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Annex 3C: Load Related Expenditure

Access SCR Impact - Part C

December 2021

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EXECUTIVE SUMMARY

In June 2021, Ofgem published a consultation[1] on its minded-to positions for three key areas of its Access and Forward-looking Charges Significant Code Review: distribution connection charging, the definition and choice of access rights, and transmission charges for small distributed generators. Changes to current arrangements are proposed to support customers' adoption of low carbon technologies and achieve net zero which is at the heart of our RIIO-ED2 business plan.

In summary the Access Significant Code Review (SCR) minded-to position is:

Connection Boundary -

- For demand, no contribution to reinforcement,
- For generation, contribution to reinforcement at the same voltage as the point of connection and retention of the 'High Cost Cap'.
- Transmission works associated with a new connection are to continue to be recovered from the connectee.

Access Rights -

- Access rights for small users unchanged
- Access rights for larger existing users to be unchanged
- New Access rights for users post implementation based on parameters which define how the user experiences their connection such as the hours they can be curtailed,

TNUoS Charging for Small DG -

- Transmission Use of System (TNUoS) charges on Small DG which are those generators with a Maximum Export Capacity (MEC) of 1MW or above

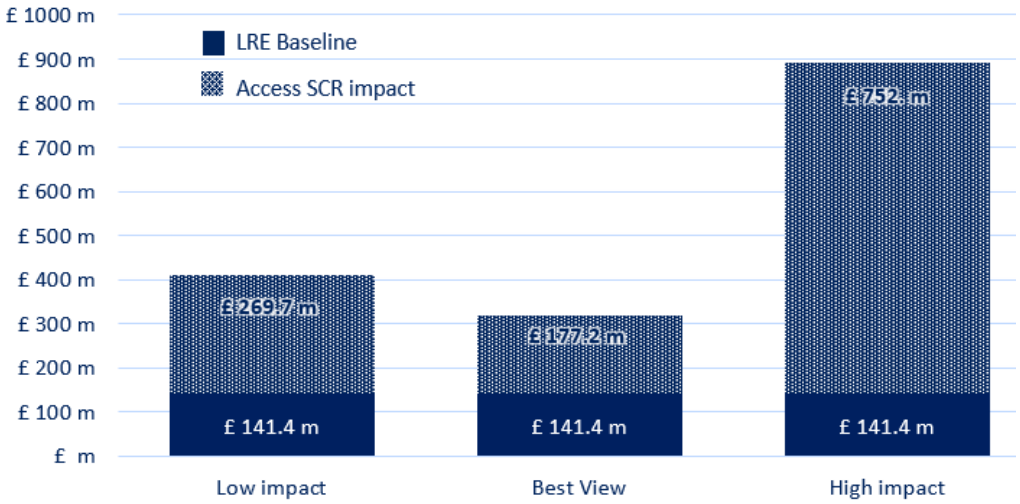
Under the minded-to Access SCR arrangements, the connection charging boundary will become shallower so that less cost is recovered through initial connection charges. Connecting customers will pay less, and in many cases none, of the network reinforcement costs associated with their connection. At a very high level, it is expected that the adoption of shallower connection charges and the consequential lower connection charges suggested in the minded-to position will increase the need for network capacity and load related investment.

We have quantified potential impacts of the changes to connection charging by assessing expected components of the impact individually, as shown below, and presented the results in this Annex provided in accordance with Ofgem's latest business plan guidance.

Components considered in the evaluation of Access SCR impacts	
New customer impacts	Additional Connections Applications – Demand
	Additional Connections Applications – Generation
	Addressing specific expected network issues - EV chargers at motorway service stations
	Addressing specific expected network issues – Cumbria ring reinforcement
	Transition of network investment funded through customer contributions to DUoS funding
	Removal of ECCR contributions to previous reinforcement costs
Existing customer impacts	Transition of non-firm to firm access
	Reduction in customer contribution for in-flight connection projects
Indirect impacts	Core Closely Associated Indirects
	Business Support Costs

[1] https://www.ofgem.gov.uk/publications/access-and-forward-looking-charges-significant-code-review-consultation-minded-positions

The estimated costs of the impact of Access SCR reforms range from £177.2 million to £752 million, as shown below relative to our baseline load related investment plan. Low, best and high views are presented in Business Plan Data Tables M30a and M30b. Even our low view considers a change in customer behaviour driven by the Access SCR reforms. However, there is a possibility of an extreme low scenario with no change in connection activity is customers consider that the benefits of shallower connection charging are balanced by changes in use of system charging. Our best view is the lowest estimate of our potential Access SCR impact scenarios due to factoring in efficiencies from holistic network design and coincidence in network needs driven by additional demand and generation connections because of Access SCR charging reforms.



The detailed modelling that has informed the development of our load related plan and forecasting of customer connections has been applied to provide well justified estimates of each of the components making up the total estimated values of Access SCR impacts. Extrapolation of the value of our load related plan means that flexibility is factored in, although we expect that commercial solutions may be the least cost solution to provide some customers with firm connections, essentially paying constraint payments instead of more expensive network reinforcements.

Thorough knowledge of our network and our experience of customer activity has helped us identify specific expected network issues that we have developed and costed network solutions. Strong government support for EV charging facilities at motorway services and the associated high level of customer activity, has led us to consider that it is highly probable that changes to charging will encourage customers to apply to connect more chargers requiring us to reinforce our network in these typically remote locations currently with limited supply capacity. Changes in charging and new generation capacity becoming available in RIIO-ED2 due to the expected completion of transmission reinforcement works at Harker mean that we are also confident that more generators will accept connection offers in Cumbria. We already know that additional generation beyond that included in our DFES forecast will exceed the rating of our Cumbria 132kV ring, so have included specific reinforcement scheme costs in our Access SCR impact assessment.

Although draft plans were submitted based on existing connection charging arrangements (i.e. no change), our final plan reflects Ofgem's minded-to proposals. In accordance with Ofgem guidance, at this stage our baseline load related plan totally excludes any allowance for Access SCR impacts as quantified in this Annex. Instead it is assumed that the split between baseline and Uncertainty Mechanisms will be determined after submission of final business plans. Therefore, we have made proposals for a LRE re-opener mechanism to cover direct costs due to Access SCR impacts and a Regulatory-Driven Changes re-opener to cover closely associated indirect costs

1 INTRODUCTION

In this the third of our three Load Related Expenditure Annexes (Annex 3C) we present the results of our review of the potential impacts of Ofgem's minded-to position on the Access SCR. It is provided in compliance with Ofgem's RIIO-ED2 Business Plan Data Template guidance that requires an Access SCR impact Annex.

In June 2021, Ofgem published a consultation[2] on its minded-to positions for three key areas of its Access and Forward-looking Charges Significant Code review: distribution connection charging, the definition and choice of access rights, and transmission charges for small distributed generators. Changes to current arrangements are proposed to support customers' adoption of low carbon technologies and achieve net zero which is at the heart of our RIIO-ED2 business plan.

The objectives of this document are to quantify the additional load related investment that may be required if customer charging rules change and explain how we have estimated the potential increase in load expenditure based on our thorough understanding of our network and knowledge of previous customer behaviours.

Although the Access SCR is not yet concluded, the minded-to position is considered more indicative of RIIO-ED2 arrangements than the current regime. This Annex covers the requirements of Ofgem's Business Plan Guidance paragraphs 5.37 to 5.42 entitled "Access and Forward-looking Charges Significant Code Review (SCR)", in particular:

- final RIIO-ED2 business plans to take cognisance of the Access SCR minded-to consultation,
- identify parts of our business plan impacted by future Access SCR outcomes on connection charging.

Our low, best and high views of the estimated costs of the impact of Access SCR reforms are presented in Business Plan Data Tables M30a and M30b. In accordance with Ofgem guidance, these costs are totally excluded from baseline allowances at this stage. We assume that Ofgem will subsequently decide how Access SCR impacts are split between baseline and Uncertainty Mechanisms in RIIO-ED2. We have therefore made proposals for a LRE re-opener mechanism to cover direct costs due to Access SCR impacts and a Regulatory-Driven Changes re-opener to cover closely associated indirect costs.

