2 Types of FSP



Note: DSR, Demand Side Response. EV, electric vehicle. VPP, Virtual Power Plant.
Source: Oxera.

We now explain the differences between the four types of FSP listed above, and why companies that operate across a number of FSP business models are called Aggregators or VPPs.

Individual DSR companies are companies that can increase or decrease their levels of demand in response to price signals. These are typically large industrial or commercial entities that perform energy-intensive processes and can therefore make material differences to the levels of grid congestion if they turn down their levels of demand during peak times.

Aggregated DSR companies are companies that, like Individual DSR, turn the level of power demand up or down on their assets. However, unlike Individual DSR, they tend not to own their own assets and therefore, as the name suggests, 'aggregate' across a wide range of smaller assets. The most common assets that Aggregated DSR aggregates across are likely to be EVs, although they can also aggregate more generally across the power demand of domestic customers, schools, and businesses.

Generators are companies that own flexible generation assets such as gas peakers.[44] If they are connected to a zone that is behind a grid

[44] Gas peakers are small gas generators that only operate when additional electricity supply is needed at short notice. Their flexibility makes them well suited to performing this role.

constraint, they can increase the supply of power into that area in order to match the demands of customers.

Storage operators are companies that own storage assets such as batteries or pumped hydro. When the distribution grid is in need of more demand, they can support it by charging (in the case of batteries) or using power to pump water into a reservoir from which it can later be released. Conversely, when a particular location needs more electricity supply, they can discharge the electricity that they previously charged (or, in the case of pumped hydro, release the water that was previously pumped up into the reservoir).

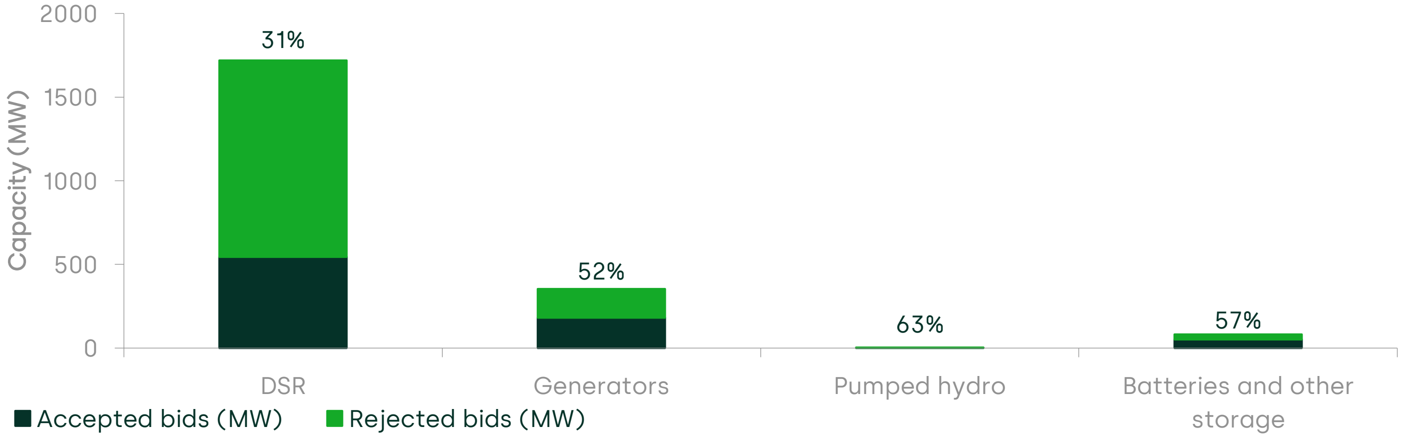
Some companies also combine a range of the services described above, as indicated by the large bracket in Figure 2.2 that points to the terms 'Aggregators' and 'VPPs'. As these companies are combining across a wide range of different asset types, they are also called Aggregators. If the types of asset over which they aggregate are only generation, then they are called VPPs.[45]

While the breakdown of assets bidding into tenders is likely to vary by DNO, we can observe that offer and procurement of DSR is the predominant category for SPEN, as shown by the data from its flexibility auctions, in Figure 2.3 below.[46] Specifically, in SPEN's tenders between 2019 and 2021, Aggregators accounted for 79% of flexibility bidding into SPEN's tenders, with 16% coming from generators and the rest from storage (both batteries and pumped hydro). The dominant role of DSR, which is likely to primarily consist of EV Aggregators, is also consistent with Ofgem's focus on Consumer Energy Resources in its recent Call for Input.[47]

The success rates that different technology types have in winning tenders vary between 31% and 63%, although the total capacities of pumped hydro and batteries/other storage may be too low to draw a meaningful conclusion on their relative likelihood of success compared to other technologies. The main point worth drawing out from the figure below is that DSR, while being the largest contributor to SPEN's flex market, also has the lowest success rate in tenders. We discuss some of the reasons why this might be the case in section 3.

[45] See, for example, the Entsoe definition of a VPP here.
[46] At the time of writing, SPEN appears to be the only DNO that publishes data on the success of different bidders split by type of asset.
[47] Ofgem (2023), 'Call for Input: The Future of Distributed Flexibility', available here, accessed on 30 March 2023.

Figure 2.3 Total and accepted flexibility bids into SPEN tenders by technology from 2019–21 inclusive

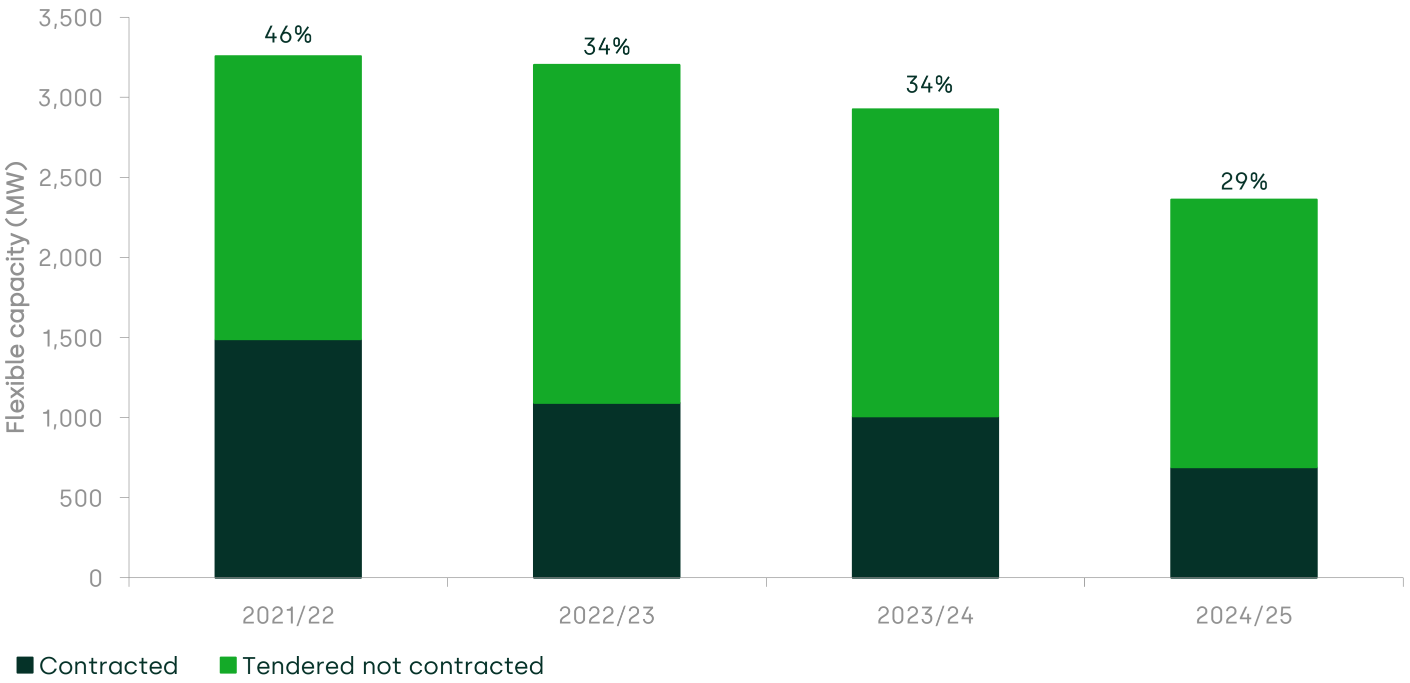


Note: The bars represent the total bids from flexibility providers in MW, while the dark green represents the bids that were successful. The numbers above the bars represent the percentage of bids (in MW) for each technology that were successful. The data includes bids for spring 2019 to spring 2021 inclusive.
Source: For more details, see the Flexible Power website, available here, accessed on 30 March 2023.

2.4 Trends in the purchase of flexibility

The total capacity of tendered and contracted services has been increasing over time since DNO flexibility services were first tendered in the UK in 2018. However, there is still a large gap between the capacity in MW which is contracted and tendered, with only 34% of MW tendered for 2022 successfully contracted. This is shown in Figure 2.4.

Figure 2.4 Total capacity of tendered and contracted services from 2021/22–2024/25



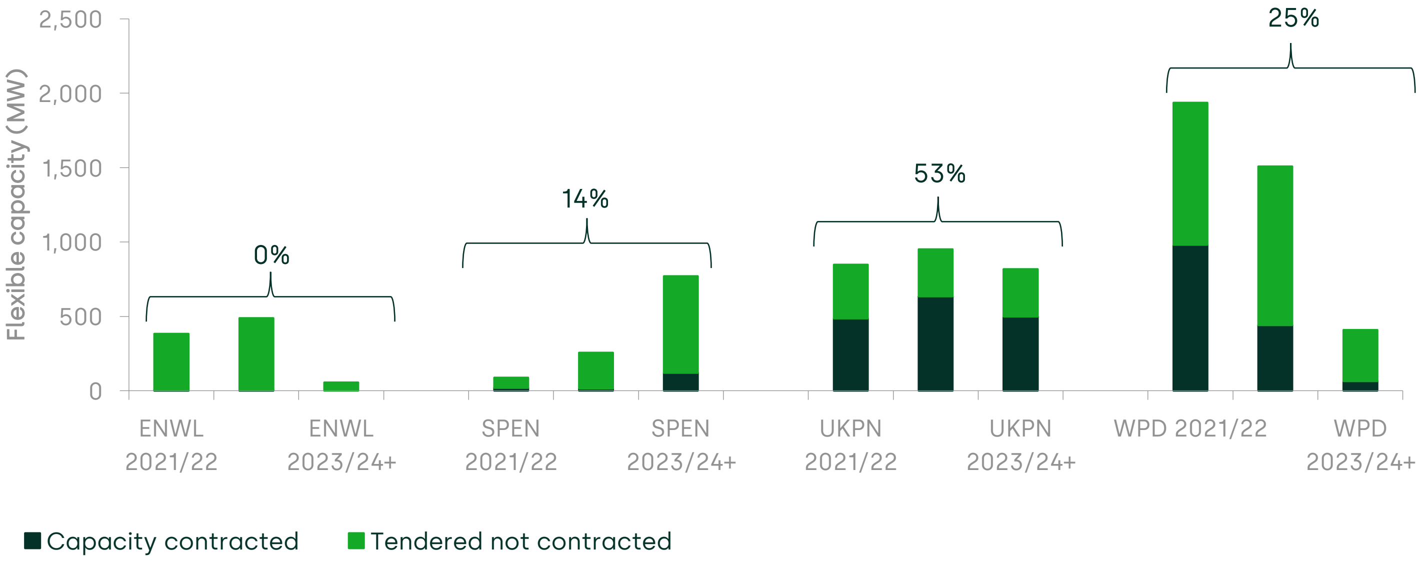
Note: This figure above covers flexibility contracted by ENWL, SPEN, UKPN and WPD. We have excluded SSEN and NPG from the figure as the dataset is missing tendered and contracted values for these companies from 2021/22. The total bar shows the MW tendered, while the dark green bar shows the MW contracted. The number above the bar

shows the percentage of tendered services that have been contracted. We have excluded SSEN's tendered and contracted data for all years because since 2022 it has been running open tenders for unspecified amounts of capacity, and therefore the (unspecified) amounts tendered and procured cannot be shown on a comparable basis to the other networks over this period.
Source: Oxera analysis of ENA data. Oxera analysis of ENA data. Energy Networks Association (2021), 'ON22-WS1A-P0 Flexibility Figures 2022/23', available here, accessed on 24 March 2023.

The vast majority (>99%) of the flexibility that DNOs tender for is for generation turn-up or consumption turn-down.[48] This is because grid constraints typically arise when there is too much demand in a given area, and so consumers in those areas need to reduce demand or generators in those areas need to increase supply.

The level of flexibility tendered also varies significantly between DNOs. The DNOs tendering for the highest levels of capacity are UKPN and WPD, with the latter tendering up to 1,500 MW a year. The DNO tendering the fewest number of MW is ENWL, with SPEN tendering capacities in between these two groups.[49] This is shown in Figure 2.5. In addition, as shown in Figure 2.5, the DNOs that tender for the most capacity also tend to be successful in subsequently contracting the most capacity. This is shown by the fact that the DNOs with tallest bars in the figure also have the highest proportions of those bars coloured in dark green.

Figure 2.5 Total capacity of tenders by DNO by year



Note: The sum of the light green and dark green bars indicates the number of tendered MW for each year, while the dark green bar indicates the number of MW that have been contracted for that year. The percentages above indicate the average proportion of tendered services that have been contracted for each DNO for 2021/22 to 2027/28 inclusive. We have excluded SSEN and NPG from the figure as the dataset is missing tendered and contracted values for these companies from 2021/22.

