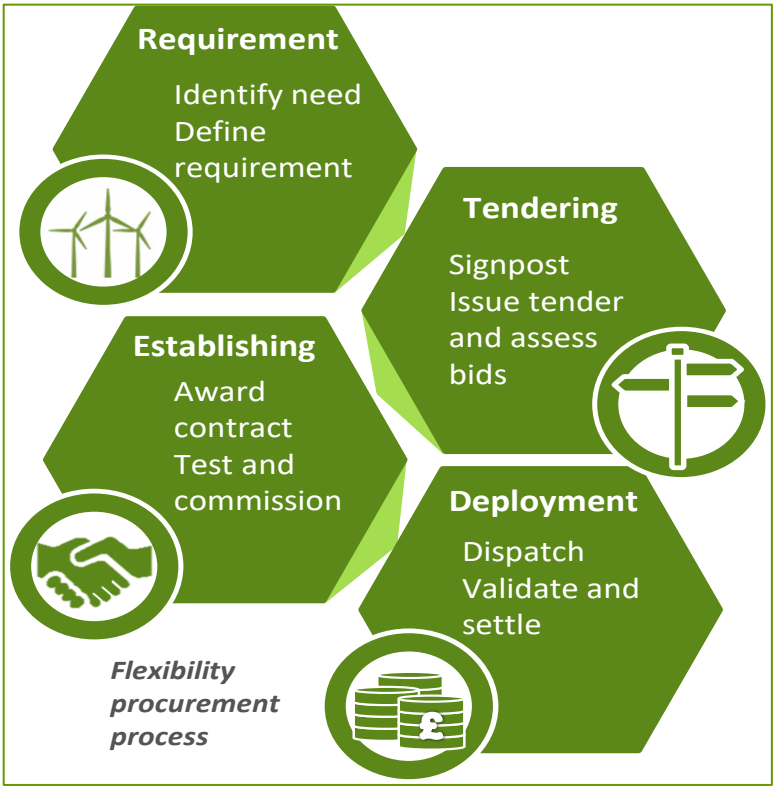
Valuing Flexibility Services for the Distribution Network

January 2020



1. Introduction

The energy landscape is changing fast as the way we generate, distribute and use energy evolves. To deliver Net Zero carbon targets, a significant proportion of transport and domestic heating demand will need to be electrified. We're also going to see an increase in renewable generation. This new demand and generation will push distribution power flows beyond existing network capacity in many areas.

Given the unprecedented magnitude and impact of these changes, DNOs need to develop the way we design, build and operate our networks and explore new solutions.

As we transition to a Distribution Services Operator, the use of flexibility services (which is where we pay third party assets to operate in ways which benefit the network) is one such new solution to help us continue to deliver a safe, reliable, economical and decarbonised supply to customers.

Given the potential benefits of flexibility services, we are committed to considering flexibility as an alternative to all significant network reinforcements. We are also exploring other planning and operational use cases. To date, we have tendered for over 230MVA of flexibility services, we were the first DNO to publish site specific ceiling rates, and we are still the only DNO to tender for reactive power flexibility services.[1]

But to effectively and economically use flexibility services, we need to be able to identify where they are the best value solution to a particular network problem[2]. To do this, **we need to be able to value flexibility** on a site-specific basis.

We are committed to being transparent around our flexibility procurement decisions and explaining how we value flexibility is a key part of this. This document explains the method we have developed to value flexibility.

This is not a formal consultation but feedback and input is welcomed and encouraged.

For stakeholders interested in the valuation of flexibility, we would also alert you to Product 1 of Workstream 1a of the 2020 Open Networks project. This workgroup, which we will be jointly chairing, is looking at developing a common method of valuing flexibility across all DNOs. This project is run by the ENA who can be contacted at opennetworks@energynetworks.org for more information.

[1] For details of our ongoing flexibility tender, please visit our web-site https://www.spenergynetworks.co.uk/pages/flexibility.aspx

[2] DNOs have an overarching obligation to economically and efficiently operate the network. We should therefore only be using flexibility where it is the best value solution.