1.1 Annex 3C in relation to other parts of our RIIO-ED2 submission

1.1.1 Main plan

This Annex provides detail and supporting evidence for section 6.1 of our main business plan submission.

1.1.2 Load Related Annexes

The Access SCR's inherent impact on what customers will pay to connect to our network is expected to change customer behaviours and their requirements for more resilient firm connections instead of accepting flexible connections with associated lower connection costs. This Annex is closely linked to our load related plan because more load related network reinforcement will be required to accommodate increased numbers of connections and higher levels of security of supply.

For clarity and readability, our load related plan and the impacts of the Access SCR are described in three separate, but highly linked parts of our load Annex as shown in Fig. 1.

[2] https://www.ofgem.gov.uk/publications/access-and-forward-looking-charges-significant-code-review-consultation-minded-positions

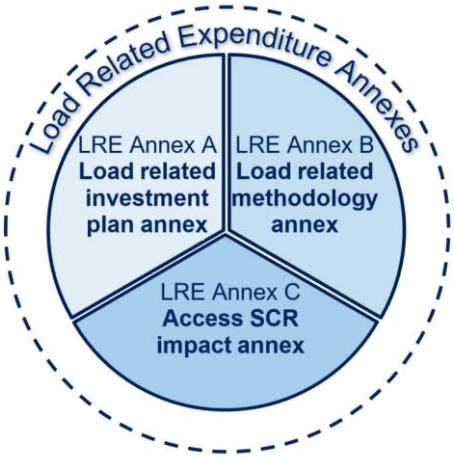


Fig. 1. Load Related Expenditure Annexes

1.2 Related Business Plan Data Tables

The Access SCR impact described in this Annex relates to the following business plan data tables and the corresponding commentary:

- M30a – SCR totex
- M30b – SCR breakdown

1.2.1 Other Related Documents

Engineering Justification Papers (EJPs) have been created to support the potential investment required to address known network constraints likely to be exacerbated by the Access SCR minded-to position on changes to charging arrangements anticipated to cost more than two million pounds. This Annex should be read in association with the Engineering Justification Papers as listed in Table 1. Trigger levels and the requirement for potential additional network investment are presented along with high level options on the basis that the extent, type of solution and timing of the intervention will be reviewed as the need becomes confirmed. Due to our objective of defining extremes of Access SCR impacts at this stage, we have not produced Cost Benefit Analysis (CBAs) which will be developed as the level of needs becomes apparent and we can assess the use of flexibility services.

Table 1: Summary of Access SCR impact EJPs

Scheme name	EJP reference
Motorway Service Area EV Enablement – North	LRE EJP 15
Motorway Service Area EV Enablement – Central and South	LRE EJP 16
Cumbria Ring Reinforcement	LRE EJP 17

1.3 Ofgem's Access SCR Minded-to Position

To inform its reform of network charging to ensure an efficient transition to a low carbon future and smart network, Ofgem is reviewing two elements of Distribution Use of System charges paid by suppliers and passed on to customers, namely:

1) Forward looking, which covers the cost of expanding the network, and

2) Residual charges coving the cost of maintaining and operating the electricity network.

Through its "Access and Forward-looking Charges Significant Code Review: distribution connection charging, the definition and choice of access rights, and transmission charges for small distributed generators" Ofgem has considered the current arrangements under which connecting customers contribute to the reinforcement of networks and have consulted on their minded-to position on reforms.

In summary the Access SCR minded-to position is:
Connection Boundary -

- For demand, no contribution to reinforcement,
- For generation, contribution to reinforcement at the same voltage as the point of connection and retention of the 'High Cost Cap'.
- Transmission works associated with a new connection are to continue to be recovered from the connectee.

Access Rights -

- Access rights for small users unchanged
- Access rights for larger existing users to be unchanged
- New Access rights for users post implementation based on parameters which define how the user experiences their connection such as the hours they can be curtailed,

TNUoS Charging for Small DG -

- TNUoS charges on Small DG which are those generators with a MEC of 1MW or above

The Access charging review is closely associated with Ofgem's Targeted Charging Review (TCR) which is changing how residual charges are recovered. New distribution network charging rules, which will come into force after 2022, are considered to be fairer, more transparent and simpler by changing to a fixed charging basis. These charges are expected to have a lesser impact on the need for network capacity, although Triad avoidance may be reduced so increasing the electrical demand of large customers at times of peak demand.

1.4 Document structure

This document comprises three further main sections:

- Section 2 presents an estimate of the additional load related investment that may be required during the RIIO-ED2 period if the minded-to changes to charging were implemented. A number of impacts are described along with how they correspond to the need for additional network developments.
- Section 3 discusses the uncertainty of the Access SCR impacts and how this informs the requirements of an Uncertainty Mechanism.
- Section 4 introduces our enhanced deliverability plan in acknowledgement that the possible volumes of work under reformed connection charging rules are greater than those of the current RIIO-ED1 period.

2 ACCESS SCR IMPACTS

2.1 Overview

Implementation of elements of the Access SCR minded-to position is expected to have impacts on the need for additional load related investments and closely related indirect costs.

Under the minded-to Access SCR arrangements, the connection charging boundary will become shallower so that less cost is recovered through initial connection charges. Connecting customers will pay less, and in many cases none, of the network reinforcement costs associated with their connection. At a very high level, it is expected that the adoption of shallower connection charges and the consequential lower connection charges suggested in the minded-to position will increase the need for network capacity and load related investment, as shown in Fig. 2.

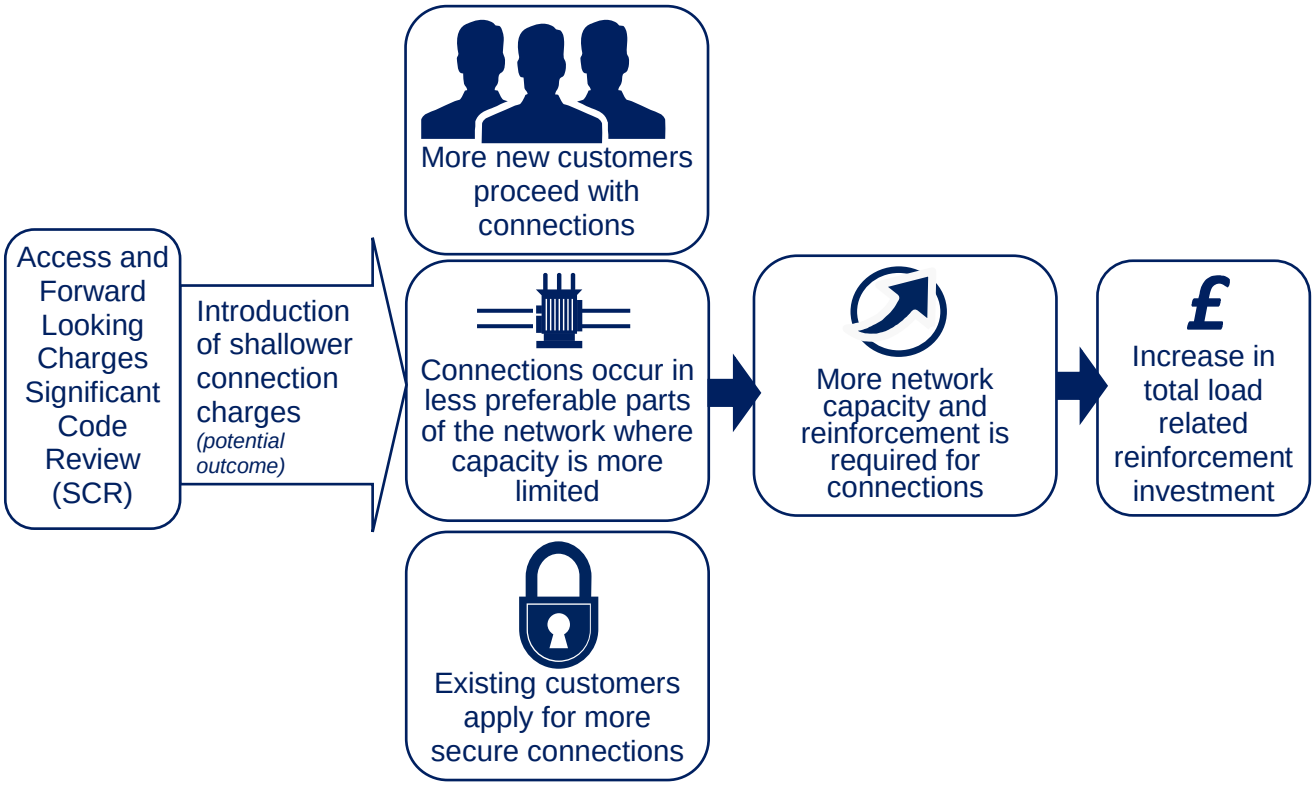


Fig. 2. Uncertainty due to potential Access SCR outcomes

The need for additional network investment is expected to come from meeting the requirements of new customer and existing customer connections:

New customer connections:

- More customers beyond our forecasts may connect across our network at all voltage levels meaning that the required network capacity is greater than we determined based on our DFES.
- Forecast connections included in our DFES may connect to parts of the network where reinforcement costs are greater than we have modelled based on the cost of reinforcement associated with historic connections.
- Accepted non-firm connections (not yet energised) may reapply for offers without or lesser reinforcement charges.