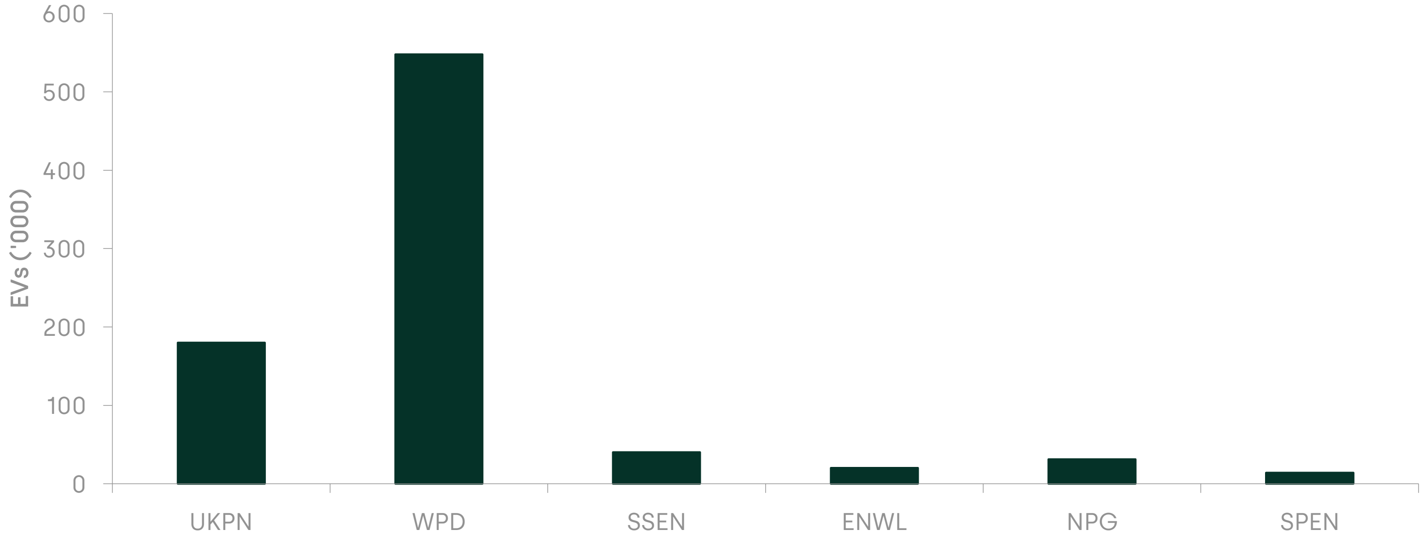
[48] 11,470 of the 11,515 sites that have been tendered through Piclo are for deficit, which reflects situations where there is insufficient electricity in a particular zone. Piclo (2022), 'Piclo Flex UK Competitions', available here, last downloaded on 22 March 2023.
[49] NPG and SSEN are not included in this analysis as the dataset does not have data for these companies from 2021/22.

Source: Oxera analysis of ENA data, Oxera analysis of ENA data. Energy Networks Association (2021), 'ON22-WS1A-P0 Flexibility Figures 2022/23', available here, accessed on 24 March 2023.

Based on our interviews with FSPs, the reasons for the inter-DNO differences are likely to be the quantity of Distributed Energy Resources (DER) available in the regions of different DNOs. One FSP, an EV Aggregator, explained that the reason it contracts more with UKPN and WPD is because this is where most of their EVs are located. This is confirmed by the data in Figure 2.6 below which shows that UKPN and WPD, which were also the highest tenderers and contractors according to Figure 2.5, have the highest numbers of EVs in their regions. By contrast, the other four DNOs have much lower numbers of EVs in their geographic regions.

The low number of EVs in some geographies may mean that DNOs are both less likely to tender for flexibility services, and if they do, likely to have fewer EV Aggregators that are willing to bid for tenders.

Figure 2.6 Number of EVs in each DNO as of 2021



Source: Oxera analysis of data from: UK Power Network (2022), 'RIIO ED2 Business Plan 2023-2028', available here, accessed on 30 March 2023; Western Power Distribution (2021), 'Our Business Plan 2023-2028', available here, accessed on 30 March 2023; SSEN (2020), 'Electric Vehicles Strategy', available here, accessed on 30 March 2023; Musgrove, C. (2022), 'Billions to be invested in North West's power network as it's predicted 1.2 million electric cars will be on the region's roads by 2030', *Lancashire Post*, 3 April, available here, accessed on 30 March 2023; Northern Power Grid (2021), 'Business Plan 2023-2028', available here, accessed on 30 March 2023; and SP Energy Network (2021), 'Enabling the path to Net-zero: Our RIIO-ED2 Business Plan for 2023-2028', available here, accessed on 30 March 2023.

2.5 Remuneration of DNOs for the purchase of flexibility services

As DNOs are regulated entities, their remuneration for the purchase of flexibility is determined by the regulatory regime. Based on our discussions with SPEN and understanding of the regulatory framework, we understand that SPEN is primarily incentivised to procure flexibility in two ways.

First, if the flexibility product defers network reinforcement, then the DNO has an incentive to procure the flexibility if this results in cost savings (i.e. lower network expenditure than payments made for procuring flexibility) relative to a situation where it had to undertake the required network reinforcement expenditure immediately. This is because if the DNO underspends on its TOTEX allowance then, through the TOTEX Incentive Mechanism (TIM), it receives the percentage of that underspend that corresponds to the incentive rate (the incentive rate is the percentage of TOTEX underspend that is retained by the network, with the remainder being passed onto consumers to reduce energy bills).[50]

Second, if the flexibility product reduces grid outages, then the DNO may earn additional revenues under the Interruption Incentives Scheme (IIS). Specifically, it may receive a reward/penalty for any reductions/increases in the number of Customer Interruptions (CIs) and Customer Minutes Lost (CMLs) relative to the target that Ofgem sets for them.[51] The magnitude of the reward/penalty reflects the Value of Lost Load (VoLL).[52]

[50] Ofgem (2022), 'RIIO-ED2 Final Determinations Overview document', paras 9.2–9.6, available here, accessed on 30 March 2023.
[51] Ofgem (2022), 'RIIO-ED2 Final Determinations Core Methodology Document, p. 160, available here, accessed on 30 March 2023.
[52] Ibid.

3 Barriers to the uptake of flexibility for FSPs

We have allocated the barriers that prevent FSPs from participating in flexibility markets under five categories, as shown in Figure 3.1. We visualise this by way of an upfront summary, and spend the remainder of this subsection discussing each of the categories in further detail. When discussing each category, we first discuss the more significant barriers before moving onto the less significant barriers.

Figure 3.1 Barriers faced by FSPs

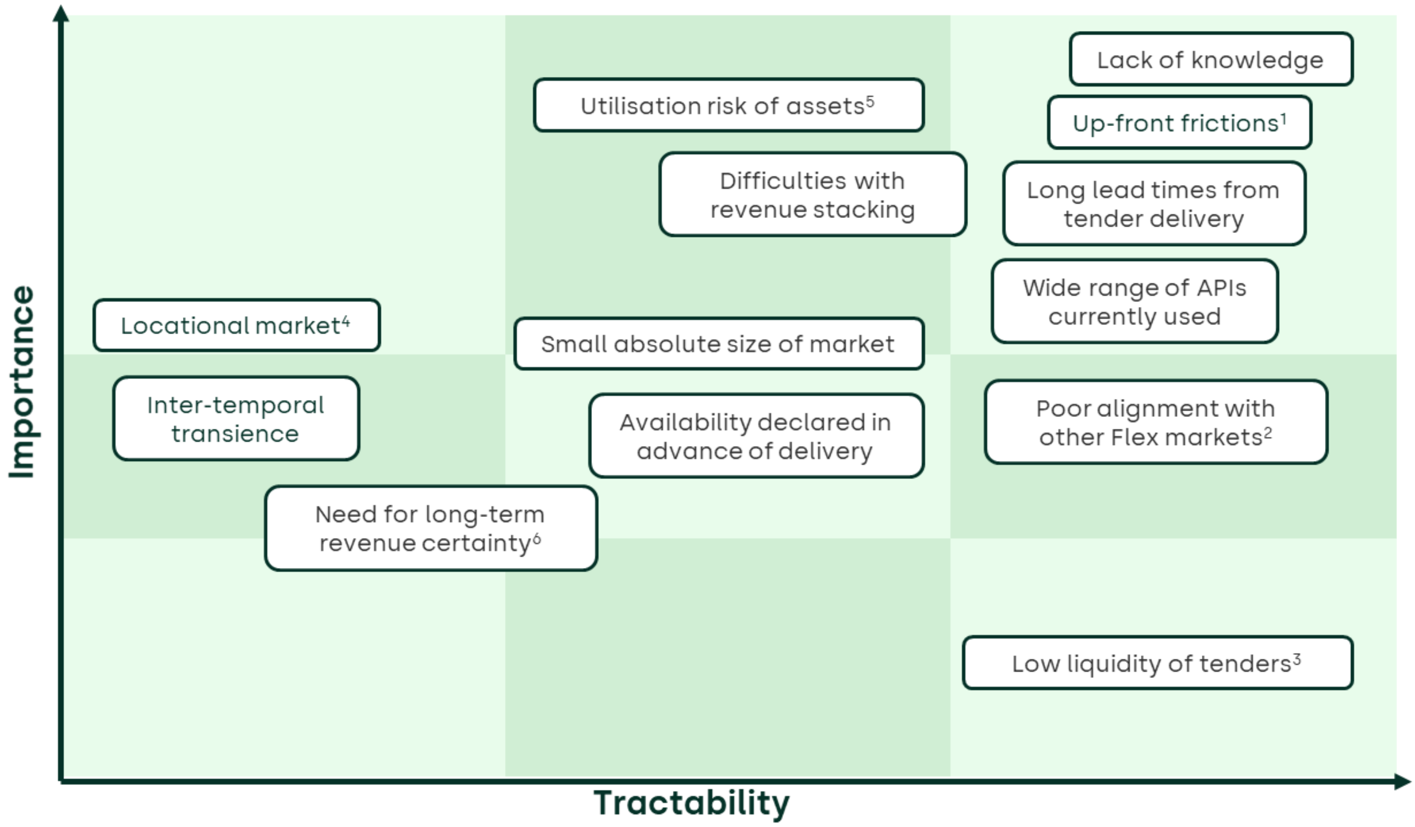
Fundamental market characteristics	Revenue risks	Administrative and procedural barriers to entry	Difficulty of making longer-term commitments
Locational market[1]	Utilisation risk[2]	Up-front frictions[3]	Long lead times from tender to delivery
Inter-temporal transience	Need for LT revenue certainty[4]	Poor alignment with other flex markets[5]	Availability declared in advance of delivery
Small absolute size of market	Difficulties with revenue stacking	Wide range of APIs currently used	
	Low liquidity of tenders[6]	Lack of knowledge	

Note: [1] Due to the nature of the flexibility market assets have to be located in a specific geographical location. [2] Utilisation risk of assets means the that committed assets may not be dispatched. [3] By 'up-front frictions' we mean issues such as the pre-qualification process that FSPs have to undertake and the fact that contracts can be long and complicated. We explain this in further detail in section 3.2. [4] Revenue certainty can be provided for a small number of years but not for long (10+ years) periods of time, which may be a requirement for CAPEX-intensive technologies. This is due to the fact that in the long term, networks are likely to be reinforced, thereby decreasing the need for local flexibility. [5] These 'other' flex markets cover ESO, Wholesale and other DNO markets. [6] Low liquidity of tenders means that historical tender data may be inappropriate for future forecasting.
Source: Oxera.

We have also evaluated the individual barriers presented above in terms of our initial views of their (i) importance, and (ii) tractability (i.e. how easy we think it might be to find a solution to them). This mapping has allocated each barrier to a high, medium, or low level of importance, and a high, medium, or low level of tractability.

The stylised results of this mapping are visualised in Figure 3.2 below, and we comment on these further when discussing solutions in section 5.

Figure 3.2 Stylised categorisation of barriers, by importance and tractability



Note: [1] By 'up-front frictions' we mean issues such as the pre-qualification process that FSPs have to undertake and the fact that contracts can be long and complicated. We explain this in further detail in section 3.2. [2] These 'other' flex markets cover ESO, Wholesale and other DNO markets. [3] Low liquidity of tenders means that historical tender data may be inappropriate for future forecasting. [4] Due to the nature of the flexibility market, assets have to be located in a specific geographical location.
[5] Utilisation risk of assets means that committed assets may not be dispatched.
[6] Revenue certainty can be provided for small number of years but likely not for long (10+ years) periods of time, which may be a requirement for CAPEX-intensive technologies. This is due to the fact that, in the long term, networks are likely to be reinforced, thereby decreasing the need for local flexibility.
Source: Oxera.

For the remainder of this section, we discuss each grouping of barriers in turn.

3.1 Fundamental market characteristics

The first set of barriers that we discuss are the fundamental characteristics of the market. The reason for discussing these first is two-fold. First, as these are fundamental characteristics of the market, they interact with the other barriers that we discuss below. Second, these are unlikely to be barriers that DNOs can substantially reduce for FSPs.

We consider that all of the barriers identified in this category are of medium importance but low tractability.

The first barrier is that **the DNO flexibility market is locational**, and therefore only FSPs with assets located in specific constraint locations can access the revenues from services tendered in that location. This limits the number of FSPs that can participate in tenders.

Some of the FSPs we interviewed explained that some constraint locations are situated in areas that are very sparsely populated, and therefore where there is limited-to-no generation equipment, which makes it particularly difficult for FSPs to secure sufficient flexibility resources in those areas. An example of this is provided in Figure 3.3, which shows that some of the constraint locations that SPEN has run tenders for are located in rural areas of North Wales.

Figure 3.3 Flexibility tender locations within SP Manweb licensed area

Source: Scottish Power Energy Networks (2022), 'April 2022 – Procurement Report', p. 2, available here.

The consequence of this is likely to be that constraint locations with very few assets have very few FSPs tendering and therefore contracting. This is reflected in the data we presented in Figure 2.5 and Figure 2.6, which showed that the DNOs that have procured the most flexibility are also those that have the highest numbers of EVs in their networks. One of the FSPs that we interviewed as part of this review, which was an EV Aggregator, also confirmed that it contracted more with UKPN and WPD because most of their EVs were in those locations.