2. Flexibility Financial Model

Our approach

When considering how to best solve network problems, DNOs typically have a number of solutions to choose from (e.g. reinforcement, reconfiguration, flexibility). We need to identify the 'best value' solution; this is the solution that is *better value than all the other solutions*. This point is key – it means that if flexibility can solve the problem at lower overall cost than the counterfactual solutions, then flexibility is the best value solution.

This comparative assessment approach means that the value of flexibility (i.e. the amount of money we have to spend on flexibility services: the "service pot") in any given scenario is determined by the cost and value of the counterfactual solution (e.g. a reinforcement), and not by the required volume of flexibility services. This amount we're willing to spend (on flexibility services) is determined by the cost we're seeking to avoid (the counterfactual solution).

For example: to solve a network constraint the model calculates that the counterfactual solution (a reinforcement) equates to a cost of £50,000/year. This means that if we can procure flexibility services for less than £50,000/year to solve the constraint then flexibility services are the best value solution; £50,000 is our "service pot". The "service pot" size is determined by the counterfactual solution, and not by the volume of services we need to procure.

Our flexibility financial model does two things to achieve this comparison and calculate the service pot size. For the two solutions (i.e. flexibility and the counterfactual solution to which it is being compared):

1. It converts the counterfactual solution(s) to a £/year basis, so we are considering all solutions on the same financial basis. This is necessary, for example, to get an equitable comparison of a 45-year reinforcement scheme with a three-year flexibility contract.
2. It calculates a range of other Value Factors (beyond just the cost of the counterfactual solution) which will affect the service pot size and uses them to adjust the pot size.

Value Factors

A simple model would only compare the ***cost*** of two solutions to identify which is the best value. However, this approach would ignore all the differing ***benefits*** of the two solutions. For example: if using flexibility services to defer building a new overhead line also defers £1000/year of associated operation and maintenance (O&M) costs, then that additional benefit of flexibility services should be factored into the service pot. Our method considers both the differing costs and benefits of the two solutions.

We call all these costs and benefits that determine the size of the service pot 'Value Factors'. Value Factors are ***factors that affect the service pot size by changing value depending on whether you use flexibility services or the counterfactual solution***. We are interested in their relative value between services and the counterfactual solution, not their absolute value – we need to do an intervention, so it's about finding which is the best-value solution.

We considered a long-list of potential value factors. Each Value Factor had to pass two initial tests to be considered for inclusion within the model:

- **Test 1: Causal Relationship.**
  Is there a clear causal relationship? i.e. will the Value Factor be affected by the use of flexibility services? For example, using flexibility services is unlikely to affect the cost of fixing network faults, so 'network repair costs' is not a Value Factor.

- **Test 2: Can DNO Manage the Value Factor?**
  Are DNOs allowed to manage that Value Factor? For example, using flexibility services may reduce the need for system peaking plant, but it is beyond a DNO's licenced remit to spend customer money for this reason, so it is not a Value Factor.

Six Value Factors passed these two tests:

Value Factor	Description
Deferred Capital Cost	The benefit from deferring the cost of the counterfactual solution. This is where the cost of the counterfactual solution is considered.
Value of lost load - Customer Minutes Lose (CML) and Customer Interruptions (CI)	This compares the difference in reliability between flexibility and the counterfactual. The impact of failure (the number of lost customers and the time to restore supplies – CI and CML) of flexibility and the counterfactual solution is assumed to be the same, so this is determined on the likelihood of failure (i.e. the reliability of the intervention).
Losses	This difference in the value of distribution electrical losses between flexibility and the counterfactual solution. Losses could differ between two solutions due to differences in power flows (network current) and the resistivity of network assets.
O&M (operation & maintenance) costs	Any difference in O&M costs between the two solutions.
Health Indices (HI)	Each network asset has a health index (rated 1-5) which is a way of tracking changes in their condition over time. This Value Factor reflects whether flexibility involves deferring the replacement of existing assets and their HI rating.
Optionality benefit	Optionality benefit is the option value of deferring an investment decision in a fixed asset. Where there is high uncertainty, then there is value in being able to "wait and see" before committing to an investment; this value arises from the "better" decision that can be made once the period of high uncertainty is passed.

We also considered two further tests:

- **Test 3: Materiality -** The materiality of the Value Factor (i.e. will it materially affect the service pot size)
- **Test 4: Complexity** – How complex it is to calculate the Value Factor.