Existing customers:

- Customers who are already connected to our network may reapply for more secure connections to avoid curtailment because they will no longer be responsible for reinforcement charges or connection charges will be lesser in the case of generation.

Table 2 shows details of a recent offer for the connection of a 7MW generator. It illustrates how an offer based on a shallower connection boundary in accordance with the minded-to position on the Access SCR could change and become more likely to be accepted. The costs of DUoS funded connections reinforcement would accordingly increase significantly.

Table 2: Example generator connection charge under the current and a potential shallower connection charging methodology

Cost type	Current charging methodology	Access SCR minded-to charging methodology
Extension Assets	£0.9m	£0.9m
Customer Funded Reinforcement	£11m	Nil
DUoS Funded Reinforcement	£1m	£12m
Total customer charge	£11.9m	£0.9m
Customer conclusion	*Offer not accepted*	*Offer more likely to be accepted*

The Access SCR review of DUoS charges is expected to rebalance usage-based and capacity-based charges, and potentially introduce charges that vary by time-of-use and by location. It is unknown how these changes to ongoing use of system charges and upfront connection charges will affect customer behaviour, but we expect a transitionary period especially if the reforms occur over time rather than all together. Our analysis of Access SCR impacts has not considered in detail how changes to use of system charging will impact customer connections. However, they could reduce the impact of the minded-to position for shallower connection charges. Consequently, actual Access SCR impacts may be less than our low, best view and high estimates presented here.

2.2 Components of Access SCR impact assessment

Quantification of the need for additional load related investment due to the prospective changes associated with the Access SCR and TCR requires us to consider the form of the changes, how customers will respond and what their altered behaviour will mean to our network and the requirement for reinforcement.

We have evaluated the impact of the Access SCR minded-to position in terms of the components listed in Table 3 based on the high level categories of new and existing customers mentioned earlier.

Overall, we have assessed that changes to charging in accordance with the Access SCR minded-to position could increase load related investment in the range from £177.2 million to £752 million with our best view being £177.2 million as shown in Fig. 3. This range of additional load related investment including closely related indirect costs represents a significant uncertainty. Low, high and best view estimates of the increase in load related investment have been determined by considering the varying certainties of the impacts along with different methodologies that reflect potential overlaps or different customer behaviours.

In some cases, low, best view and high impact values are the same because we are certain that the impacts will happen and so there is no range of impacts.

Our low view has been derived by adding the lowest estimates for each of the individual impacts identified by Ofgem in the outline M30 memo table. Even our low view considers a change in customer behaviour driven by the Access SCR reforms. However, there is a possibility of an extreme low scenario with no change in connection activity if customers consider that the benefits of shallower connection charging are balanced by changes in use of system charging.

Our best view recognises that we shall make efficiencies and that actual delivery of network investment would be holistic rather than the piecemeal way that the overall Access SCR impact is assessed as a shopping list for our low and high views. We have left some shopping list items out of

our best view to avoid duplication, for example, additional generation connections may occur in places where we also get more demand connections, so the same reinforcement can solve both requirements. In this case, there may be low and high impacts for generation and demand separately, but our best view is for the efficient resolution of both needs together. This is the equivalent of the shopping list including a garage, for somewhere to store a car and shed, for a bike, but only buying the garage because it can accommodate the car and bike together.

Our consideration of overlaps has led to our best view being 34% lower than the low total which simply adds together individual low estimates. The following sub sections of this Annex explain how each of the components of our assessment were calculated including the rationale behind what is included in our best view.

Our estimate of the high impact has also been calculated as the simple addition of the individual impacts identified by Ofgem in the outline M30 memo table. Given this shopping list methodology, there is further uncertainty in the high estimate due to how some impacts may be solved together. Geographic uncertainty of where the additional demand and generation connections occur mean that it is difficult to estimate the effect of their co-location on overall network needs. Although it is not necessarily accurate to apply the same 34% reduction from low to best view impact scenarios, we do expect efficiencies to arise in practice. Application of holistic solutions will result in the actual high impact being less than the value of the extreme high scenario estimate evaluated here.

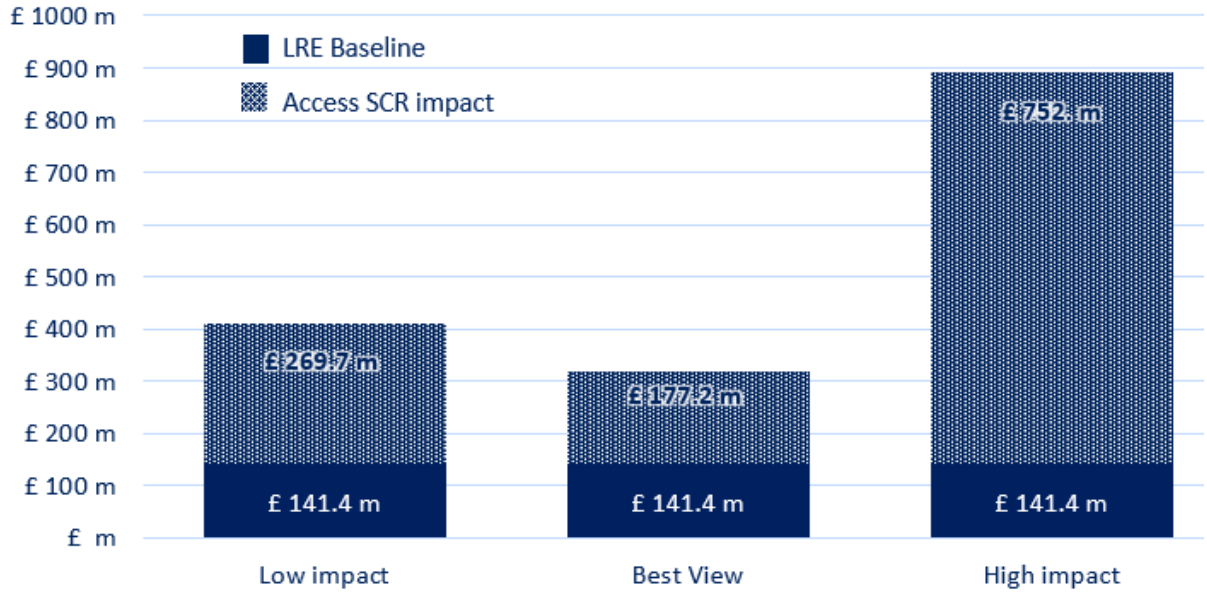


Fig. 3. Range of potential impact on load related investment needs due to Access SCR reform