The result of this is that there are some areas of the DNO flexibility market that never receive bids and are unlikely to receive bids unless the constraint locations are substantially increased in size. However, we understand from discussion with SPEN that it is not possible to expand the size of the constraint locations because these are determined by the technical constraints of the network.

The second barrier that we have identified is that **the DNO flexibility market is inter-temporally transient**. This means that, while a constraint in a particular location may require a flexibility solution for a given amount of time, there may come a point when the network needs to be reinforced anyway. Due to this, the DNO flexibility market is unlikely to be able to support flexibility assets for their entire lifetime, and so FSPs may not be able to secure long-term (e.g. 10+ year) revenue streams from them.

The third barrier we have identified is that the **DNO flexibility market is perceived to offer low revenues**, both in absolute terms and relative to other markets such as the Balancing Mechanism, various ancillary services tendered by the ESO, or the wholesale market that FSPs can also participate in. For example, SPEN considers that deferring network reinforcement through procuring flexibility will save it £36m across the entire ED2 period,[53] meaning that this is the (approximate) maximum that SPEN is willing to spend on flexibility tenders. By contrast, the Dynamic Containment market tendered by the ESO has **annual** revenues of c.£130m.[54] This low-revenue opportunity relative to other markets was confirmed to us by a number of FSPs that we spoke with. Those that already participate in the DNO market commented on the fact that it was very small (one FSP mentioned that it accounted for c. 1/8th or 1/9th of its revenues) and those that do not participate in it commented on the fact that they currently prioritise other markets.

The small-revenue opportunity is likely to mean that not participating in the DNO flex market does not at present carry a high opportunity cost, and therefore that FSPs are less likely to make great efforts to participate in it than they would if the revenue opportunity were larger.

The implication of this is likely to be that most of the other barriers that we discuss in this report are more problematic than they would otherwise be if the market presented a substantial revenue opportunity. If the market provided substantial revenues, then FSPs would be more likely to commit resources to overcoming the barriers that they face.

A related element of this barrier is the fact that the individual contracts that FSPs bid for can be very small in terms of their capacity, with the mean tender made through Piclo being for c.1MW and the median for c.100kW.[55] This means that larger assets, like many generators and some batteries, may be less likely to find value in the tenders, as a very small proportion of their capacity would be covered by the market.

We have also listed all of the barriers in this section as having low tractability. Due to this, in section 5 we present relatively few solutions to them. As the market is, by definition, locational and inter-temporally transient, relatively little can be done to resolve this situation (although we do list some indirect solutions). Furthermore, the capacities of the flexibility that DNOs tender for, and amounts that they are able to pay for them, are the outcomes of tools such as the Common Evaluation Methodology (CEM). This tool calculates the

[53] This corresponds to the baseline scenario outlined in SPEN (2022), 'Our RIIO-ED2 Business Plan for 2023 – 2028', p. 31 and 40, available here.
[54] For more details, see National Grid ESO data, available here, accessed on 24 March 2023.
[55] Piclo (2022), 'Piclo Flex UK Competitions', available here, last downloaded on 22 March 2023.

extent to which the procurement of a particular service reduces the need for network reinforcement, improves the reliability of electricity supply to customers, or reduces CO_2 emissions, and tells the DNO the amount that it should be willing to pay for a particular solution.[56] Therefore, as long as the tool is appropriately calibrated, the capacities that are offered for tender and the prices that DNOs are willing to pay for them should be appropriate. We discuss this further in section 5.

Despite the fact that the above are fundamental market characteristics, it is important to note that their importance may be reduced over time. Specifically, the prices that DNOs can afford to pay FSPs are driven primarily by the costs of network reinforcement but the costs of FSPs are driven to a large extent by energy prices. EV and battery storage costs will be driven by electricity prices, and generators' costs will be driven by gas prices (as we understand that most are gas peakers). Both gas and electricity prices are currently highly elevated relative to historical averages, and so if these fall in future, the costs of FSPs should also fall while the prices that DNOs are willing to pay should stay the same. This decline in energy input costs should increase the profitability of DNO markets for more FSPs and encourage more participation in tenders.

3.2 Administrative and procedural barriers to entry

We have identified four barriers within this category. Of these four, we hypothesise three to be of high importance and one to be of medium importance.

The three high-importance barriers are:

- up-front frictions that prevent new entrants from tendering;
- lack of knowledge about the market;
- a wide range of APIs that FSPs need to use.

We discuss each of these in turn.

The literature we have reviewed and the FSPs we have interviewed have outlined a number of **up-front frictions** that disincentivise new entrants from bidding into DNO flexibility markets. The main frictions include:

- the pre-qualification process,[57] as FSPs have to undertake different pre-qualification routes with each DNO and the ESO;
- a lack of a consistent framework approach to the signing of flexibility contracts,[58] which means that a new contract has to be signed for each product after each tender, and different contracts are required by different DNOs and the ESO;

[56] Two of the key outputs of the model are the net benefit of the flexibility solution and the ceiling price. Energy Networks Association (2020), 'Common evaluation methodology and tool', pp. 13–15 and 19, available here.
[57] For more details, see the National Grid ESO website, available here, accessed on 30 March 2023.
[58] See, for example, Energy Networks Association (2021), 'Open Network Project 2021 project initiation document', p. 23, available here.

- the contracting process is lengthy and complex, and contracts can take a very long time (e.g. several months) to sign, including a lot of negotiating time with DNOs. As we explained in section 2.1, and as also cited by Ofgem in its Call for Input,[59] this may be driven by a lack of product standardisation, which means that the contractual conditions for one DNO's Dynamic product may differ from the contractual conditions of another's;
- as has also been recognised by Ofgem,[60] a lack of accurate, easily accessible historical or forecast market data makes it difficult for FSPs to value the potential opportunity of bidding into DNO markets.

Such frictions may have a substantial impact on FSPs' willingness to sign up to flexibility services.

The **lack of knowledge** about the market is a fairly self-explanatory barrier which causes fewer FSPs to bid into flexibility tenders because they do not know enough about how the DNO flexibility markets work. While the level of knowledge should increase over time as the market becomes more established, some of the FSPs that participated in the flexibility conference that we attended expressed limited knowledge about how the DNO markets operate. Furthermore, a generation-owning FSP told us that baselines for generation (at least in the case of SPEN) are set to 0, meaning that generators could meet the requirements of the DNO market while also operating in another market (i.e. they could stack their revenues). The FSP suggested that such knowledge was unlikely to be common within the FSP community, because it would require other FSPs to have read DNO flexibility contracts in detail.[61] Therefore, many generators may simply be unaware of the fact that the DNO flex market allows them to stack revenues.

The **wide range of APIs that FSPs need to use** create additional costs for FSPs. When speaking to FSPs, we have heard that there are a large number of different and non-standardised APIs that they need to connect their assets to. Broadly speaking, there are three elements to the DNO flexibility value chain: procurement, operation, and settlement.[62] With six different DNOs, this means that there could, in theory, be up to 18 different APIs that FSPs need to interact with. In practice, there are fewer than 18 because some DNOs use the same platforms as each other in parts of the flexibility value chain. For example, all DNOs have at some point used Piclo for their tendering, and four DNOs (SSE, SPEN, NPg, and National Grid / WPD) currently use Flexible Power for operations and settlement. Despite this, there is still a diversity of APIs rather than full standardisation.

Furthermore, our conversations with FSPs revealed that sometimes payment can be delayed. While we understand that the limited

[59] Ofgem (2023), 'Ofgem Technical Annex to the Call for Input on Distributed Flexibility', p. 28, available here, accessed on 30 March 2023.
[60] Ofgem (2023), 'Ofgem Technical Annex to the Call for Input on Distributed Flexibility', pp. 27 and 29, available here, accessed on 30 March 2023.
[61] This FSP felt that in many cases the contracts are written with DSR in mind, as the baselines discussed in the contracts are not set to 0.
[62] This also aligns with the process split identified by Ofgem in its Call for Input. Ofgem (2023), 'Ofgem Technical Annex to the Call for Input on Distributed Flexibility', p. 6, available here, accessed on 30 March 2023.

volumes contracted by SPEN have not necessitated any delays in payment to date, our conversations indicated that delays could arise from the need for manual approval of invoices by DNO Accounts teams. While it is unclear how widespread this issue is, there is a risk that delays could increase in the future as the quantities of tendered flexibility increase, such that the required Accounts approvals rise commensurately.

The medium importance barrier is that there is **poor alignment of standards and tender timelines between different DNO, as well as ESO, flexibility markets**. The poor alignment between DNO and ESO flexibility tenders[63] may make it more likely that FSPs will de-prioritise bidding into DNO markets, as ESO markets[64] or wholesale markets[65] will be higher-revenue opportunities. Standards are also not aligned, with product definitions and baselining methodologies differing between the DNO and ESO flexibility markets.[66]

This lack of standardisation contrasts with the design of ESO-level balancing markets in the EU, where there is generally considered to be a high degree of standardisation.[67]

We consider that all of the barriers listed in this section have a high level of tractability, and therefore discuss solutions to all of these in section 5.

3.3 Revenue risks

Based on the discussions that we have had, we have identified four specific barriers that fall into this category, the first two of which we consider to be of high importance, one that we consider to be of medium importance, and one that we consider to be of low importance.

The high-importance barriers are:

- utilisation risk;
- difficulty stacking revenues with other flex markets.

The medium-importance barrier is that some FSPs want long-term revenue certainty before locating in a particular area, and the low-importance barrier is that tenders (currently) have low levels of liquidity.

We discuss each of these in turn.

Utilisation risk refers to the risk that an FSP is not dispatched after it has declared itself available to a DNO. This presents a risk to FSPs

[63] Energy Networks Association (2021), 'Open Network Project 2021 project initiation document', pp. 18–19, available here.
[64] By ESO markets we mean all markets for flexible assets that are operated by the ESO, covering the Balancing Mechanism, all of the many different Ancillary Services, and the Capacity Market.
[65] For the purpose of this report, we define wholesale markets as covering all futures/forwards markets, the day ahead market, and intra-day markets.
[66] Energy Networks Association (2021), 'Open Network Project 2021 project initiation document', pp. 31–32, available here.
[67] ENTSO-E (2020), 'Balancing Report 2020', p. 4, available here, accessed on 30 March 2023.

because almost all of the DNO flexibility products are either partially or entirely compensated through utilisation payments. Therefore, if an FSP sets aside an asset for the delivery of a service but then is not activated during that time window, it will miss out on the utilisation payment proportion of its remuneration

There are two reasons why utilisation risk is of high importance.

First, the DNO flexibility market is relatively new and therefore FSPs do not have significant levels of historical utilisation data available to them which they could use to predict how regularly they will be dispatched. While DNOs have somewhat mitigated this risk by publishing the expected levels of utilisation for a particular product in a particular constraint location prior to the auctions,[68] these forecasts can be very long term[69] and therefore may be seen as lacking credibility due to high levels of forecasting uncertainty. To our knowledge, there has also been no independent assessment of the accuracy of DNO forecasts, and therefore this risk to FSPs remains unmitigated.

Second, revenue stacking of DNO flexibility products with other revenue streams is limited, especially for DSR (see below for more detail). Due to this, FSPs risk losing out on alternative revenue streams when they bid into DNO flexibility markets, meaning that utilisation risk makes DNO flexibility comparatively less attractive.

The second high-importance barrier is that **it is not always possible to stack revenues across different flexibility markets**. This barrier was also recognised by Ofgem in its Call for Input.[70] In the specific context of DNO flexibility markets, there are differences in the ability to stack revenues depending on (i) the technology of the asset, and (ii) the DNO flexibility market in question. We explain both of these in turn.

First, the technology of the asset matters because generation and storage typically receive baselines of zero, i.e. the asset needs to be generating at the capacity that it bid into a flexibility tender when it is called on by the DNO. This means that for generation and storage assets it is relatively easy to stack revenues because the generator can offer a generation turn-up service to the ESO, or sell electricity onto the wholesale market, and still be remunerated for its sales into the DNO flex market without creating any conflicts.[71] In this sense,

[68] See, for example, the flexibility map on the ENW website, available here, accessed on 30 March 2023.
[69] For example, SPEN conducted a tender for ED2 (2023–28) services in 2021, meaning that the utilisation forecasts it provided were two to seven years into the future. SPEN (2022), 'Procurement Report', p. 2, available here, accessed 30 March 2023.
[70] Ofgem (2023), 'Ofgem Technical Annex to the Call for Input on Distributed Flexibility', p. 28, available here, accessed on 30 March 2023.
[71] To understand this, consider a generator that has made itself available for 5MW of capacity in a DNO flexibility market. As the baselines are 0, all that the generator needs to do is generate at a capacity of 5MW for the duration of the dispatch instruction that it receives from the DNO. However, this generator could have already sold the energy that it generates during this period into another market such as the wholesale market, and would therefore receive revenues in respect of the same electrons in both the DNO flexibility market and the other markets. By contrast, if the generator's baselines worked in such a way that it had to offer 5MW of incremental capacity, then the fact that it had already sold energy into the wholesale market would mean that it would only be able to

when generation receives a baseline of 0, it is remunerated for participation in DNO flex markets in a similar way to how it is remunerated in the Capacity Mechanism, where it can stack revenues with all other flexibility services.[72]

By contrast, the baselining for DSR is designed in such a way that DSR is remunerated for the change (specifically, decrease) in consumption that its activation causes. DSR therefore does not receive a 0 baseline, but rather one calculates a counterfactual quantity of demand used by the customer and subtracts the actual demand to calculate the volumes that are eligible for remuneration. Due to this, it is far more difficult for a DSR Aggregator to stack revenues because if the DSR is called on by the DNO and the ESO at the same time, it would be unable to turn down consumption for both the DNO and the ESO.[73]

Second, for the DSR, some DNO flexibility markets are more easily stackable than others. Specifically, the Sustain product can be stacked with revenues from the wholesale market because the dispatch schedule is agreed in advance of gate closure for the day ahead market. Therefore, the BRP[74] that the FSP is a member of can take the expected dispatch under the Sustain product into account when delivering its Final Physical Notification (FPN).[75] This ability to coordinate between a wholesale market position and the requirements of the Sustain product means that the FSP's actions on the wholesale market will not create an imbalance and therefore no cost will be imposed on the BRP.