These were not absolute tests but were considered together to avoid making the model overly complex for the sake of Value Factors that had an insignificant impact on service pot size. Finally, more work is needed to understand how best to calculate the optionality benefit Value Factor.

This model will be kept 'live' through ongoing activity, allowing Value Factors to be easily added as circumstances change (e.g. to include new ED2 outputs), and the materiality threshold can be reduced to add more Value Factors in as we gain experience and confidence in the model.

How the model works – a quick example

The model calculates the service pot size by running a comparative assessment of all the Value Factors and summing them. For example, comparing flexibility services to a new reinforcement involving the installation of a new circuit and lower loss equipment (the numbers are entirely illustrative):

Value Factor	Value of Services Compared to Reinforcement
Deferred Capital Cost	+£30,000/year (the cost saving from deferring the reinforcement)
O&M (operation and maintenance) costs	+£500/year (as the reinforcement would involve installing a long new circuit, so flexibility services would save the associated O&M costs)
Losses	-£300/year (as losses will be higher with service use, as the reinforcement would involve installing new lower-loss equipment)
Total Service Pot	**£30,200/year**

In this example, the value ("service pot") of flexibility services is £30,200, so if flexibility services can be bought for less than £30,200/year then they are the best value solution.

For our tenders, the annual service pot is then converted into availability and utilisation ceiling rates (£/MW/h) for that site. This is simply done by dividing the pot across the annual service requirements for that site and forming a view on how many times per year the service will be dispatched.

Model summary

In summary, the model compares solutions based on their cost and a range of Value Factors. The output of the model is a £/year service pot to spend on services in that particular scenario – if services can be procured for less than this service pot then services are the best value solution.

This approach results in a site/scenario specific value for flexibility services that reflects its true value in that specific location, rather than a generic value based on a fixed £/MW rate or service type which doesn't reflect the actual value of flexibility in that scenario.

This model can be used for a range of different scenarios. The next two sections present two use cases developed so far, and the Value Factors for each:

1. Use Case 1 – Flexibility services to defer reinforcement.
2. Use case 2 – Flexibility to increase network security of supply (e.g. during planned maintenance outages).

3. Use Case 1 – Flexibility Services to defer the need for reinforcement

A major use case for flexibility services is to defer network reinforcements. Therefore, we need to compare 45-year reinforcements and annual flexibility services on the same basis. For a given reinforcement scheme, the model calculates how much we can spend (£/year) on services to defer that capital expenditure.

The value of flexibility using Value Factors and the four tests described in Section 3:

Value Factor	Used	Results
Deferred Capital Cost	Yes	**Test 1:** Yes, using flexibility allows DNOs to defer reinforcement investment. **Test 2:** Yes, DNOs are incentivised to manage this value through the RIIO-ED1 TOTEX efficiency incentive. **Test 3:** Yes, value likely to be material and increase pot size. **Test 4:** simple to calculate as value based on cost of the counterfactual solution and DNO's allowed cost of capital. ***Commentary:*** *In most cases, this Value Factor has the biggest influence on the size of the service pot.*
Value of lost load (CML, CI and RGSOP)	Not yet (missing data)	**Test 1**: Yes, if the reliability of flexibility services is different to the reliability of network assets, then the likelihood of a fault which incurs CML, CI and RGSOP will be different. **Test 2:** Yes, DNOs are incentivised to manage this through the RIIO-ED1 CI, CML and RGSOP incentives. **Test 3:** Unknown - we cannot evaluate materiality until further data on the reliability of flexibility services is known. **Test 4:** There are two broad ways of calculating this: (1) A simple method, where a generic network reliability value from NAFIRs[3] is compared to a generic flexibility service reliability value or (2) A more site-specific method, where the fault history of that section of the network is compared to a more specific flexibility service value (based on technology type, and possibly other factors). At this stage the simpler method gives a sufficiently representative answer for a fraction of the complexity. ***Commentary:*** *The industry lacks reliability values for flexibility services. Until we have this data (from service use), we can't justify using a different reliability value for services as for reinforcement. Therefore, cannot currently include.*
Losses	No	**Test 1**: Yes, using flexibility or reinforcement will affect peak current and network resistivity; impacting I^2R losses. **Test 2:** Yes, DNOs are required to manage losses via licence obligation, and a financial value is given to losses in ED1. **Test 3:** No, value not likely to be material for most schemes. As both services and reinforcement could reduce losses (the former from reducing peak current, the latter from creating a lower resistivity network) the difference is likely to be below the materiality threshold.