Table 3: Components of Access SCR impact assessment

	Annex subsection	Component of Access SCR impact	Description	Estimated value of additional load related investment £m		
				Low	Best View	High
New customers	2.3	**Additional Connections Applications – Demand**	Estimate of the cost required to provide the additional network capacity due to more connections and connections in parts of the network requiring more costly reinforcement or in areas of the network where flexibility services are not as available. Generation includes fault level reinforcement. Best view recognises the overlap with Cumbria ring reinforcement and generation connecting where the network is reinforced for demand.	£44.6	£44.6	£85.4
		Additional Connections Applications – Generation		£102.5	£0	£370.5
	2.3.2.1	**Addressing specific expected network issues - EV chargers at motorway service stations**	Due to there currently being sparse network in their remote locations, reinforcement will be required to deliver network capacity to connect 145MW of rapid EV chargers at nine motorway service areas where new connections are expected assuming implementation of modified charging rules in accordance with the current Access SCR minded-to position. Government support means that this is high certainty and included in low, best and high views.	£46	£46	£46
	2.3.2.2	**Addressing specific expected network issues – Cumbria ring reinforcement**	When reinforcement charges are reduced due to Access SCR reforms, reinforcement of our 132kV circuits forming the "Cumbria Ring" will be required to accommodate the further generation in this popular area with advantageous environmental conditions. Low and best views are based on an initial phase of reinforcement in RIIO-ED2 corresponding to the capacity due at Harker when National Grid work is completed, due in December 2026.	£15.8	£15.8	£42.6
	2.3.3	**Transition of network investment funded through customer contributions to DUoS funding**	Customers will no longer contribute to the cost of reinforcement and associated indirects as they have done historically. Evaluated on the basis of our baseline submission and reflecting that generator connections will still pay for some reinforcement, this is very certain and included in low, best and high views.	£15.9	£15.9	£15.9
	2.3.4	**Removal of ECCR contributions to previous reinforcement costs**	Models that second comer customers will not contribute to reinforcements already partly funded by a previous customer. Nil included in our baseline.	£0	£0	£0
Existing customers	2.4.1	**Transition of non-firm to firm access**	Estimate of the reinforcement needs due to the conversion of constrained connections to more secure connections when existing customers with flexible or non-firm connections request firm contract under SCR reforms.	£17.2	£34.2	£108.4
	2.4.2	**Reduction in customer contributions for in-flight connection projects**	Estimate of the reinforcement needs of in-flight connections that are not energised and re-apply for connections without reinforcement charges.	£0	£3.4	£3.4
Indirects	2.5	**Core Closely Associated Indirects**	Other costs including resourcing will increase as the numbers of connections goes up with greater reinforcement requirements.	£15.8	£9.8	£45.7
		Business Support Costs		£11.8	£7.3	£34.0
			Total	**£269.7m**	**£177.2m**	**£752.0m**

2.3 Quantification of impacts of Access SCR charge changes on new customer connections

The impacts of applications received on or after 1 April 2023 being charged under the new rules according to the minded-to position on the Access SCR have been estimated based on:

- increased numbers of customers progressing with their connection application due to removal/reduction of contributions to reinforcement,
- greater average cost of reinforcement due to the loss of locational charging signals and the removal of customer contributions to reinforcement being a barrier to the progression of a connection requiring greater reinforcement, and
- flexible connections will be less attractive to customers because the reinforcement contributions that they can currently avoid will no longer be paid by connecting customers.

Our estimate of the impact of additional new connections has been broken down into a volumetric assessment and consideration of specific regional impacts aligned with known capacity constraints. Based on our understanding of historic connection activity, we can anticipate where changes to charging will encourage most connections exacerbating known network pinch points. Examples of such effects include accelerated net zero and stakeholder plans, such as EV chargers at remote motorway service stations and additional renewable generation in Cumbria.

2.3.1 Volumetric assessment of Access SCR changes on new customer connections

Fig. 4 shows the methodology for our volumetric assessment for estimating the increased load related investment due to the impact of changes to charging on new demand and generation customers using two equally credible alternative methods.

This approach indicated increases in the number of demand acceptances and the capacity of accepted generation connections compared to actual acceptances for each voltage level as listed in Table 4. The total incremental reinforcement cost associated with modified Access SCR connection charges was found to vary between £147 million for one method and £456 million for the other method including impacts from both additional demand and generation connections. Both methods are considered to be valid and it is not possible to judge which may be more accurate, therefore the results should be taken to be a very high-level guide with the variation in results reflecting the difficulty of predicting the impact of changing the charging boundaries.

Our results may be considered as worst case because other factors that could reduce the level of acceptances, such as regional environmental conditions and locational DUoS, have not been included at this stage. The wide range of this pragmatic quantified analysis indicates the many uncertain factors influencing potential reinforcement costs due to the introduction of shallower connection charges.

We have taken the results of method two as our low value and method one for our high value. The best view for this component of the Access SCR impact has been taken as the method one value for demand only on the basis that we are more confident that impacts from demand connection. This is because demand customers will not contribute to network reinforcement costs even at the same voltage of connection. Generation customers are less likely to be affected by the minded-to charging reforms because they would continue to pay contributions to reinforcement at the same voltage and are more able to alter their location to connect where reinforcement is not required. Also, generation may connect in locations where we are already reinforcing for demand, thereby also creating capacity for more generation. For these reasons, modelled increases in network reinforcement due to change in customer behaviour are not explicitly included in our best view. Although this may be viewed as a bold assumption, we consider that it is appropriate in the absence of more detailed modelling and is aligned with the tolerance of our estimates of other elements of our best view.

Table 4: Estimated connection offers under the shallower charges according to the Access SCR minded-to position

Demand **Connection offer category**	**Current charging boundary** **Acceptance rate based on 3 years data**	**Shallower connection charging** **Shallow connection charging Estimated acceptance rate based on £/kVA threshold**	**Method 1** Increase in ED2 reinforcement costs based on average historic totals **£m**	**Method 2** Increase in ED2 reinforcement costs based on extrapolation of general reinforcement costs **£m**
EHV	15%	22%	£18.8	£13.6
HV	16%	26%	£62.9	
LV	33%	35%	£3.7	£31.0
Overall impact			**£85.4m (high)**	**£44.6m (low & best view)**
Generation **Connection offer category**	**Additional generation capacity under shallow connection rules MW**		**Method 1** Increase in ED2 reinforcement costs based on average historic totals **£m**	**Method 2** Increase in ED2 reinforcement costs based on extrapolation of general reinforcement costs **£m**
DG at EHV	+4,019		£360.5	£60.5
DG at HV	+931		£9.98	
DG at LV	+0.13		£0.00	£42.0
Overall impact	Increase in generation capacity +4,950		**£370.5 (high)**	**£102.5 (low)**
Total increase in ED2 reinforcement costs			**£455.9m (high)**	**£147.1m (low)**

The first step in our volumetric assessment was to examine the total costs of offers accepted by customers over three years to establish the average £/kVA values at which demand and generation customers proceeded with the connection. We used this to set an assumed economic threshold below which connections were commercially viable. We then modelled customer behaviour based on shallow connection charging by applying this £/kVA threshold to all offers excluding all their reinforcement charges. This provided us with a revised list of the offers we would have expected to have been accepted due to shallower connection charging.

From there we applied two methods to estimate the total cost of the reinforcement associated with these additional customer acceptances. Method one calculated this estimate using the same source quotation data; we summated the known reinforcement elements of those additional offers we judged would have been accepted if they had excluded reinforcement. We also considered a different method since method one is sensitive to the location of the connections included in the historic data analysed to determine the average reinforcement charges.

For method two, total reinforcement costs were evaluated for the increased number of acceptances by considering the impact on our network due to an adjusted forecast.

Our forecasts incorporate the pipeline of known accepted customer connections and offers based on the application of confidence factors in recognition that not all offers are accepted and not all customer acceptances proceed to connect. Normally based on an analysis of historic performance, these confidence factors provided an alternative way to consider the impact of more customer acceptances on our peak demand forecasts. The greater confidence factor corresponding with the estimated increased level of acceptances with shallower connection charges was applied in our forecasts to

establish the associated increased peak demand. This in turn was used to estimate the increase in the necessary load related investment. With the peak demand for a shallow charging methodology falling between two known levels, we extrapolated between the peak demand and investment for the ex-ante and accelerated region cases to establish the investment associated with the increased level of connections under shallower connection charges.

Both methods include additional fault level costs associated with more generator connections.