However the Secure, Dynamic, and Restore products cannot be stacked with wholesale market revenues because they are dispatched after the FSP has submitted its schedule to the BRP, and therefore create imbalance.[76] This would be unproblematic if the imbalance caused by the DNO flex market action was corrected for by applying a retrospective correction to the FPN submitted by the BRP, as is currently the case for services procured by the ESO. However, we understand that such corrective retrospective actions are not undertaken for DNO flex products.[77]

participate in the DNO flexibility market if it could offer a further 5MW of capacity (i.e. a total of 10MW rather than 5MW). We note that a report written for the ENA in 2020 stated that DNO flex services are not stackable with ESO flexibility markets. This is correct in the case of assets that do not receive a 0 baseline from DNO flex markets (i.e. DSR), which is likely to be the majority of assets in DNO flex markets. See Energy Networks Association (2020), 'Open Networks Project DNO Flexibility Services Revenue Stacking', pp. 19–20, available here.

[72] Energy Networks Association (2020), 'Open Networks Project DNO Flexibility Services Revenue Stacking', p. 9, available here.

[73] This is reflected in the ENA's summaries of the ability to stack DNO flex services. Energy Networks Association (2020), 'Open Networks Project DNO Flexibility Services Revenue Stacking', pp. 19–20, available here.

[74] The BRP is the party that is responsible for maintaining the balance of supply and demand for electricity of all generation and demand assets included in its portfolio.

[75] The FPN describes the amount of physical net import or export that a particular BRP expects across its portfolio. Import is defined as flows of electricity to a BRP, and export is defined as flows of electricity away from a BRP.

[76] Ibid.

[77] Energy Networks Association (2020), 'Open Networks Project DNO Flexibility Services Revenue Stacking', p. 6, available here.

While the discussion above focuses on the challenges in stacking revenues within the same time period, based on discussions with industry stakeholders, we also understand that it can be difficult for FSPs to stack revenues in sequential time periods. The main reason for this is that, according to the FSPs we spoke with, service windows provided by DNOs are relatively wide, meaning that if the FSP is providing a non-stackable service to the DNO, it is unable to participate in wholesale or ESO markets for large parts of the day. If service windows were narrower then FSPs would be able to provide more services in a given day than they currently do. We understand from SPEN that these wide service windows arise primarily with the Dynamic service but, as we showed in Figure 2.1, this is the product that is procured in the largest capacities.

The medium-importance barrier that we identified is that some FSPs have told either us or SPEN that they **need long-term revenue certainty for new-build assets**. This refers to the fact that, if there are no assets in a particular constraint location, then any FSPs that provide flexibility services through larger assets such as generators or storage (i.e. anything other than demand response) will need to construct that asset in the specific constraint location in order to earn revenues from DNO flexibility markets. As these larger assets are relatively CAPEX-intensive (note that this is less likely to be the case for DSR), FSPs may be more likely to locate in a given constraint location if they believe that providing services to DNO flexibility markets will support CAPEX recovery, particularly over the medium to long term, in line with the life of the asset(s). These types of FSP investments may therefore need to be incentivised by providing certainty over long-term revenue streams, as without such certainty the FSPs are unlikely to adjust their locational decision to support the provision of DNO flexibility services.

Currently, DNO flexibility markets do not provide this sort of long-term certainty because:

- of all the tenders that we have seen on Piclo, the longest duration was for just under nine years, with very few being for more than seven years.[78] This is considerably shorter than the contract duration offered by the Capacity Mechanism, which is 15 years for new-build plant assets and offers higher annual revenues;[79]
- the revenue that can be realised from a given contract is unclear due to the utilisation risk, as explained above.

There is a tension between the needs that FSPs have for long-term price certainty and the difficulties for DNOs of entering into long-term pricing commitments. The tension exists because anything that provides the former would likely exacerbate the latter. This is an issue that we will address in section 5 when we discuss possible solutions to the barriers that we have identified.

The low-importance barrier that we identified is that there is **insufficient liquidity** in the market to give confidence about efficient price formation. While liquidity can have a different meaning when

[78] We defined the duration as the length of time from the closure of the tender to the end of contract delivery period. Oxera analysis based on Piclo data available here, accessed on 28 March 2023.
[79] The statement about higher annual revenues comes from an interview with an FSP.

used in different contexts or when applied to different markets, the way that market participants have used it in the context of DNO flexibility markets is to describe low volumes of bidding into tenders. This low level of liquidity is likely to increase the volatility of tender results, meaning that historical prices are not a good guide to future prices. For example, some zones may have high prices if there is a low volume of bidders and the incumbent FSPs therefore know that they can charge prices close to the ceiling prices that DNOs publish. Therefore, as the market evolves and more FSPs start bidding into tenders, the prices may move away materially from the levels they have been at historically.

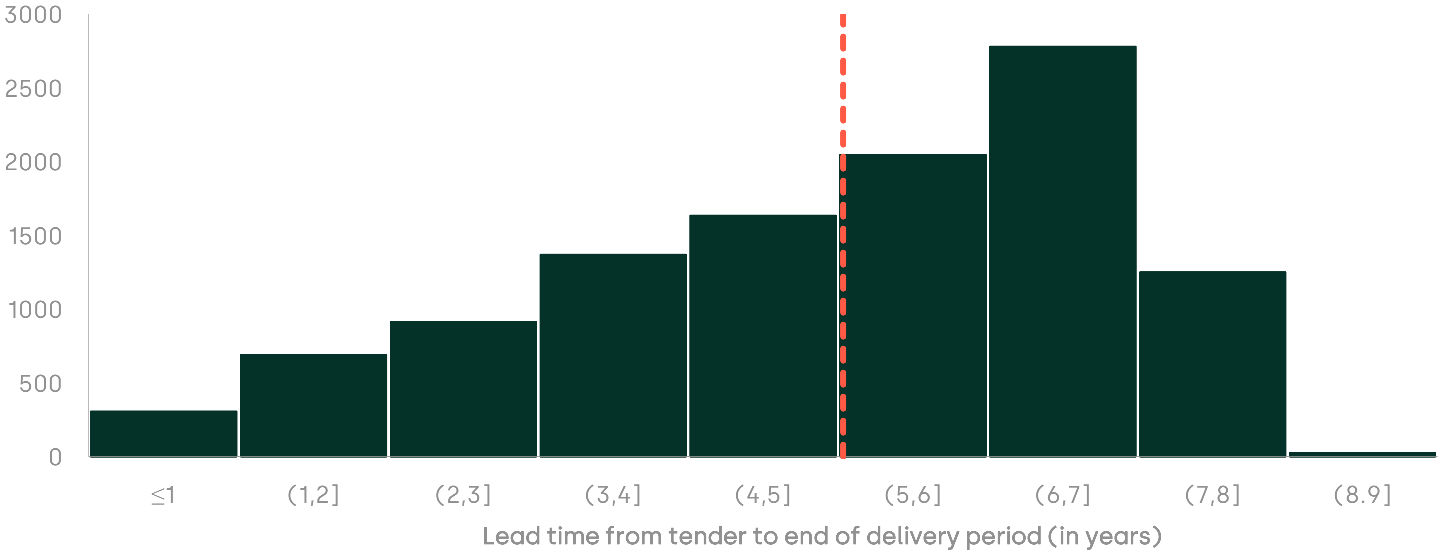
If historical prices are not a good guide to future prices, FSPs may be less likely to bid into DNO flex markets. However, the reason why we have categorised this as a low-importance barrier is because, in principle, FSPs' bids could be based on their expected costs (and opportunity costs) of participating in the DNO flex market. Furthermore, if the issues discussed in section 3.2 were reduced, then participating in a tender (even with an unknown probability of success) would be less costly from the FSP's perspective. Therefore, it appears reasonable to consider that insufficient liquidity is a relatively modest barrier.

3.4 The difficulty of making longer-term commitments

We have identified two barriers that arise from the difficulty of making long-term commitments. One of these is of high importance and the other is of medium importance.

The high-importance barrier is **that long lead times from tender to delivery mean that FSPs need to make long-term pricing commitments**. Figure 3.4 summarises the tender durations, defined as the length of time from the end of the tender until the end of the contract delivery period, in DNO flexibility markets. Each histogram 'bin' (listed on the x axis) summarises the number of tenders that occurred for flexibility solutions with a duration that fits within the bin's range. The most popular tender lengths are five to seven years, with a mean tender length of five years.

Figure 3.4 Lead times from end of tender to end of contractual delivery period



Note: The red dotted line represents the mean lead time from end of tender to end of delivery period. The figure includes tenders from all DNOs tendering flexibility on Piclo, namely ENWL, NIE Networks, SSEN, SPEN, UKPN and WPD.
Source: Piclo data.

Owing to these long lead times, FSPs have to take a view on the following three factors when putting together their bids.

- First, they have to consider the capacity of the assets that they are likely to have in a particular constraint location in the future. This is only a problem when talking about FSPs that provide services using planned assets, most of which are domestic and EV Aggregators. In general, one would expect this to result in FSPs under-bidding the volumes of assets that they can provide, meaning that their revenues are lower than they would be if tenders were conducted for time frames over which they had more certainty. However, SPEN has also explained to us that in past tenders, EV Aggregators have had to withdraw from the contracting process because they were unable to recruit sufficient assets.
- Second, FSPs have to consider the opportunity cost of participating in a particular DNO flexibility market. This is mainly a problem for assets that offer DSR on either an individual or an aggregated basis, as they cannot revenue stack as easily as generation and storage assets (as we explained above), and therefore need to understand the magnitude of their forgone revenues.
- Third, FSPs have to take a view on future OPEX, including commodity costs. This is likely to mainly be a problem for generators and (electric) storage operators because they will need to forecast the costs of gas and electricity respectively so that they know how much to charge for turn-up of generation or discharge of electricity.

It should be noted that these long-term pricing commitments are at odds with the trends in ESO flexibility markets, which have been moving towards real-time procurement of flexibility. For example, the Short-term Operating Reserve (STOR) market has increasingly started to make use of daily auctions rather than long-term contracts.[80] Further, the Enhanced Frequency Response (EFR) product, which had contract lengths of up to four years,[81] has been replaced with the Dynamic Containment product, which has contract lengths of 24 hours.[82]

The medium-importance barrier is that **having to decide on the availability of assets in advance is challenging** for domestic and EV Aggregators, particularly when it comes to smaller constraint locations. When a constraint location is relatively small, domestic and EV Aggregators are unlikely to have many assets located in it. This makes it harder to forecast whether the domestic customers that the Aggregator has contracted with will turn down their consumption, or whether an EV owner will be charging their car at that particular point in time. Therefore, it is harder for the FSP to know what quantity of DSR

[80] Lempriere, M. (2021), 'National Grid ESO hails milestone as STOR moves to daily auctions', *Current*, 1 April, available here, accessed on 30 March 2023.
[81] Arora, K. (2016), 'Energy Storage: Behind the Meter Part 2 - Ancillary Services', available here, accessed on 30 March 2023.
[82] National Grid ESO (2020), 'Dynamic Containment FAQ', p. 2, available here, accessed on 30 March 2023.

will be available to respond to a signal from the DNO. For this reason, domestic and EV Aggregators told us that they often make conservative availability declarations. If they did not have to make conservative decisions, they would have tended to bid more capacity into the tender, and therefore would have been able to receive more revenue.

4 Barriers to the participation of domestic customers in flexibility markets

We have also assessed the barriers that domestic customers face when engaging with flexibility markets. When discussing the barriers that FSPs face in the section above, our assessment was focused exclusively on the barriers to uptake in DNO flexibility markets. However, in discussing domestic customers in this section, we consider their participation in both DNO flexibility markets and other flexibility services (i.e. ESO flexibility services and behind-the-meter optimisation, for example in response to TOU tariffs).[83]

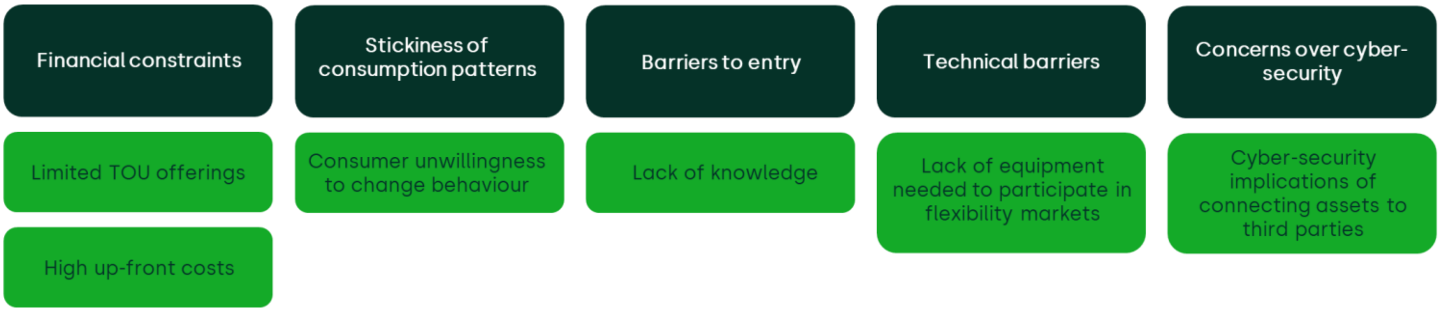
The reason for taking a wider perspective on flexibility for domestic customers is because they engage not with specific markets but with specific products or intermediaries (i.e. TOU tariffs or Aggregators). If domestic customers have a TOU tariff but are not contracted with an Aggregator, they adjust their consumption (if they want) to the price signals they receive. This does not directly support DNO flexibility markets but, to the extent that there is a positive correlation between distribution network constraints and high end-user electricity prices, their actions will still alleviate grid constraints. Furthermore, if the customer has an additional contract with an Aggregator, or their Supplier is also an Aggregator, then the customer may indirectly participate in DNO flexibility markets. From the perspective of the domestic customer, however, their interaction with DNO flexibility markets and TOU tariffs may be very similar, as in both cases they will either have their consumption automatically optimised by a third party, or be required to respond to signals (likely via a smart phone app) to turn down consumption at certain times.

