electricity north west

Bringing energy to your door

Engineering Justification Paper

RIIO-ED2 Project Level Report

Ref No LRE EJP 8 – Service Unlooping Programme

Date 30 June 2021

Table of Contents

Table of Tables

Table of Figures

Acronyms and Abbreviations

BPDT	Business Plan Data Table
CI	Customer Interruptions
CML	Customer Minutes Lost
DFES	Distribution Future Electricity Scenarios
EJP	Engineering Justification Paper
ENWL	Electricity North West Limited
ESQCR	Electricity Safety, Quality and Continuity Regulations
EV	Electric Vehicle
FY	Financial Year
HP	Heat Pump
HV	High Voltage
IDNO	Independent Distribution Network Operator
LCT	Low Carbon Technology
LV	Low Voltage
NIA	Network Innovation Allowance
NPV	Net Present Value
ToU	Time of Use (in relation to tariffs)

1 Summary Table

Table 1-1 below provides a high-level summary of the key information relevant to this Engineering Justification Paper (EJP) and the service unlooping programme in RIIO-ED2.

Table 1-1 Investment Summary

Reinforcement - Service Unlooping Programme			
Name of Scheme/Programme	Service Unlooping		
Primary Investment Driver	Load / safety		
Scheme reference/mechanism or category			
Output references/type	LV mains and service cable LV service termination		
Cost	Whole programme To Be Confirmed £70.0m in ED2		
Delivery Year	FY28		
Reporting Table	CV2		
Outputs included in RIIO ED1 Business Plan	No		
Spend apportionment	RIIO-ED1	RIIO-ED2	RIIO-ED3+
	£4.5m	£70.0m	>£580m based on forecast EV volumes and not considering future innovations

2 Introduction

This Engineering Justification Paper outlines the proposed service unlooping programme that is part of the RIIO-ED2 load related expenditure programme.

Looped services pose a risk to exceed network capacity when customers connect EV chargers or heat pumps. It is important to remove the danger and ensure that the electrical network is not a barrier to the uptake of Low Carbon Technologies (LCTs) necessary to meet the national net zero target.

It is estimated that 20 % of domestic premises in the ENWL region are supplied by a looped service as shown in Figure 2-1. These lopped installations typically have lower capacity than modern installations, with two, three and sometimes four dwellings fed from a single service cable. Historically, looped services were conceived as an economic and simple way to enable the widespread expansion of electricity distribution networks in the mid twentieth century, where the properties were gas centrally heated.

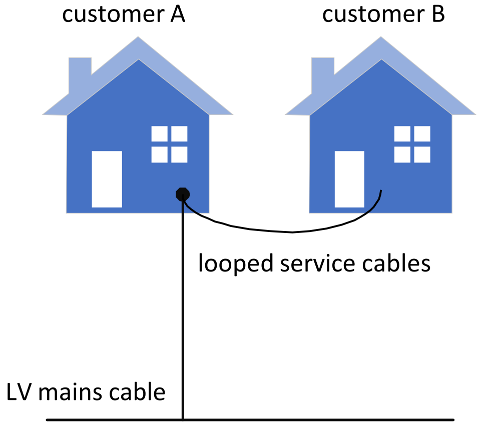

Figure 2-1 Domestic customers with looped services.

However, as the electrification of transport and heating are key elements of UK's transition to net zero carbon, the electricity demand of domestic customers who install an EV charger and/or a heat pump is expected to increase significantly. The uptake of EV volumes in particular is forecasted to increase significantly by over 60 times the current levels during the RIIO-ED2 period. This will lead to large numbers of EV charge points being installed at domestic dwellings.