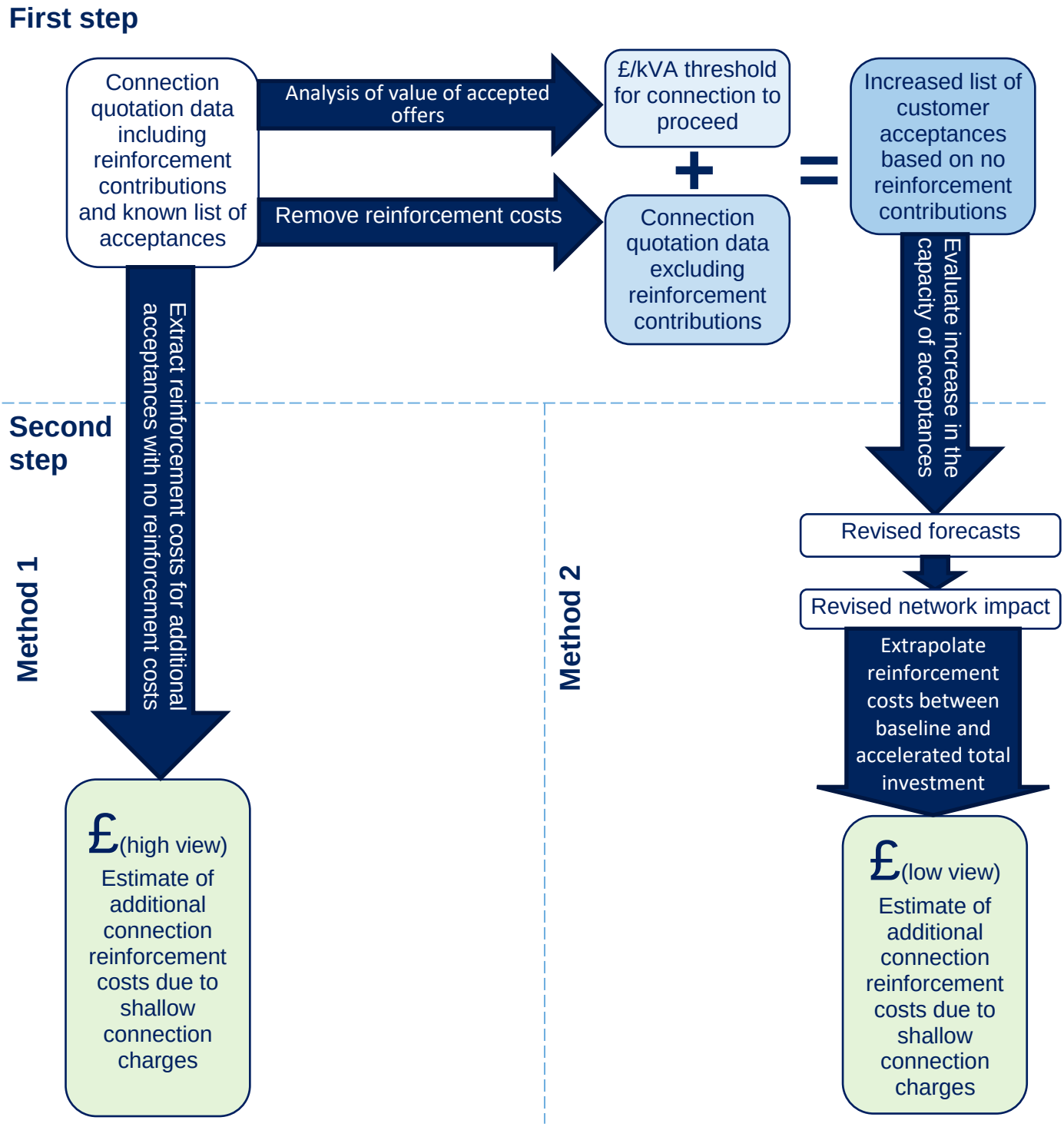


Fig. 4. Approach used to estimate the magnitude of load related investment required due to impacts of charging changes on new customers

2.3.2 Quantification of impacts of Access SCR charging changes on known network constraints

We have identified parts of our network where increased connection activity encouraged by changes in charging is likely to be problematic based on our understanding of popular connection locations and where customers frequently do not accept connection offers due to uneconomic reinforcement charges.

The following specific strategic reinforcement of our network is expected to be required with the implementation of Access SCR changes;

- **EV chargers at motorway service areas**
    - Connections for multiple rapid chargers at motorway service areas (MSAs) is an example where connection offers currently do not proceed due to significant reinforcement charges. It is anticipated that these customers will capitalise on the removal of reinforcement charges brought about through the Access SCR review by applying to connect during the RIIO-ED2 period.
- **Additional generation in Cumbria**
    - With over 1.1GW of generation already or accepted to connect to our network in Cumbria, the capacity of our 132kV circuits routed mainly around the Lake District National Park will limit the connection of further generation. Reinforcement of these circuits known as the "Cumbria Ring" will be necessary to remove the barrier to generators connecting in this popular area for renewables.

2.3.2.1 Network investment to support rapid EV chargers at motorway service areas

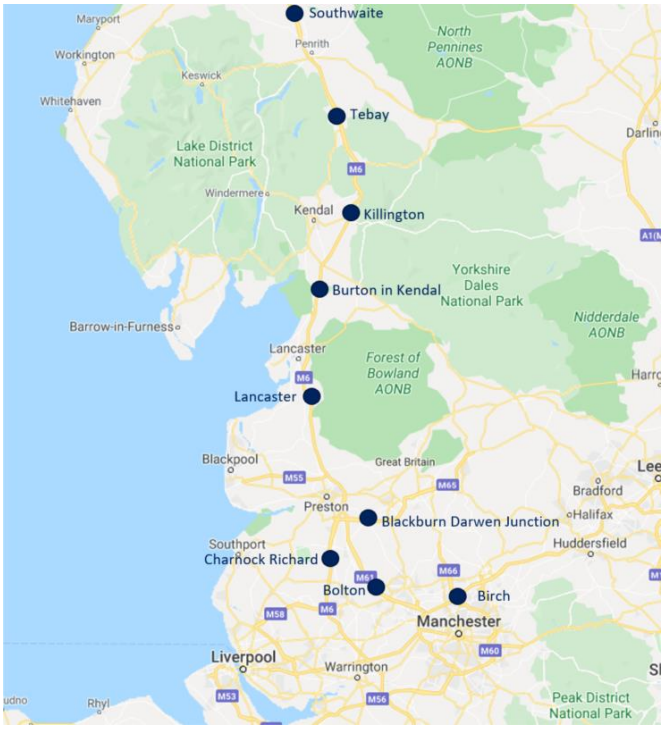


Fig. 5. MSAs considered in updated Project Rapid reinforcement assessment

By their nature MSAs tend to be in secluded parts of our region shown in Fig. 5, often in areas with little habitation. A consequence of this is that our current networks in these remote areas are often very dispersed and insufficient to accommodate significant new load. Presently, offers for the connection of multiple EV chargers can include reinforcement charges which would not be applicable under the Access SCR minded-to changes. The removal of potentially unacceptable reinforcement charges means that EV charger developers are more likely to apply for and accept connections at MSAs to meet their future requirements. For this reason, it will be sensible to apply holistic planning approaches to develop our network efficiently rather than in a less economic, piecemeal fashion.

Taking a strategic approach to the reinforcement of networks in these areas will enable us to consider smart options and factor in futureproofing such as laying ducts to facilitate future upgrades more easily or installing a higher voltage cable but running it initially at a lower voltage.

We have estimated the network investment to support additional EV charger demand of 145MW across the North and South services at nine MSAs in our region by updating our previous inputs to Arup's Project Rapid commissioned by the Department for Transport (DfT), Office for Zero Emission Vehicles (OZEV) and the Department for Business, Energy & Industrial Strategy (BEIS) to assess the electrical infrastructure requirements needed to accommodate EV charging on motorways.

Our update is based on Arup's high demand scenario which is robustly justified using regional transport models, EV uptake scenarios and the charging needs specific to local needs. This high demand scenario was chosen because we expect that EV developers are likely to respond to increasing requirements by applying for maximum anticipated needs. For each MSA location we estimated the value of the optimal solution by comparing high level costs for well-developed reinforcement options for delivering the additional capacity with enhanced network resilience to ensure the security of supply. Full details of the options and their appraisals can be found in LRE EJP15 Motorway Service Area EV Enablement – North and EJP16 Motorway Service Area EV Enablement – Central and South.