Based on our research and interviews with EV and domestic Aggregators, there are fewer market barriers to domestic customers participating in flexibility than there are for FSPs. However, many of the barriers that are faced by FSPs have knock-on effects on domestic customers because anything that makes market participation for FSPs more costly (including in terms of time taken to access the market) also reduces the financial benefits that FSPs can pass on to domestic customers. Since one of the biggest barriers faced by domestic customers is the real and perceived lack of financial benefit (see section 4.1), relieving the FSPs' barriers would therefore also be likely to increase domestic customer participation.

As in section 3, we have grouped the barriers that we have identified into five categories, although these five categories have fewer barriers within them than the categories we identified for FSPs. These categories are presented in Figure 4.1 below, and we discuss each in turn throughout this section.

[83] As explained in section 2.2, domestic customers can also participate in flexibility at the ESO level and by offering behind-the-meter optimisation in response to the incentives provided by TOU tariffs.

Figure 4.1 Barriers faced by domestic customers

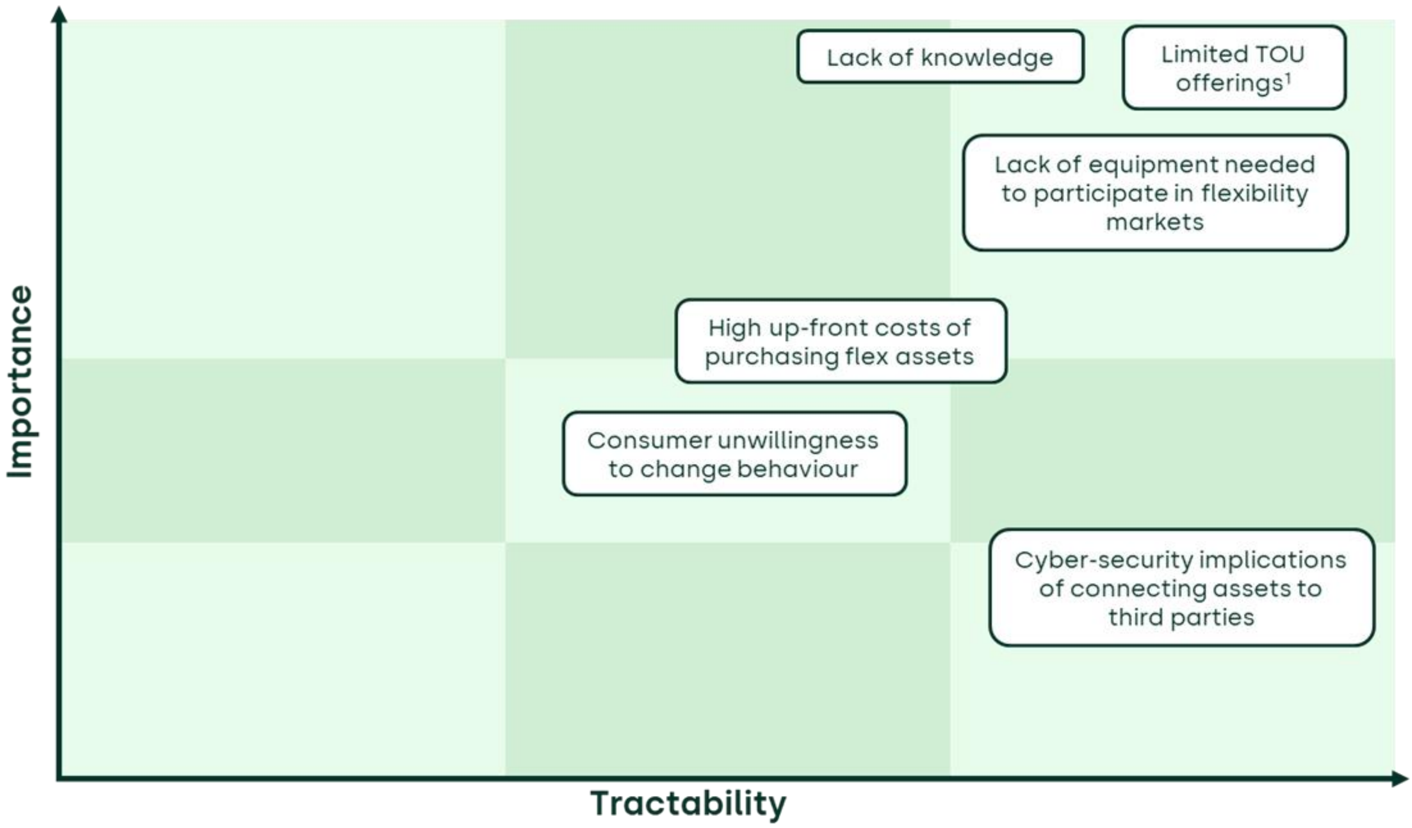


Note: TOU stands for Time of Use and refers to a type of energy tariff where consumers face more than one price during the day.
Source: Oxera.

We have also evaluated the individual barriers presented above in terms of our initial views of their (i) importance, and (ii) tractability (i.e. how easy we think it might be to find a solution to them). This mapping has allocated each barrier to a high, medium, or low level of importance, and a high, medium, or low level of tractability.

The stylised results of this mapping are visualised in Figure 4.2 below.

Figure 4.2 Stylised categorisation of barriers, by importance and tractability



Note: [1] TOU, Time of Use.
Source: Oxera.

In the remainder of this section, we discuss each grouping of barriers in turn.

4.1 Financial constraints

We have identified two main financial constraints that domestic households face, one of which we are hypothesising to be of high importance as a barrier and the other which we have assessed to be of medium importance.

The high-importance barrier is the fact that there are a **very limited number of TOU tariffs where the price varies on a half-hourly basis**. When we first conducted some analysis in June 2022, we found that on the price comparison website MoneySuperMarket there were no TOU tariffs of any sort and on QuoteZone there were only two, neither of which varied on a half-hourly basis.[84] When we undertook this research again in March 2023, we found only one TOU tariff that varies on a half-hourly basis being offered in the market, with the provider in question also recommending against choosing the tariff for most customers due to high price volatility during the ongoing energy crisis.[85]

The medium-importance barrier is that there are **high up-front costs** of purchasing some of the equipment that may be needed to provide flexibility. For example, behind-the-meter batteries can cost well in excess of £5k,[86] although cheaper options are also available.[87] Furthermore, customers may need to pay for upgrades to their property, such as for fuses with larger current limits, when they install an EV charge-point.[88] While these items are not necessary for providing flexibility services, they do increase the extent to which a household can offer flexibility.[89]

The highest level of financial incentives to provide flexibility services are enjoyed by households with high electricity consumption, such as those who own an EV, heat pump or advanced batteries. Without these, to get any meaningful incentive to participate in the flexibility markets the household would need to turn all of their appliances 'smart'. This requires effort and investment and may not be viable for older appliances. For example, according to MSE, an average 'smart' thermostat will cost a consumer around £200–£300,[90] and this would be only one of many appliances that a customer would need to

[84] Research conducted on 22 June 2022.
[85] For more detail see Octopus website, available here, accessed on 30 March 2023.
[86] For example, according to Joju Solar, the total cost for a fully installed Tesla Powerwall 2 system is £12,970 to £17,760, although according to Solar Guide, the cost is more like £6,700–£8,700. Joju Solar, 'Tesla Powerwall', available here. Joju Solar, 'Tesla Powerwall', available here. Solar Guide, 'Tesla Powerwall 2.0 Cost, Specs and Reviews', available here.
[87] EDF's Powervault 3 starts from £3.3k. PES, 'EDF Energy launches competitive home battery system for solar PV', available here, accessed on 30 March 2023.
[88] For more details, see the UK Power Networks website, available here, accessed on 30 March 2023.
[89] This is because: (i) regarding the fuse, EVs are typically the domestic assets that consume the most electricity and therefore having a domestic charge-point means that a customer can have a more material impact on the load on the grid than if they do not have a charge-point; (ii) regarding the battery, a customer may be able to respond more efficiently to price signals because if they, for example, need to use electricity to cook or watch TV, then they can discharge their battery rather than draw electricity from the grid (thereby reducing the load on the distribution network).
[90] For more details, see the Money Saving Expert website, available here, accessed on 16 March 2023.

purchase to make their home 'smart'. Furthermore, research commissioned by Citizens Advice[91] suggests that for households without EVs and heat pumps, the current potential annual energy bill saving is approximately £5. This saving would need to be split between the Suppliers, FSP, networks, and end-customer. Therefore, there are unlikely to be purely financial reasons for consumers without electricity-intensive assets to invest in smart home technology.

Overall, these factors decrease the willingness of consumers (outside of a relatively narrow high-usage group) to participate in the market. Despite this, the high-usage group can be reasonably expected to grow in the future, given the ban on the sale of new combustion engine vehicles in the UK in 2030[92] and the fact that heat pump installations are expected to increase.[93] For this reason, we consider this to be a medium- rather than a high-importance barrier.

4.2 Stickiness of consumption patterns

We have identified one barrier within this category, which we consider to be of medium importance. This barrier is that some consumers may be **unwilling to change their consumption levels** in response to price signals. If consumers are unwilling to change their electricity consumption, it will be difficult to aggregate domestic demand to provide flexibility services—as it will only be effective at high prices, at which point it may no longer be economical for the DNO to choose flexibility over network reinforcement.

The willingness of consumers to change consumption patterns has been shown to differ between different types of activity, with time-critical activities such as leisure (e.g. watching TV) and cooking or eating being less likely to shift than others such as household cleaning activities (e.g. washing machines, dishwashers).[94] Furthermore, evidence from trials of TOU pricing show that households substantially reduce their peak demand such that the proportion of their daily demand that is consumed during peak times is reduced by 15–17%.[95] However, the results of these trials are based on customers who chose to switch to TOU tariffs and therefore may reflect people who are particularly price-sensitive or who are more flexible in their energy use patterns. Therefore, it may be the case that these positive results are reflective of early adopters' willingness to adjust their electricity demand and not representative of all consumers. Nonetheless, as discussed in the previous subsection, it is reasonable to expect that the high electricity usage group for which the potential savings are relatively high is set to increase in the future.

On balance, there is uncertainty about the level of willingness that customers have to adjust their demand, especially if the potential

[91] For more details, see Citizens Advice, available here, accessed on 16 March 2023.
[92] Department for Transport (2020), 'Government takes historic step towards net-zero with end of sale of new petrol and diesel cars by 2030', available here.
[93] The UK government has a target of around 600,000 annual installations by 2027. For more details see the DESNZ website, available here, accessed on 30 March 2023.
[94] Smale R., van Vilet B., Spaargaren G. (2017) 'When social practices meet smart grids: Flexibility, grid management, and domestic consumption in The Netherlands', *Energy Research & Social Science*, **34**, pp. 132–140, available here, accessed on 30 March 2023.
[95] National Grid ESO (2021), 'CrowdFlex Phase 1 Report', p. 3, available here, accessed on 30 March 2023.

savings from adjustments to demand are low. If savings were higher, more customers would have the incentive to adjust their consumption. At the present moment in time, it is difficult to accurately forecast customer preferences, but the growth of high-usage customers is likely to increase the incentives to adjust consumption patterns in the future. Thus, we consider this barrier to be of medium importance.

4.3 Technical barriers

We have identified one technical barrier, which we consider to be of high importance: that **domestic customers often do not have the right equipment to participate in flexibility markets**. Most significantly, many households do not have smart meters, which are needed for all TOU tariffs and flexibility services. Only 55% of UK households have smart or advanced meters,[96] but most of these are the old SMETS1 meters, which are currently unable to remain 'smart' after domestic households switch Suppliers.[97] The result of this is that, at present, most households cannot offer flexibility services.

4.4 Barriers to entry

We have identified one barrier within the 'barriers to entry' category, which we consider to be of high importance. This barrier is that flexibility markets are relatively niche, with **most people unlikely to know that they exist** and therefore unlikely to participate in them.[98] Ofgem's Call for Input also highlighted the lack of consumer awareness as a barrier.[99] Those that do know they exist are likely to know about them at quite a high level, meaning that the proportion of people with a detailed understanding of flexibility markets, either at the DNO or the ESO level is likely to be very low.

This creates barriers to uptake in providing flexibility because domestic customers who do not know about flexibility will not engage with flexibility markets. Similarly, domestic customers who have a limited understanding of flexibility markets will be likely to need support from a third party such as an Aggregator in order to understand how and why they benefit from participating in flexibility markets. It is notable that the websites of many domestic and EV Aggregators provide prominent information about the benefits of providing flexibility,[100] possibly in an attempt to mitigate against this barrier.