[3] National Fault and Interruption Reporting Scheme

		Test 4: No, highly complex to calculate requiring detailed load flow analysis, coupled with granular forecasting. ***Commentary**: Excluded at this stage due to the being complex to calculate for relatively little value.*
O&M (Operation and Maintenance) Cost	Yes	**Test 1**: Yes, if using flexibility avoids the creation of new additional overhead lines but No if replacing existing assets, as O&M costs aren't usually linked to asset age. **Test 2:** Yes, DNOs are incentivised to keep their costs low through the RIIO-ED1 TOTEX efficiency incentive. **Test 3:** This value will only be material where the reinforcement results in new additional overheads lines. **Test 4:** Yes, simple to calculate as value dependent on whether either solution results in more/less overhead line. ***Commentary**: Likely to be low value but simple to calculate so has been included. (We are investigating if a value should be attributed to the avoidance of new underground cables.)*
Health Index (HI)	No	**Test 1**: Yes, where flexibility involves the replacement of existing assets. If flexibility avoids the replacement of an HI1 asset, this will increase the service pot. If flexibility avoids the replacement of an HI5 asset, will reduce the service pot. **Test 2:** Yes, there is a RIIO-ED1 HI incentive on DNOs. **Test 3**: No, the incentive is an overall volume driver, for a DNO that has appropriately managed their asset base this value won't be material for individual schemes. **Test 4:** Due to low materiality calculation not yet completed.
Optionality Benefit	Not yet (calculation to be developed)	**Test 1**: Yes, where flexibility helps a DNO make better long-term decisions. The shorter the flexibility service contract, the greater the optionality benefit (given the reduced financial commitment to secure that optionality). **Test 2:** Yes, DNOs have an overarching RIIO-ED1 TOTEX efficiency incentive to make good investment decisions. **Test 3:** Yes, preliminary work shows this is likely to be material for higher value investment decisions. **Test 4:** No, this is complex to calculate. Ofgem's 2012 publication[4] on this issue could not propose a method. ***Commentary:** We consider there are two broad approaches - an average value or a site-specific approach. Further development work is required before this Factor can be applied.*

In summary, when considering flexibility services to defer network reinforcement, our work to-date has shown that the capital cost of the counterfactual solution is the single greatest factor which determines how much money we can spend on flexibility services. Optionality benefit remains the biggest unknown factor.

[4] https://www.ofgem.gov.uk/sites/default/files/docs/2012/03/real_options_investment_decision_making.pdf

4. Use Case 2 – Flexibility Services to provide additional network security during planned outages

Another use case for flexibility services is to help secure the network at times of network stress. For example:

- during a planned maintenance outage, where the network is inherently weaker as an asset has been taken offline; or
- where a reinforcement is being built but won't be completed for a few years and there is a need to manage the constraint in the interim period.

In these use cases, the value of flexibility arises from reducing the impact of a network fault, i.e. flexibility services won't reduce the likelihood of a fault[5], but if a fault occurs flexibility services may lessen the impact by reducing net demand, enabling more customers to remain on supply.

This financial assessment is not like use case 1, where the value of services mainly arose from avoiding the large capital cost of reinforcement. Use case 2 is more like an insurance policy where we are using flexibility services to reduce the impact of low-probability high-impact events: we increase our definite costs (the cost of the flexibility service) to reduce the possible event cost (CML, CI and RGSOP).

The following table shows how we calculate Value Factors in this use case. We are not looking to calculate their absolute value, but the difference in their value depending on whether we use flexibility services or another solution (e.g. standby diesel generation or making no intervention).