Our estimate of £46 million for the reinforcement across nine MSAs is considered to be high certainty as developers are already talking to us about their needs, encouraged by the government's rapid charging fund (RCF) supported by the OZEV to help motorway and major A road service area operators prepare the network for 100% zero emissions vehicles. We have confidence in the £46 million needed to deliver this capacity using asset-based solutions as it is built from cost estimates for preferred options which are typically the lowest cost for a feasible solution. Lower cost options which depend upon the cancellation of other connections have been excluded because it is likely that most connections will proceed under the reformed charging rules. For this reason, we have judged the low, high and best view impacts to all be valued at £46 million in the case of MSA reinforcement.

2.3.2.2 Network investment to support additional generation in Cumbria

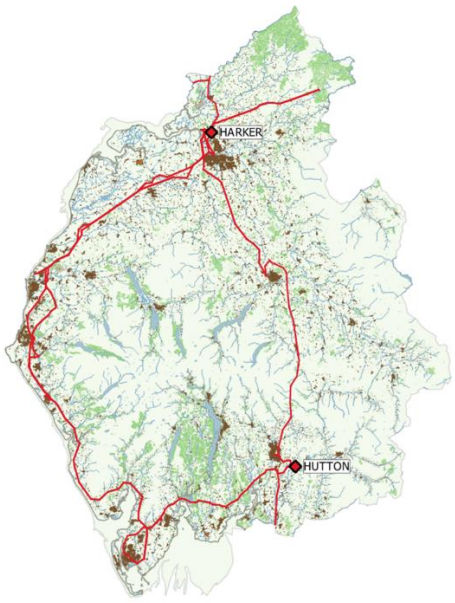


Fig. 6. 132kV overhead line circuits known as "Cumbria Ring" and associated transmission interface points at Harker and Hutton

The Cumbria Ring, with over 350km of double circuit overhead line circuit, comprises different types of conductor with some strung to operate at 50°C and other spans at 75°C. The associated variance in ratings around the circuit, the location of demand centres and the placement of generation means that limitations are reached as additional generation is connected. Our analysis, summarised in LRE

EJP17 Cumbria Ring Reinforcement, has identified reinforcement in two phases depending on the extent of requirements for additional generation as summarised in Table 5.

Table 5: Summary of Cumbria ring reinforcement phases

Cumbria ring reinforcement phase	Additional generation capacity accommodated MW	Total reinforced length km	Investment £m
Phase 1 (low & best view)	238MW	154km	£15.8m
Phase 2 (high view)	Additional 212MW on top of Phase 1	185km	£26.8m

The impact of new generation connections on our Cumbrian network could be accommodated on the transmission network after the completion, expected December 2026, of National Grid's planned works at Harker Grid Supply Point. In recent years, transmission capacity at Harker has limited the ability to connect additional generation to our Cumbrian network. Consequently, the increase in the transmission capacity for accommodating distribution connected generation by 240MVA upon completion of the Harker works is also likely to further drive new generation connections on to our distribution network encouraged by Access SCR charging reforms.

Our best view of the impact is based on Phase 1 reinforcement as Phase 2 would entail reinforcement at our interfaces with the transmission network beyond the works already planned at Harker. It is likely that such reinforcement would only be feasible after RIIO-ED2 due to the timescales involved. Our experience of connection activity in Cumbria means that we are confident that this is where the impact of Access SCR charging reforms on generation will be felt and so have included Phase 1 reinforcement in our low view and Phase 2 in high.

2.3.3 Transition of network investment funded through customer contributions to DUoS funding

Our baseline (ex-ante) load related investment plan accounts for customer connection driven network reinforcement, part of which is payable by the customer under the current charging rules. Our forecast accounts for the overall increase in electricity usage across our network driven by both load growth and connections, so we assume that the capacity requirements identified through the analysis of DFES impacts include all those required for new customer connections. Assuming that all customer driven reinforcement needs are included in the reinforcement identified through analysis based on DFES forecasts means that customer contributions to connection driven reinforcement reduce the value of load related reinforcement in our baseline plan paid by all DUoS customers. The customer contributions expected during the RIIO-ED2 period have been estimated using detailed analysis of four years of data on accepted connection offers across all voltages in collaboration with our DFES forecasts to reflect increased volumes of connections.

The modified charging rules according to the minded-to position on the Access SCR will alter the value of customer contributions, with only new generation customers contributing to reinforcement of the network at the same voltage of their connection. We have estimated that customer contributions of £15.9 million will be removed from our plan therefore increasing overall DUoS funded load related expenditure.

The extra £15.9 million is taken to have high confidence due to it being estimated using a well justified robust analysis of a significant data set and using our best view Central Outlook DFES forecast. For this reason, we have included the same amount in our low, high and best view SCR impact scenarios.

2.3.4 Removal of ECCR contributions to previous reinforcement costs

Ofgem's business plan guidance section 5.41 requires the common assumption that "Legislative change will be enacted to allow the ECCR and SCR reforms to operate together from April 2023". This

means that following the minded-to reforms, second-comer connection customers would not contribute to reinforcement previously funded by customers as they would under the current rules.

Our plan does not include any forecast for ECCR contributions to prior reinforcement as historic levels are low and are difficult to forecast. No adjustment is therefore included in any of the scenarios.

2.4 Changes to existing customer connections due to Access SCR changes

Ofgem's business plan guidance section 5.41 requires the common assumption that "Existing customers on flexible or non-firm connections can request to make their connection firm under the new rules from 1 April 2023".

For our assessment of the impact on existing customers we have separated those who are already energised and those who have accepted a connection offer and are proceeding to connect on a non-firm basis (in-flight connection projects).

2.4.1 Transition of non-firm to firm access

A challenge we may face in the RIIO-ED2 period should charging rules change in line with Ofgem's minded-to position on the Access SCR is that existing non-firm connections will apply to transition to firm connections, requiring significant reinforcement of our network.

We have considered this possibility in our estimate of Access SCR impacts, alongside the assumption that "A cost benefit analysis can be carried out on an individual constraint basis to ensure the most efficient long-term solution is adopted for each connection" as given in the guidance.

We have focussed our high-level assessment on:

- 33kV generation is included on the basis that our experience is that 33kV generation is frequently constrained by the 132kV network rather than at the voltage of connection. This means that connection offers for 33kV generation would typically be cheaper due to Access SCR reforms and customers would be more likely to benefit from changing from non-firm to firm connections.
- Battery Energy Storage Systems (BESS) at all voltages is included because our experience is that reinforcement to accommodate their connection is normally driven by the demand requirement and therefore would not be chargeable. These consequential no cost offers to convert from non-firm to firm connections are likely to drive existing customers to apply for better security connections.

We have excluded the following generation:

- HV generation is excluded because firm HV connections typically require costly reinforcement at the voltage of connection. The generator pays for this reinforcement and the cost of this is likely to deter HV generators from accepting a firm connection offer.
- 132kV generators are excluded because they quite frequently require 132kV reinforcement which they would pay for and require transmission reinforcement which they must securitise. Both of these factors would discourage changes in customer behaviour.

Results of a review of our existing BESS and 33kV generation already connected to our network and in the pipeline of non-firm accepted connections can be seen in Table 6. There is presently 167MW of BESS connected to our network and over 1GW of BESS schemes accepted to connect to our network. The majority of this is connected on a non-firm basis and may seek to transition to a firm connection should the minded-to position on Access SCR be implemented.

Table 6: Summary of non-firm connected BESS and 33kV generation

	Energised, MW (No. Schemes)	In-Flight, MW (No. Schemes)	Total, MW (No. Schemes)	Capacity Range
BESS at HV	0	48 (9)	48 (9)	1 – 10MW
BESS at 33kV	117 (5)	396 (16)	513 (21)	10 -50MW
BESS at 132kV	50 (1)	675 (12)	725 (13)	30 -100MW
BESS TOTAL	**167 (6)**	**1,119 (37)**	**1,286 (43)**	
Generators at 33kV	811 (64)	606 (34)	1,417 (98)	

Our standard connection offer for BESS and generator customers is to connect under non-firm arrangements, typically single circuit connections. Their non-firm basis means that we use constraint management to prevent overloads on the network and may need to disconnect them when our network configuration is abnormal with an outage of one of our circuits or transformers.