It is well established in the behavioural science literature that activities that require people to opt in, particularly activities that they

[96] Department for Energy Security and Net Zero (2023), 'Smart Meter Statistics in Great Britain: Quarterly Report to end December 2022', p. 1, available here, accessed on 30 March 2023.
[97] Department for Energy Security and Net Zero (2023), 'Smart Meter Statistics in Great Britain: Quarterly Report to end December 2022', p. 4, available here, accessed on 24 March 2023.
[98] ACER (2016), ' ACER Market Monitoring Report 2015 - Electricity and Gas Retail Markets', 9 November, p.30, available here, accessed on 21 March 2023.
[99] Ofgem (2023), 'Ofgem call for Input on the Future of Distributed Flexibility', p. 27, available here.
[100] In both of the following cases, the link can be navigated to directly from the banner on the homepage. See EV.Energy and Ohme's websites, available here and here.

do not have much information on, tend not to be undertaken.[101] Given that participation in flexibility markets would require domestic customers to learn about niche and complex parts of the energy market, this unwillingness to opt in is likely to be particularly pronounced. This may explain why, in our interviews with domestic and EV Aggregators, difficulties in recruiting new customers have been frequently cited as a barrier to providing flexibility.

We have categorised this as a high-importance barrier because it seems plausible that lack of awareness, combined with the behavioural biases that prevent individuals from undertaking cognitively challenging tasks, are among the biggest barriers to uptake of flexibility services. This is consistent with the findings of a study undertaken for Ofgem, which concluded that low awareness of TOU tariffs was the biggest barrier that prevented EV owners from taking up TOU tariffs.[102]

4.5 Concerns over cyber-security

We have identified one barrier within this category, which we have categorised as being of low importance: that **domestic customers are concerned about the cyber-security implications** of allowing third parties such as Aggregators to control their assets.

Many Aggregators automate the energy usage of their customers' assets, meaning that customer assets are connected to Aggregators' IT systems and controlled by them. Therefore, any bad actor that successfully launched a cyber-attack against an Aggregator could, in principle, gain control over domestic customers' assets. If this was seen by consumers as a realistic possibility, then it could reduce domestic customers' willingness to sign up to Aggregators, thereby limiting their involvement in flexibility markets.

We have categorised this as being of low importance because while, in principle, this seems like it could be a reasonable concern, it has not been raised as a material barrier in recruiting consumers in our interviews with FSPs that perform domestic / EV aggregation services.

[101] See, for example, Jachimowicz, J., Duncan S., Weber E., Johnson E. (2019), 'When and why defaults influence decisions: a meta-analysis of default effects', available here, accessed on 30 March 2023.
[102] Ofgem (2020), 'Energy consumers' experiences and perceptions of smart 'Time of Use' tariffs', p. 7, available here, accessed on 30 March 2023.

5 Solutions to the barriers in the market

As explained in earlier sections, some of the barriers that the FSPs identified are fundamental features of the market, and therefore relatively little can be done to solve them. The focus of this section is therefore to identify solutions that would reduce or remove these barriers. This is an important distinction because the barriers to participation in DNO markets could, in theory, all be addressed by paying more to FSPs, but this would come at the cost of increased customer bills, as DNO costs are ultimately recovered from customers.

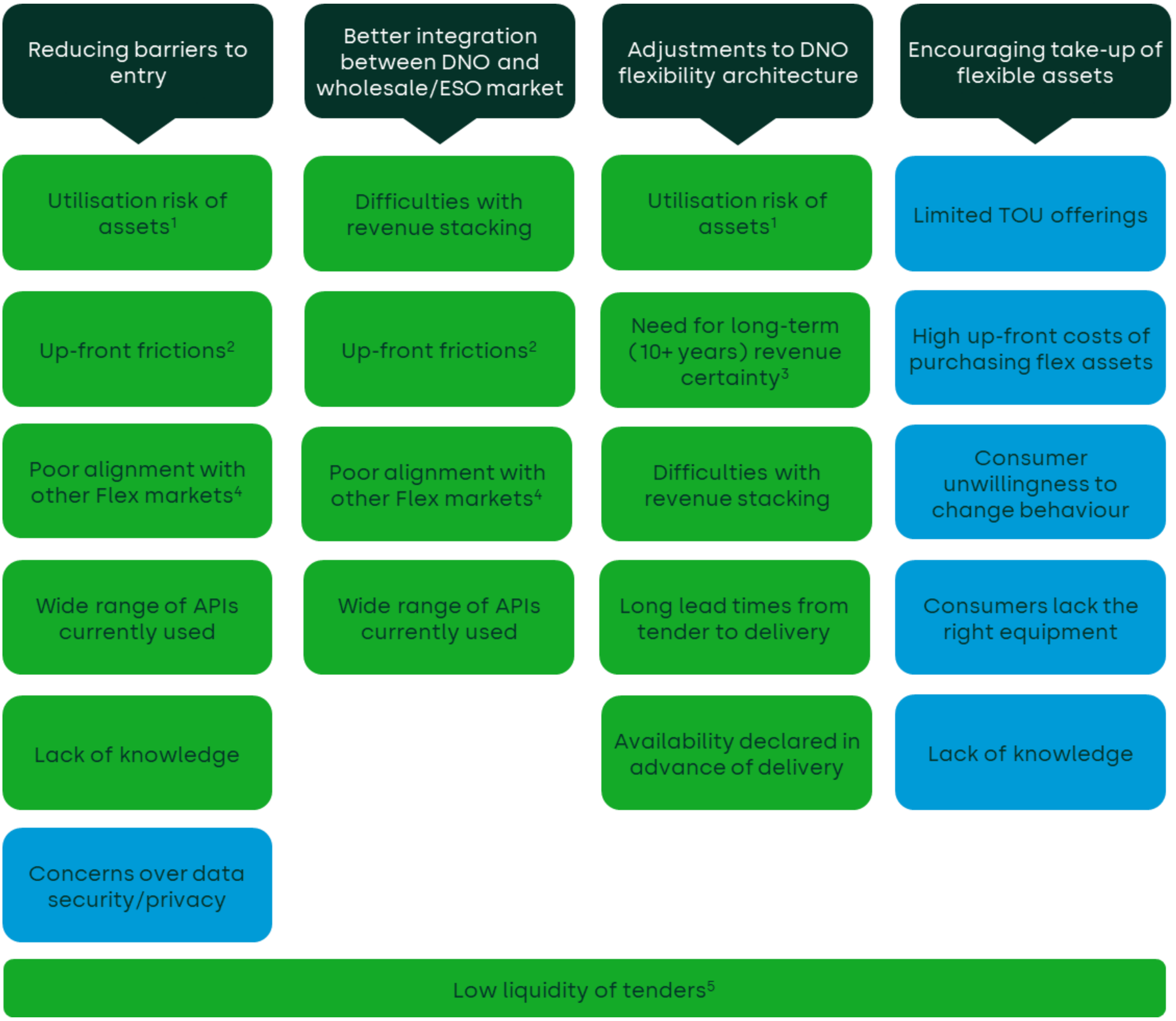
When considering solutions to the barriers in the DNO market, we have not separated the solutions between those that address the barriers faced by domestic customers and FSPs. This is because many of the solutions affect both of these groups, and also because some of the barriers are inter-related. For example, the financial constraints that customers face affect their willingness to electrify, which in turn means that it may take longer for Aggregators to recruit assets to provide DSR.

This section describes four groups of solutions, listed in order of importance, that we consider stakeholders in the DNO flexibility market could focus on to reduce the barriers identified in sections 3 and 4. They are::

- reducing administrative barriers to entry (section 5.1);
- better integration between DNO markets and wholesale / ESO markets (section 5.2);
- adjustments to DNO flexibility market architecture (section 5.3);
- encouraging take-up of assets that can be recruited by FSPs participating in DNO flexibility markets (section 5.4).

Figure 5.1 below maps each of the barriers that we consider could be at least partially addressed to the solution group that aims to solve it.

Figure 5.1 Solution groups and the barriers they address



Note: Dark green shading represents solution groups; light green shading indicates barriers faced by FSPs; blue shading indicates barriers faced by domestic customers. The barrier 'inter-temporal nature of the market' is not included in this figure because it is a fundamental characteristic of the flexibility market that we do not think can be resolved. [1] Utilisation risk of assets means that committed assets may not be dispatched. [2] By 'up-front frictions' we mean issues such as the pre-qualification process that FSPs have to undertake and the fact that contracts are long and complicated. We explain this in further detail in section 3.1. [3] Revenue certainty can be provided for a small number of years but not for long (10+ years) periods of time, which may be a requirement for CAPEX-intensive technologies. This is due to the fact that, in the long term, networks may be reinforced, thereby decreasing the need for local flexibility. [4] Flex markets include ESO, Wholesale and DNO markets. [5] Low liquidity of tenders means that historical tender data may be inappropriate for future forecasting.
Source: Oxera.

We note that some of the solutions discussed below are already being developed as part of the Open Networks Project at the ENA. We provide information about the Open Networks Project's workstreams for 2023 in Box 5.1 below.

Box 5.1 Summary of Open Networks Project's 2023 workstreams

The Open Networks project is divided into four workstreams, which we provide information on below.

The **network operation** workstream includes the following objectives:

- Primacy rules for DNO and ESO service conflicts;
- Development of API standards for dispatch system interoperability across the ESO and DNOs before Summer 2024;
- Facilitation of sharing forecasts and real-time information between the ESO, DNOs and non-network stakeholders.

These objectives may contribute to addressing some of the barriers discussed in this report such as the wide range of APIs that are currently used, difficulties with revenue stacking and poor alignment with other Flex markets.

The **market development** workstream includes the following objectives:

- Improving the Standard Agreement for procuring flexibility services across DNOs and ESO;
- Simplify and standardise the pre-qualification process across DNOs;
- Align DNO flexibility product definitions.

These objectives may contribute to addressing the administrative and procedural barriers to entry.

The **planning and network development** workstream includes the following objectives:

- Supporting Ofgem in achieving common methodologies for carbon reporting;
- Reviewing and updating Network Development Plans;
- Implementing plans for receiving consistent information from Distributed Energy Resources (DERs);

The objective described in the third bullet includes streamlining the requirements for new DER connections and therefore may assist in increasing the uptake of flexible assets.

The **monitoring and keeping established work areas on track** workstream includes following objectives:

- Continuing to develop the Common Evaluation Methodology for traditional and flexible intervention options;
- Consistent information for ANM connected assets;
- Monitoring the roll-out of the Baselining tool.

Source: ENA (2023) 'Open Networks launch document' available here, accessed on 5 April 2023.

5.1 Reducing administrative and procedural barriers to entry

There are two areas that our research indicates need to be addressed in order to reduce administrative and procedural barriers to entry in DNO flexibility markets:

- the increased provision, by DNOs to FSPs, of readily available data that can be compared between DNOs and is free of charge, on the historical and future prices and volumes of the DNO flexibility market;
- standardisation of processes across DNOs (we also discuss extending standardisation to the wholesale and ESO markets in section 5.2).

5.1.1 Open data

In the context of DNO markets, open data covers the provision of historical tender results, ceiling (or guide) prices, historical dispatch levels in certain locations, and (accurate) dispatch forecasts for the future.

These are all signals that FSPs will use to understand whether they want to enter the market. Providing this information will increase the transparency of DNO markets, and so should help FSPs make informed decisions on whether they want to participate.

FSP business models are based on arbitraging between a number of different markets (wholesale markets, ESO markets, and the DNO markets), so anything that allows them to model and value the opportunity of DNO flexibility will help them make decisions. Many FSPs understand that DNO markets are a relatively small opportunity: the size of the market will not change with the publication of this data but the level of certainty that FSPs have over the revenues that they can earn will increase, which will tend to facilitate entry.

Much of the data referred to above is already published under the reporting requirements stated under condition C31E of the licence.[103] However, it is currently published separately by each DNO, meaning that FSPs bidding into different tenders need to gather and combine the data from different sources. Other industry stakeholders like Piclo also publish tender data, but as it only covers part of the industry, it does not publish data on all of the DNOs. Furthermore, data on future dispatch does not appear to be easily accessible for comparison in a similar format between DNOs,[104] notwithstanding that we observe some instances, and understand from discussion with SPEN that some DNOs, including SPEN, do already publish some of this information.[105]

[103] See, for example, SPEN's C31E report, available here.
[104] For example, while UKPN has provided expected utilisation data for all of the constraint locations it is tendering for in spring 2023, which is in line with our recommendations, this data appears to only be downloadable in PDF format. Furthermore, as it is located on the UKPN website, it is unlikely to have the same format as other DNOs' data. We also note that while we have used UKPN as an example here, we expect that similar issues may arise with other DNOs. See UKPN website, 'Spring 2023 flexibility requirement', available here.
[105] In the case of SPEN, we understand it has published its expected utilisation rather than specific dispatch schedules.

Due to the fact that the data is currently decentralised, centralising its location is likely to reduce the effort that FSPs need to go to when bidding into tenders. This suggestion builds on the data that Ofgem explained could be made available as part of the 'thin archetype' in its Call for Input. The thin archetype proposed the creation of a directory of flex providers, which would also increase transparency.[106] Further to this, our solution proposes that information about past and future tendering and dispatch is made available.

While we do not have a view on where the central repository for this information should be located, we consider that two factors need to be taken into account. First, the data should be freely available to market participants in order to prevent the introduction of additional administrative and procedural barriers to entry. Second, while it may be efficient to place every single data resource and market function with the same platform (as this would be a single point for information and interaction with the market), care should be taken to ensure that competition can still exist in the marketplace for platform services, to the extent that competition is desirable and acts in the consumer interest. If this does not happen, there is a risk that any platform that performs the centralised role will eventually have reduced incentives for improving quality and increased incentives to raise prices for users (if privately owned and unregulated[107]).

It is also important that the forecasts (i.e. ceiling or guide prices and future dispatch) that DNOs publish are accurate, meaning that they reflect: (i) the expected dispatch levels for FSPs (as these will determine their utilisation payments), and (ii) the prices that DNOs are willing to pay.

Improving the accuracy of dispatch forecasts can be achieved if DNOs invest in enhancing their forecasting capabilities. As an example, we understand from SPEN that it is making investments into modelling future dispatch more accurately by developing a model that is used to validate and improve its Engineering Net Zero (ENZ) tool, which is used to generate forecasts.

To generate confidence among FSPs, testing of DNO forecast data quality could occur on an ongoing basis, as sufficient data becomes available to carry out back-tests of forecast versus outturn data.