Value Factor	Used	Results
Deferred Capital Cost	No	**Test 1**: There is no causal relationship as flexibility services do not defer any capital investment in this use case. ***Commentary:*** *Other Tests not shown as it has failed Test 1 meaning that it is not relevant.*
Value of lost load (CML, CI and RGSOP)	Yes	**Test 1**: Yes, the use of flexibility services in this use case does reduce the cost of lost load. **Test 2:** Yes, DNOs are incentivised to manage this value through the RIIO-ED1 CML, CI and RGSOP incentives. **Test 3**: Yes, preliminary work shows this is likely to be material where the likelihood of fault and/or the impact of fault are high. **Test 4**: Yes, this can be calculated. It is not a simple calculation as assessments are needed to identify the site-specific likelihood and impact of a fault. The value here is calculated like other insurance policies: **Value = likelihood of fault x reduction in impact due to flexibility service (CML, CI and RGSOP cost)** ***Commentary:*** *This is the main driver of the service pot in this use case. The reliability of flexibility services is an important assumption in the calculation. The industry lacks reliability values for flexibility services. For now, we have assumed a 100% reliability, i.e. that the service will respond and deliver during a fault.*

[5] Faults are typically caused by external factors, e.g. vegetation or vandalism.

Losses	No	**Test 1**: yes, there is a causal relationship – keeping more customers on supply will increase network power flows and so increase faults. **Test 2:** Yes, DNOs are required to manage losses via licence obligation, and a financial value is given to losses in ED1. **Test 3**: This fails materiality as the fault period should be sufficiently short (a few hours) such that there will be a negligible difference in overall network losses. **Test 4:** No, highly complex to calculate requiring detailed load flow analysis, coupled with granular forecasting.
O&M (Operation and Maintenance) Cost	Yes	**Test 1**: yes, there is a causal relationship where using flexibility services reduces the cost of other methods to manage the possible fault impact (e.g. a reduced requirement for standby diesel generators). **Test 2**: yes, the TOTEX efficiency incentive is an overarching RIIO-ED1 incentive on DNOs to manage efficient expenditure. **Test 3**: this is likely to be material. **Test 4**: this is likely to be known. ***Commentary:*** *This value factor compares the cost of the flexibility service with the cost of other solutions (e.g. using standby diesel generators).*
Health Index (HI)	No	**Test 1**: There is no causal relationship as flexibility services in this use case will not affect the asset replacement programme. ***Commentary:*** *Other Tests not shown as it has failed Test 1 meaning that it is not relevant.*
Optionality Benefit	No	**Test 1**: There is no causal relationship as flexibility services in this use case will not be used to defer large capital investments. Their availability is also very unlikely to affect the timing of planned maintenance work given the number of other factors involved. ***Commentary:*** *Other Tests not shown as it has failed Test 1 meaning that it is not relevant.*

In summary, when considering flexibility services to manage periods of system stress, our work to-date has shown that the cost impact of the fault (value of lost load) and the cost of the alternative solutions are the two factors which determine how much can be spent on flexibility services.

5. How to get involved

This document sets out our approach for valuing flexibility for any given reinforcement or network security scenario. This approach was used to provide site-specific ceiling rates for our most recent tender launched in October 2019.

We consider that this modelling approach has the advantages that:

- It is simple to use and can be done for any length service use period.
- It relies on the same forecasts that are used to plan network reinforcements. This results in a fair comparison and does not require users to undertake additional forecasting.
- The decision to use Flexibility Services can be reviewed regularly.
- Currently the model only considers value to Distribution customers; however, this approach allows for other Value Factors to be included in future, for example to capture greater consideration of the whole system benefits of flexibility.

We would welcome your feedback and input at any time to Flexibility@spenergynetworks.co.uk. Whilst we are particularly interested in hearing your views on the following, we would welcome any feedback on any other point.

1. Our comparative assessment and Value Factor approach.
2. Are we missing any value factors? Are we calculating them correctly?
3. Do you have any input on how to calculate optionality benefit?

Any queries relating to this document or our other Flexibility work can be sent to Flexibility@spenergynetworks.co.uk.

For stakeholders interested in the valuation of flexibility, we would also alert you to Product 1 of workstream 1a of the 2020 Open Networks project. This workgroup, in which we will be participating, is looking at developing a common method of valuing flexibility across all DNOs. This project is run by the ENA, please contact opennetworks@energynetworks.org for more information.