To transition connections from non-firm to firm will require a range of solutions to be employed. Adopting our flexibility first approach, the purchasing of flexible services and demand side response will be considered on a "dynamic" post fault basis. We shall analyse the required flexibility services for the situations that our network configuration is abnormal system considering the operating profile of the BESS/generator connection transitioning to a firm connection. In some cases, installation of new EHV circuits, transformers and switchgear will be required to provide the necessary capacity. Challenges with available space at existing sites and land rights and consents issues could further add to this cost. Site specific designs will be carried out at the time when these situations arise to determine the lowest whole system cost to solve a specific issue.

Using existing unit rates, a range of solutions at specific sites has been calculated based on the MWs required to be made firm, and these costs are presented in Table 7.

Table 7: Estimated cost to transition existing and pipeline BESS and 33kV generation from non-firm to firm connections

View	Inflight Progression	Energised and Inflight Conversion	Cost
Low View	20%	25%	£17.2m
Best View	40%	50%	£34.2m
High View	100%	100%	£108.4m

Our site-specific assessment has resulted in a range of £17.2m to £108.4m in RIIO-ED2 for this activity. It is likely as well that should the best view or high view scenarios proceed, reinforcement will be triggered at a grid supply point level which could create significant challenges in securing additional capacity to support this transition. The best view cost in Table 7 above is based upon typical inflight progression rates observed at present for accepted schemes, coupled with an estimate that half of these in turn will look to move to firm connections.

The figures above also include the cost identified at a number of BSP and primary substation sites where reverse power flow would potentially be an issue, rather than BESS driven demand which is where the larger issue is believed to lie.

2.4.2 Reduction in customer contributions for in-flight connection projects

Ofgem's business plan guidance section 5.41 requires the common assumption that "Customers with in-flight projects which are not yet connected could choose to cancel and re-apply under the new rules. These customers would not be eligible for refunds of any costs incurred up to that point."

We have assessed the impact of this by assessing the expenditure profile of accepted projects based on the current rules that would result in expenditure in the early years of ED2. For smaller LV projects we would expect that any accepted in RIIO-ED1 would complete in the first year of ED2, whereas larger EHV projects would see expenditure only in the first three years of the RIIO-ED2 period. We anticipate that customers will seek to cancel projects where there has been no expenditure and therefore they would not be liable for any costs incurred and then subsequently reapply without those costs being chargeable. For the best view and high cases we have assumed that largely all projects that have not incurred costs will cancel and therefore there will be a loss of customer contributions of £3.4 million, split £1.8 million and £1.7 million between primary and secondary networks respectively. For the Low view we have assumed zero (£0) reduction on the basis that no inflight projects cancel and reapply for their connection.

It should be noted that this assessment is on the basis of acceptances including firm and non-firm connections. The transition of accepted non-firm connections to firm connections is covered separately as described in the previous subsection.

2.5 Closely related indirect costs

To assess the total costs associated with a particular sensitivity or scenario, we have had to consider the impact of direct cost increases on the indirect cost base. In order to do this systematically, we have identified those elements of our indirect cost base which are directly associated with the scale of the directs, eg project design, project management etc. We have then expressed our current costs in these areas as a function of the historic activity levels to produce an estimate of 'first order' impacts, expressed as a percentage on-cost. These first order impacts were determined to be 7% of direct costs.

We then looked at the 'second order' impacts of increased direct costs through the increased activity required to recruit and train staff, manage contractors, oversee work delivery etc. We have identified these incremental costs through use of a specific case study of increased volumes of work, and a detailed analysis of the FTE and other impacts that this would require. We then converted this into a second on-costing rate which can be applied to different levels of incremental increase. Business Support Case second order costs have been taken as 5.2% of direct costs.

The same on-cost percentages have been applied to new direct costs for low, best and high view cases. Additional on-costs have not been applied to the values for transition from customer to DUoS funding and the reduction in customer contributions for inflight projects because these projects are already in our baseline and therefore covered by existing levels of business support.

3 UNCERTAINTY OF ACCESS SCR IMPACTS

The final decision on the Access SCR outcomes may be different to the minded-to position as thinking evolves further incorporating feedback from the associated consultation. Yet unknown additional development and detail means that the impacts of the Access SCR on network investments cannot be fully predicted with great certainty at this stage. Lack of specifics and time means that for the final plan it is not feasible to conduct the thorough bottom up analysis that underpins the forecasting and evaluation of the load related investment needs based on existing charges included in ex-ante plans. Our initial impact assessments will be superseded as changes in the final decision on charging influence the actual outcomes.

Although changes to charging will affect the volume and location of customer connections, we recognise that customers are also influenced by factors other than electrical connection cost:

- generator connections are typically more flexible than demand customers in their ability to relocate to places with lower connection charges;
- many demand connections are chiefly governed by their location, due to factors such as planning permission for a housing development; and
- large commercial/industrial connections are more likely to have the flexibility to relocate when connection charges are considered to be uneconomic.

Therefore, we anticipate that adoption of shallower connection charges will have a greater impact on generation connection behaviours compared to demand connections. Another factor affecting the impact of shallower connection charging on our customer connections is that other parts of the country may attract additional generator connections sooner after the shallower charging is introduced because they may offer more favourable environmental conditions, for example solar radiation levels or windier locations.

Changes coming from the TCR, such as greater generator DUoS charges for DG dominated areas, may deter the acceptance of generator connection offers.

Lack of final comprehensive plans, our inability to accurately forecast the needs and the large potential impact mean that we support the use of suitable Uncertainty Mechanisms to cover the uncertain investment needs driven by customer responses to the changes. Annex 29 – Managing Uncertainty sets out our proposals for Uncertainty Mechanisms to cover load related aspects of our plan, with two particularly relevant to uncertainties arising from Access SCR impacts as shown in Fig. 7.

We consider our proposal of utilising a Load Related Re-opener to manage the changes in LRE is flexible enough to manage any further changes which arise due to Access SCR decisions. In our opinion, the driver for LRE is largely irrelevant as to whether the requirement is as a result of economic growth, change in pace of decarbonisation or coming from changing behaviour due to Access SCR outcomes.

In addition to our load-related uncertainty mechanism solution, we are also proposing a Regulatory-Driven Changes Re-opener for RIIO-ED2. The Regulatory-Driven Changes Re-opener is designed to ensure that DNOs are funded for costs efficiently incurred as a consequence of regulatory or policy change, that have not been included in baseline allowances.

In summary, we consider the Load Related Re-opener would cover all additional direct costs arising from Access SCR decisions, whilst the Regulatory Driven Changes Re-opener would be used to cover increased indirect costs as a result of Access SCR decisions.