The ceiling/guide prices published by DNOs should be calibrated to reflect the full value that the flexibility solutions provide, as otherwise there is a risk that the price signal sent to FSPs could be overly conservative and discourage market entry. There is however a trade-off in the publication of ceiling/guide prices, as is also recognised by the European Commission.[108] On the one hand, ceiling/guide prices provide transparency to potential bidders and encourage market

[106] Ofgem (2023), 'Ofgem call for Input on the Future of Distributed Flexibility', available here.
[107] We recognise that Ofgem's Call for Input is also considering the delivery models for the common digital infrastructure, where one key question will be in relation to the ownership of any digital infrastructure. Ofgem (2023), 'Ofgem Call for Input on the Future of Distributed Flexibility', p. 50, available here.
[108] Chondrogiannis, S., Vasiljevska, J., Marinopoulos, A., Papaioannou, I. and Flego, G. (2022), 'Local electricity flexibility markets in Europe', p. 67, available here.

entry. On the other hand, if provided to markets with low participation levels and therefore where there are opportunities for FSPs to exercise market power, this may raise procurement costs for DNOs because there would be little reason for FSPs to bid much below the published price. We therefore consider that, while publication of accurate ceiling/guide prices is important at these early stages of market development, there may come a point when participation has increased to a level where these could be removed.

We understand from discussion with SPEN that it has historically published guide prices rather than ceiling prices for its tenders. These guide prices provide a 'guide' to FSPs of the likely level of bid that SPEN would be willing to accept, although SPEN also considers bids in excess of the guide price. SPEN is changing its approach to publishing these guide prices for ED2 so as to more accurately inform potential bidders about the full range of value that SPEN expects to obtain from flexibility. Box 5.2 summarises the change that SPEN is implementing.

Box 5.2 SPEN's planned change to its methodology for published guide prices

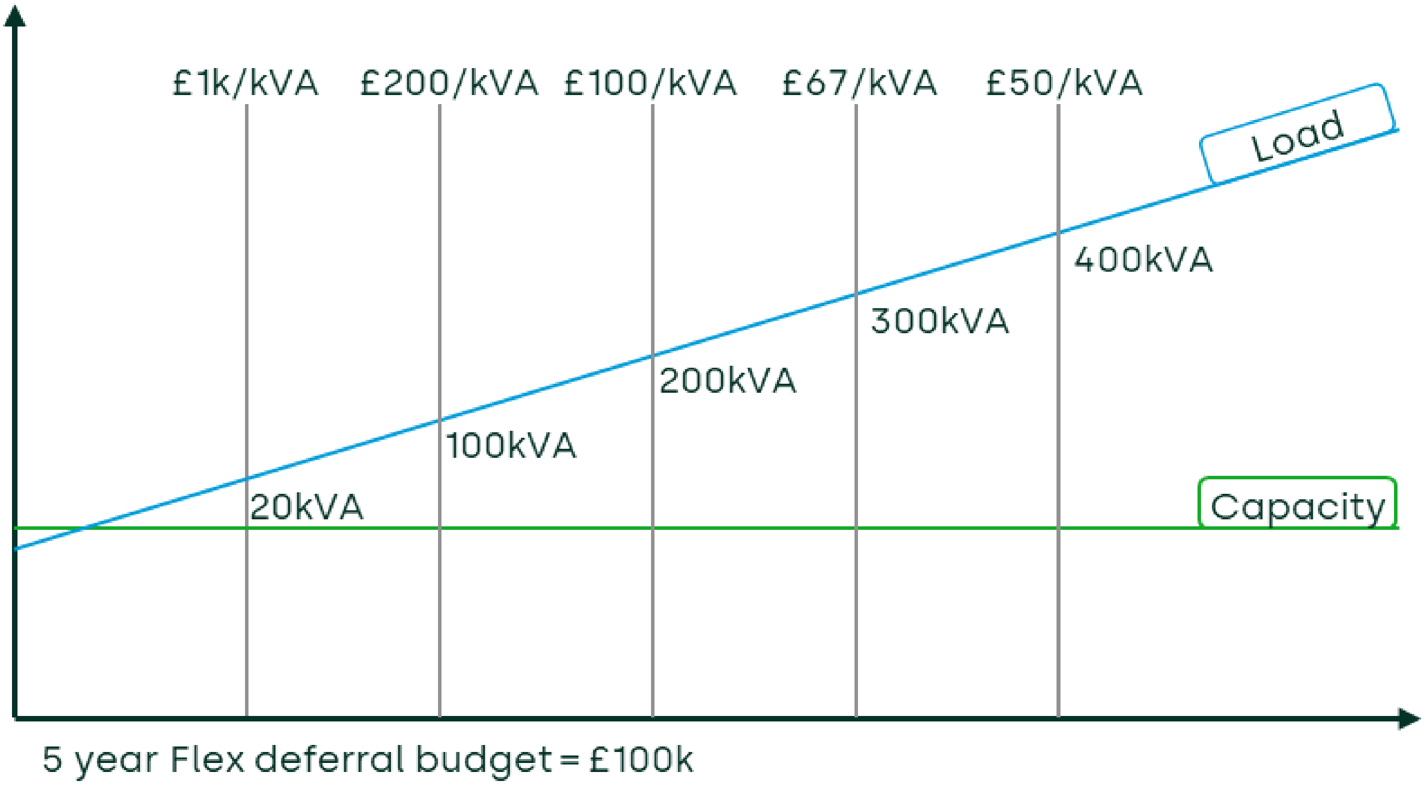
In previous tenders, SPEN has published guide prices on the basis of the saving that a flexible asset provides in the year when its saving (from deferred network reinforcement) was lowest. Now SPEN is moving to provide a range of guide prices based on the range of annual savings that the asset offers. This is depicted by SPEN on a stylised basis in the figure below, which shows the per-kVA value that a flexible asset bidding into a five-year contract provides for deferring a £20k (annual) network reinforcement expenditure.

The blue line shows the expected progression of load flowing through a particular distribution line over time, while the green line shows its capacity. The difference between the blue and green lines is therefore the 'excess load', which is the amount by which the flexible asset needs to reduce consumption or increase generation to successfully defer the network reinforcement spend.

As the excess load increases over time (by 20X, from 20kVA to 400kVA), but the cost of reinforcement does not, the per-kVA value of the flexible asset drops from £1k/kVA in the first year to £50/kVA in the final year. (We note that this change in the per-kVA value is stylised and that more realistic ranges in the value of flexibility would be likely to be narrower). SPEN would previously have published a guide price at £50/kVA, to signal that it was most likely to accept bids that are below this level—however, SPEN would have still considered bids above £50/kVA because they could still provide a lower cost solution than the network reinforcement.

SPEN's new methodology will seek to provide bidders with information on the full range of guide prices, such that FSPs perceive more clearly that some prices above £50/kVA will still be accepted. It is reasonable to expect that such an approach would tend to increase participation in tenders by signalling that higher revenues are available to FSPs, than they may have previously thought was the case.

Figure 5.2 Stylised explanation of the change in SPEN's guide price methodology



Source: Information from SPEN.

We note that alternative approaches to providing more cost transparency in relation to calibration of guide prices could be designed. For example, guide prices for utilisation could be calculated through a 'Levelised Cost of Flexibility' approach, equal to the net present value of the costs that a DNO saves over the course of the tender period, divided by the net present value of generation/demand turn-down that is required.[1]

Note: [1] This formula draws inspiration from the Levelised Cost of Electricity or LCOE, which is why we refer to it as the Levelised Cost of Flexibility. It is derived by rearranging an equality of: (i) the net present value of a stream of payments with a fixed price (i.e. what the DNO needs to pay the FSP) with (ii) the net present value of the benefits that the DNO receives from each MWh of dispatched electricity/demand reduction.
Source: Information from SPEN.

5.1.2 Standardisation across DNOs

We also consider that standardisation of contracts, pre-qualification processes, and APIs should be pursued, as long as there are no good reasons not to standardise. This is because, while the non-standardised nature of DNO markets appeared to be one of the biggest barriers that we identified for entry by FSPs, there may be cases where standardisation is counterproductive. For example, contracts for the Sustain product may need tailored scheduling provisos, whereas this may not be required for other DNO contracts.

Work is already under way on contract standardisation, with many DNOs expecting to move to a common Framework Contract that covers both ESO and DNO services.[109] However, care should be taken to ensure that the creation of a common Framework Contract genuinely reduces the level of contractual review that FSPs need to undertake, and does not just shift requirements for review to contracts for individual services. Therefore, if further contracts are required for individual DNO services, these should be kept as short as possible and restricted to areas that deviate or build on the terms of the common framework agreement. Ideally, such additional contracts should also be standardised across DNOs, which may be feasible given that we understand from SPEN that the DNOs are currently working on standardising their technical and commercial requirements for the different products, as part of their work within the ENA.

We understand from our interviews that, historically, each DNO has performed its own pre-qualification procedure, each with potentially different questions and different forms that FSPs have had to fill in. Standardisation of pre-qualification would ideally cover not just standardisation of the questions in the form, but also the removal of the need to fill in forms more than once. The end-goal of this should be a situation where, once an FSP has filled in one pre-qualification form, this could be visible to any DNO whose tenders the FSP may want to bid into.[110] Similarly, any additional information that a DNO may require from an FSP should also be shared across all DNOs as an update to the single pre-qualification form. This would avoid situations where the FSP has to respond to the same questions from multiple DNOs.

From discussion with SPEN, we understand that some DNOs including itself have adjusted their use of technology to use a single platform; SPEN is trialling the use of Piclo for procurement, dispatch, and settlement (i.e. as an end-to-end platform). This will reduce the number of APIs that FSPs need to engage with when bidding with SPEN or other DNOs that move to a single platform, but it could still lead to heterogeneity across the market. As mentioned earlier, it may be in the consumer interest to maintain (incentives for) competition in the platforms marketplace, such that it is appropriate for the industry to collectively decide on a common standard for APIs, rather than necessarily move towards a single platform.

The standardisation of these processes should also be done in a way that ensures customer data cannot be used in a way that allows anyone who views the data to identify the consumption patterns or assets that belong to individual consumers. While safeguarding consumer data is a legal requirement, it is important for this to be visible to customers in order to maintain trust in the way that their data is stored and processed.

[109] Energy Networks Association (2021), 'Why GB networks need a common and standardised agreement for flexibility services', available here.
[110] This is most likely to be relevant to company rather than asset pre-qualification. The company (i.e. the FSP) will be common across DNOs while the assets will not, due to the locational nature of the market.

5.2 Better integration between DNO and wholesale / ESO markets

There are two areas that our research indicates need to be addressed to better integrate ESO and DNO markets:

- standardisation could be extended to cover both ESO and DNO markets, rather than just DNO markets;
- there could be more coordination on flexibility products in order to make it easier for FSPs to stack revenues across the ESO and DNO markets.

5.2.1 Extending standardisation to cover wholesale and ESO markets

We have already explained how standardisation across DNO markets could be achieved and why. The reason for extending such standardisation to wholesale and ESO markets would be because many FSPs' primary market is the wholesale or the ESO market. Therefore, one of the main barriers to entry they may encounter is adding their first DNO market to their portfolio, rather than expanding from their first DNO market to a second or third.

Due to the size of the wholesale and ESO markets,[111] it is likely that there are many more flexible assets operating in these than in the DNO market. Therefore, while not all of these assets will be well suited to DNO markets (e.g. if the assets are substantially larger than the grid constraint that the DNO is trying to alleviate), extending standardisation to the wholesale and ESO markets could have a substantial positive impact on the quantity of assets that engage in DNO flex tenders.

Such a change could be implemented by extending the standardisations discussed in section 5.2.1 to also cover the wholesale and ESO markets. As mentioned, this is already being done with the ENA Framework Contract but it could be extended to also cover pre-qualification and APIs.

5.2.2 Coordination between the ESO and DNOs on flexibility products

As described in section 3.3, there are currently challenges in stacking revenues for FSPs. We consider that at least two changes to coordinating between the ESO and DNOs could be implemented, which would make it easier for FSPs operating in DNO flexibility markets to also operate in the wholesale market or an ESO market.

First, ex post adjustments could be made to the BRPs that FSPs which participate in DNO flex markets belong to. This would mean that, if an FSP was dispatched to deliver a DNO flex product, its BRP would no longer face an imbalance charge (which it would typically then pass back to the FSP). This would increase the assurance that BRPs have in relation to their FSP members participating in DNO flex markets, and also reduce the costs that FSPs incur when delivering on their flexibility product (as the imbalance that they cause to their BRP will in many cases need to be paid by them). As mentioned earlier in section 3.3, these ex post adjustments are already implemented for ESO markets

[111] See section 3.1 of this report.

through the Applicable Balancing Services Volume Data (ABSVD),[112] so it may be appropriate to assess whether this is also possible for DNO markets.

Second, clear primacy rules could be introduced to ensure that DNO and ESO markets do not conflict with each other. Currently this can happen if, for example, a generator providing a generation turn-down service for the ESO (such as through a Transmission Congestion Management product or the Balancing Mechanism) is utilised in the same location as a DNO flexibility product for generation turn-up.[113] Introducing primacy rules, alongside the required infrastructure to facilitate interaction and data sharing between the DNO and ESO,[114] would be likely to increase the confidence that DNOs (and the ESO) have in utilising flexibility. As this would effectively increase the value of flexibility to DNOs, it may further increase the quantities of flexibility that they are likely to tender for, or the ceiling/guide prices that they are willing to pay. We understand from discussion with SPEN that work on this is already underway between the DNOs and ESO.[115] However, further work is likely to be required in order to resolve these issues because we understand that the ENA's work is currently at trial phase.[116]

Both of the above changes would either enable FSPs to earn higher revenues from DNO markets than they currently do (by allowing them to participate in multiple markets simultaneously), or reduce the opportunity costs of participation in DNO markets. The higher revenues, or lower opportunity costs, would tend to increase the incentives for FSPs to enter DNO flex markets.