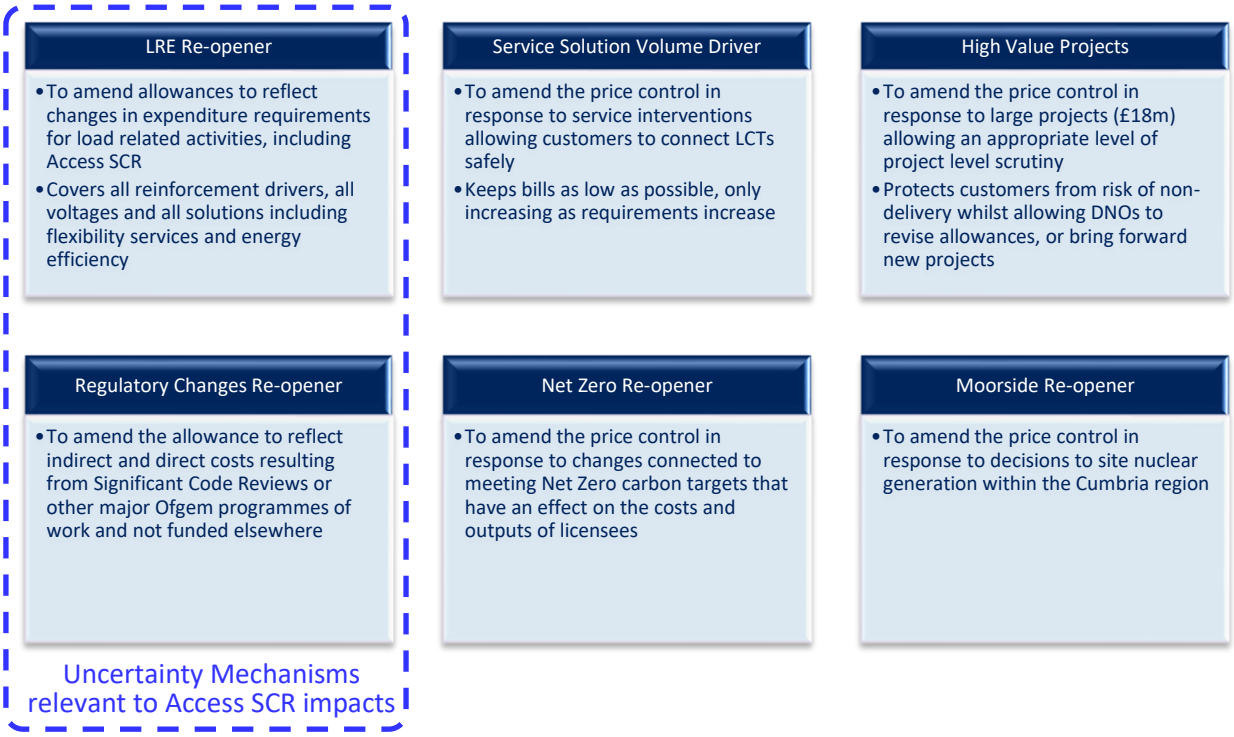


Fig. 7. Proposed load related uncertainty mechanisms

4 DELIVERABILITY

We have enhanced our deliverability plan, shown in Fig. 8, to ensure that we can ramp up activity to the level of network development associated with Access SCR and other uncertainties. Further detail on how we shall ensure that network development needs are delivered no matter what actual level of requirements transpire is provided in Part A of our Load Related Extenditure Annex 3A and our Delivery Strategy Annex 22.

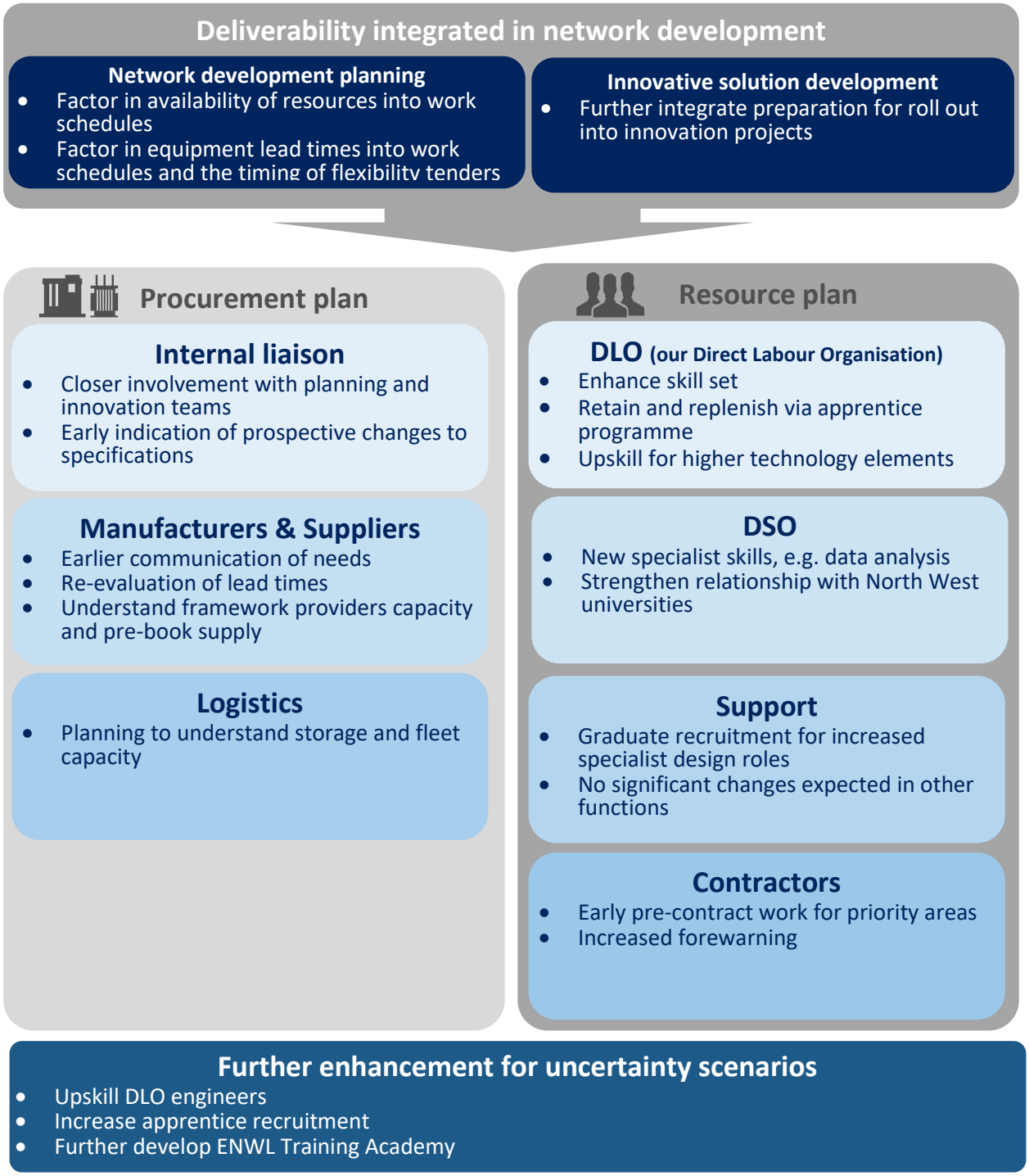


Fig. 8. Enhanced deliverability plan

5 GLOSSARY

Acronym	Definition
Access SCR	Access and Forward Looking Charges Significant Code Review - the Ofgem led review of the distribution connection and use of charging arrangements
ATLAS	Architecture of Tools for Load Scenarios
BESS	Battery Energy Storage System
BSP	Bulk Supply Point substation, typically 132/33kV
CBA	Cost Benefit Analysis
CCC	Committee on Climate Change
CO	Central Outlook scenario from ENWL DFES 2020
COP	Heat pump coefficient of performance
CT	Consumer Transformation scenario from FES/DFES 2020
DFES	Distribution Future Electricity Scenarios
DNO	Distribution Network Operator
DSO	Distribution System Operation
DUoS	Distribution Use of System
EHV	Extra High Voltage, typically 132kV and 33kV
EJP	Engineering Justification Paper
ENA	Energy Networks Association
ENWL	Electricity North West Ltd
EoI	Expression of Interest
EREC	Engineering Recommendation
ESC	Energy Systems Catapult
ESO	Electricity System Operator
EV	Electric vehicle
FCH	Future Capacity Headroom model
FES	Future Energy Scenarios
FY	Financial year
GMSF	Greater Manchester Spatial Framework
GSP	Grid Supply Point substation, transmission-distribution interface, typically 400 or 275/132kV
HIF	Housing Infrastructure Fund
HP	heat pump
HV	High Voltage, typically 11kV and 6.6kV
LA	Local Authority
LAEP	Local Area Energy Plan
LEP	Local Enterprise Partnership
LRE / LRI	Load Related Expenditure / Load Related Investment
LTDS	Long Term Development Statement
LW	Leading the Way scenario from FES/DFES 2020
LV	Low Voltage, typically 0.4kV
NRSWA	New Roads and Street Works Act (1991)
NTCC	New Transmission Connection Charges
ON	ENA Open Networks project
Primary	Primary substation, typically 33/11 or 6.6kV
RIIO	Revenue=Incentives+Innovation+Outputs
SCR	Significant Code Review
Secondary	Secondary substation, typically 11 or 6.6/0.4kV
SIWG	Strategic Investment Working Group
SP	Steady Progression scenario – FES/DFES 2020
SSMD	Sector Specific Methodology Decision
SRF	Strategic Regeneration Framework

ST	System Transformation scenario – FES/DFES 2020
ToU	Time of Use (for tariffs)
TUoS	Transmission Use of System
WS1b P2	Open Networks Workstream 1b Product 2 – Whole System FES