5.3 Adjustments to DNO flexibility market architecture

There are two areas where we considered that DNO flexibility market architecture could be improved:

- adjusting tenders to cover a range of different time horizons;
- reducing the length of availability windows where possible.

5.3.1 Adjusting tender time horizons

Developing markets with different time horizons would require DNOs to have some tenders for longer periods of time (perhaps a couple of years), and other tenders for shorter periods of time (perhaps for a couple of months or even a couple of weeks). As the market matures and volume increases, a move towards very short-term markets (such as day ahead or even near real time) could happen, if required and feasible. A longer-term aim for more short-term tenders is consistent with the way frequency response markets have developed in the UK:

[112] Ofgem (2022), 'Applicable Balancing Services Volume Data Methodology Statement', section 1.2, available here.
[113] This example is an extension of the second use case listed in Energy Networks Association (2022), 'Primacy Draft Rules Increment 1', p. 11, available here.
[114] Ibid., pp. 19–22. This shows examples of how new data exchange and coordination between DNO and ESO could be implemented in practice.
[115] Some work has already been published, such as Energy Networks Association (2022), 'Primacy Draft Rules Increment 1', available here.
[116] Ibid., p. 7.

we described earlier how these started with four-year tenders but are now day ahead.[117] One development that may have made this change possible is the growth in UK battery storage capacity, with there now being 2.4GW of battery capacity available in the UK as of 2022, with over 1GW built in the last three years.[118] This means that the ESO is unlikely to be under-supplied in its tenders and therefore does not need to secure capacity for long time periods. As the number of assets accessing DNO markets grows, such a move may also become possible in DNO markets.

In the context of the DNO market, a range of tendering time frames may increase participation because it could allow for different types of FSPs to bid into tenders that better meet their needs. To contextualise this, we observe that in our discussions with FSPs and SPEN, we were told that some FSPs want longer-term revenue certainty while those that rely heavily on planned assets would prefer not to commit themselves well in advance of delivery. On the other side of the market, DNOs want reasonably long-term security over their decisions to defer network reinforcement.

The range of preferences over contract duration means that bidding into tenders may actually increase if market entry can occur for different durations. Those FSPs that prefer longer-term contracts could bid into longer-term markets, while FSPs with planned assets could make more conservative bids into longer-term markets and then 'top up' their bids in shorter-term markets.[119]

We note that a range of contract durations is commonly seen in ESO flexibility markets. For example, all of the frequency response products that the ESO procures are currently exclusively procured through day-ahead auctions.[120] Fast Reserve is tendered from one month to twenty three months in advance.[121] STOR is procured and contracted several years in advance (currently up to March 2025), and additional tenders for top-up volumes are conducted on a day-ahead basis.[122]

While having tenders of different durations could increase participation, care would need to be taken to prevent excessive fragmentation of the market in a way that reduces total participation. This could happen because, if a very wide range of tender time frames is used, there may be a higher chance that the expected demand for one of these is mis-estimated, resulting in participation levels that are substantially below expectation. Therefore, to begin with, DNOs may want to consider having only two different time frames and to expand to a greater number of time frames gradually, if required and feasible.

[117] See section 3.4.
[118] For more details, see Solar Power portal article, available here, accessed on 27 March 2023.
[119] An example of how this could work is that a DNO could tender for 75% of its required capacity 24 months in advance, and then have a second top-up auction for the remaining 25% of capacity a few months ahead of delivery.
[120] For more details, see National Grid ESO Frequency Response Market Data, available here, accessed on 27 March 2023.
[121] For more details, see National Grid ESO, available here, accessed on 27 March 2023.
[122] For more details, see National Grid ESO, available here, accessed 27 March 2023.

5.3.2 More clarity on the length of availability windows

More clarity on the length of availability windows could refer to DNOs making either of the following two changes.

First, DNOs could reduce the length of either tendered or actual availability windows so that they only cover time-periods when an asset is being utilised. In the case of the Sustain and Secure products, it may be possible to reduce the **tendered** availability windows as the DNO market moves towards closer to real time tendering, because DNOs will have better visibility of the time-periods when constraints are likely to occur. In the case of the Dynamic product, we understand from SPEN that the availability windows are wide because it is a post-fault product and therefore there is a high degree of uncertainty about exactly when the asset will need to be dispatched. Therefore, DNOs should continue to try to shorten availability windows to incentivise higher uptake by FSPs, where technically feasible and desirable from the network's perspective.

Second, DNOs can provide more information to FSPs about the likely width of availability windows, particularly if this changes over time. With some tenders, DNOs look for flexible capacity several years in advance and therefore need to specify wide availability windows at the tender stage. However, we understand from SPEN that over time networks will gain a better understanding of which subset of the window(s) is likely to be required, and so the actual availability window that FSPs need to declare availability for is narrower.[123] While DNOs already communicate this shortening of availability windows when FSPs make their actual availability declarations, it may also be possible for DNOs to inform FSPs of any changes to the length of availability windows, further in advance.

The additional clarity on the length of availability windows should reduce the opportunity costs that FSPs face when bidding into DNO flexibility markets and help FSPs stack revenues in sequential time periods. This is because, currently, FSPs may be under the impression that the tendered availability windows are as long as actual availability windows, and therefore that participating in DNO markets will prevent them from entering wholesale or ESO markets for several hours at a time. If the availability windows were reduced, or more timely information was provided on the actual (as opposed to tendered) availability windows, then FSPs would know that the DNO market has less of an impact on their ability to bid into wholesale or ESO markets. This would allow them to potentially earn higher revenues and thereby reduce the opportunity costs of participating in DNO markets.

5.4 Encouraging take-up of flexible assets

For FSPs to participate in the flexibility markets, they have to recruit underlying assets that are able to provide flexibility. Those assets can be either generation assets or demand reduction assets. As discussed in section 4.1, only high electricity usage and 'smart' assets are likely to create sufficient financial incentives for a significant proportion of

[123] As explained in section 2.1, these declarations are often done on a week-ahead basis.

domestic customers to have interest in providing flexibility. Thus, a higher uptake of these assets should lead to more flexibility becoming available for DNOs.

While DNOs do engage with end-consumers looking to delivery flexibility,[124] most of this engagement is undertaken by Suppliers or government (for example through schemes that encourage the purchase of flexible assets). We note that this engagement with (household) end-consumers differs from engagement with FSP end-consumers (e.g. large industrials), as this is an area where DNOs engage to a greater extent.[125]

In order to increase the uptake of flexible assets via electrification (e.g. batteries, heat pumps, EVs), there is room for greater policy intervention. While the primary reason for encouraging take-up of these assets is likely to be decarbonisation of the UK economy, it is important to recognise the additional benefits they can provide in increasing flexibility markets participation rates. While a natural growth in uptake of EVs and heat pumps can be expected in the future, there are a number of specific initiatives that government and Ofgem can support, examples of which we discuss below.

The UK government can provide subsidies and help develop the market for financing schemes that reduce the up-front costs of purchasing expensive high-energy-usage assets. For example, households can receive up to £6,000 as a grant for heat pump installation through the Boiler Upgrade Scheme.[126] The uptake for this scheme is below expectations, with only about 33% of the annual budget allocated in the last three quarters.[127,128] This suggests that there is scope for the government to consider ways of adjusting the scheme to increase uptake.

In addition, smart metering infrastructure is a prerequisite to being able to participate in flexibility markets. Compared to other European countries, the UK has average levels of smart meter market penetration (at 55% relative to EU average of 51%[129]), with Spain, Italy

[124] For example, we understand that SPEN has had some engagement with community groups that own their own flexible generation/storage and are looking to use it in DNO markets to reduce the costs of local electricity bills.
[125] In SPEN's case, for example, this is done by procuring Piclo to reach out to FSPs that participate in other flexibility markets in order to gauge their interest in DNO markets.
[126] For more details, see Legislation UK website, available here, accessed 27 March 2023.
[127] Ofgem (2023), 'Boiler Upgrade Scheme, Quarterly report Issue 3', 28 February, available here, accessed 27 March 2023.
[128] A slower uptake rate may be reasonably expected from a new scheme. However, to date the quarter to quarter ramp up of participation in the Boiler Upgrade Scheme has been fairly slow (Q1: £13m, Q2: £17m, Q3: £20m; out of £150m annual budget). For more details see Ofgem report, available here, accessed on 27 March 2023.
[129] EU average calculated as the unweighted mean of the percentages presented on European Commission (2023), 'Reform of Electricity Market Design ', 14 March, p. 83, available here. UK data taken from Department for Energy Security and Net Zero (2023), 'Smart Meter Statistics in Great Britain: Quarterly Report to end December 2022', p.1, available here, accessed on 30 March 2023.

and the Nordic countries all having smart meter shares close to 100%.[130]

We consider that it is also important to increase the visibility of TOU tariffs for consumers because, as mentioned in section 4.1, there are currently very few TOU tariffs available in the market or through price comparison websites. The introduction of Market Wide Half Hourly Settlement (MHHS) may help to speed up the adoption of TOU tariffs,[131] but it is worth noting that the half-hourly settlement does not automatically imply that customers will chose TOU tariffs (i.e. they can still be settled at a flat-rate tariff on a half-hourly basis).

In the EU, there is a legal requirement for energy Suppliers to be able to offer TOU tariffs to domestic customers with smart meters.[132] It does not appear that this requirement was included in the transposition of the Directive into UK law through amendment of the electricity supply licence.[133] Given the evidence of higher TOU tariff uptake in many EU countries (over 75% in Italy, over 50% in the Netherlands and Croatia, and over 25% in Estonia, France, Spain, Sweden),[134] it may be reasonable to consider adding this requirement. While it would be preferable for the government and Ofgem to allow the market for TOU tariffs to develop 'organically', it may be helpful to monitor the following elements.

- The levels of visibility that TOU tariffs have on price comparison websites. This could, for example, be done by having specific parts of price comparison websites dedicated to these tariffs.
- The extent to which comparison websites or energy Suppliers provide tools for customers to estimate their likely bill from a TOU tariff, as well as potential savings relative to their existing (or alternative) tariffs.
- The level of TOU tariff comprehensibility. For example, research by Citizens Advice has suggested that simpler TOU tariffs should be encouraged to ensure clarity and provide a wider choice to potential customers.[135]

Moreover, the government and Ofgem could consider running information campaigns to educate and inform consumers of TOU benefits and potential financial savings. Consumer surveys and trials have showed that when fully informed, around 20% of households may be prepared to switch to a TOU tariff.[136] Therefore, it may be the case

[130] European Commission (2023), 'Reform of Electricity Market Design', 14 March, p. 65, available here, accessed on 27 March 2023.
[131] Ofgem (2018), 'Market-wide Settlement Reform: Outline Business Case', p. 21, available here.
[132] Directive (EU) 2019/944, Article 11, available here, accessed on 27 March 2023.
[133] The Electricity and Gas (Internal Markets) (No. 2) Regulations 2020, available here, accessed on 27 March 2023.
[134] ACER (2016), 'ACER Market Monitoring Report 2015 - Electricity and Gas Retail Markets', 9 November, p. 27, available here, accessed on 21 March 2023.
[135] For more details, see Citizens Advice note available here, accessed on 24 March 2023.
[136] Ibid.

that a public information campaign could materially increase TOU tariff uptake.

5.5 Conclusion

We identified in sections 3 and 4 that there are a large number of barriers that have reduced tender participation and contracting rates in DNO flexibility markets. Some of the barriers we have identified are fundamental characteristics of the market and there is therefore relatively little that can be done to overcome them: constraint management services will always be specific to a location and are not an enduring solution as the network will eventually get upgraded.

However, other barriers that we have identified can be reduced, by DNOs, the ESO, policymakers, or some combination thereof. Potentially the biggest barriers to the DNO market at present are the administrative and procedural barriers to entry, particularly as the size of the DNO market may mean that even small barriers have outsized effects on participation. Other important barriers that we have discussed, and for which we have considered potential solutions are:

- revenue risks faced by FSPs;
- the difficulty of making long-term commitments;
- various barriers faced by domestic customers, who FSPs ultimately rely on in order to deliver flexibility. These include financial constraints that prevent the purchase of flexible assets, insufficient ownership of smart meters (i.e. technical barriers), and a lack of knowledge about the existence and benefits of participating in DNO flexibility markets, or flexibility more generally.

Based on all of these barriers, in this report we have identified four groups of solutions, as follows.

Reducing administrative and procedural barriers to entry, consisting of:

- increased access to data that is free of charge and can be readily compared across DNOs for FSPs to be able to value the opportunity of DNO markets quickly, easily, and accurately;
- standardising contracting, pre-qualification, and APIs across DNOs in order for entry into one DNO's market to automatically result in entry into the other DNOs' markets.

Better integration between DNO and wholesale/ESO markets. This consists of:

- extending standardisation of contracts, pre-qualification, and APIs to cover the ESO market where possible. This is because many FSPs are likely to participate primarily in the ESO market, and therefore reducing the barriers for movement from the ESO to DNO market could have a large positive impact on participation;
- better coordination between the ESO and DNOs on flexibility products to allow for revenue stacking across the two markets. This will reduce the opportunity costs, or increase the revenues, that are available from participating in DNO markets.

Adjustments to DNO flexibility market architecture covers:

- introducing a range of tender time frames in order to allow FSPs that are better suited to long-term tendering to participate in longer-term tenders, and use the shorter time frames to allow FSPs with planned assets to 'top up' their volumes;
- adding more clarity about the length of availability windows, where possible, in order to allow FSPs to move between different DNO and non-DNO markets more easily.

Encouraging take-up of flexible assets is targeted at increasing flexible asset uptake among end-consumers. This includes focusing on a mix of policies to encourage (smart) electrification, increased access to TOU tariffs, and enhancing consumer awareness of the benefits of flexibility.

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