Smart EV charging and application of Time of Use (ToU) tariffs enabled by the smart meter roll out can release network capacity by shifting demand away of times of peak load. However, such smart ways can only release capacity in parts of the network that feed an adequate number of customers. Their effectiveness is reduced in parts of the LV network that have lower diversity in demand, that is, those parts closer to the connection points of individual domestic customers. For example, these smart techniques are not effective at the end of service cables that supply individual domestic customers as there is *no demand diversity* at this level. Although two domestic customers on a looped service could apply smart EV charging to operate within the capacity at their joint LV service, this is unlikely to work all the time because there will be periods when both want to charge their EV overnight during the same hours or charge them on an afternoon time that coincides with operation of their heat pump.

The proposed service unlooping programme has been developed to deliver a range of outcomes dependent upon the need and customer acceptance. It proposes the replacement of looped services that are expected to supply increased LCT demand with a mix of:

- **partial de-looping interventions** (Figure 2-2): where the loop effectively moves outside the domestic property. Specifically, the loop is breech jointed onto the existing service underground and the cut outs are reinforced, that is, uprated from typically 60 A to 100 A each. This removes the danger of assets above ground overheating and failing, making the installation compliant with the Electricity Safety, Quality and Continuity Regulations (ESQCR). It is also the least invasive approach which minimises disruption to the customer, as well as the most economic.
- **full unlooping interventions** (Figure 2-3): where the loop is effectively removed so that the previously looped properties are connected to the LV mains cable via separate service cables, that is, 100 A each. Although this is a more invasive approach with associated disruption to the customer, it future proofs the connection by facilitating the adoption of LCTs across all domestic customers.

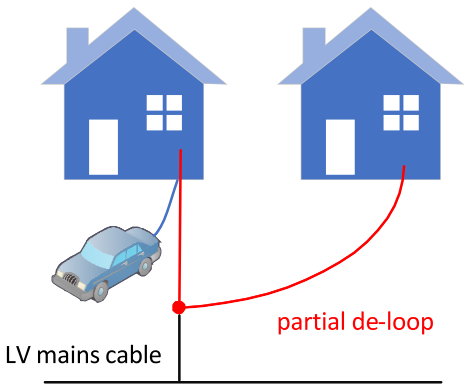

Figure 2-2 Partial de-looping option.

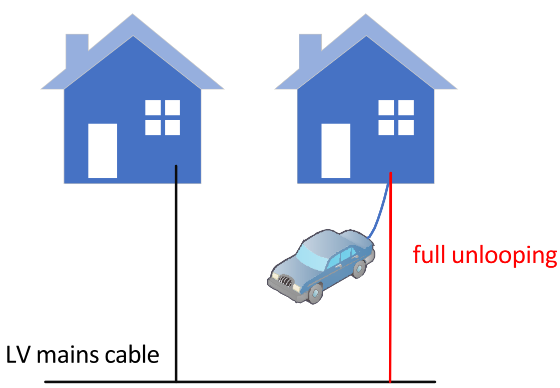

Figure 2-3 The full unlooping option.

The proposed service unlooping programme requires the partial de-looping of 8,570 loops and the full unlooping of 23,448 loops during RIIO-ED2. The per year requirements are shown in Table 2-1 and are driven by the forecasted uptake trend of EV volumes (Sections 3.2 and 3.3).

Table 2-1 Per year volumes of unlooping interventions

Type of intervention	FY24	FY25	FY26	FY27	FY28
partial de-looping	1,089	1,360	1,732	1,902	2,487
full unlooping	2,981	3,721	4,738	5,204	6,804

3 Background Information

3.1 Reinforcement requirements on looped properties

Looped services were conceived as an economic and simple way to enable the widespread expansion of electricity distribution networks in the mid twentieth century. They have provided satisfactory performance over many years and they were used extensively in terraced housing and new housing estates. It is estimated that 20 % of domestic premises (around 500 thousand households) in our region are supplied via a looped service. Typically, dwellings are supplied by a looped service cable, where a single cable is taken from the low voltage mains cable and is 'looped' from one property to the next to provide the electricity connection. This means that the electrical demand of several properties is supplied via a single service cable rather than a service cable per property connected directly to the mains cable.

The typical arrangement of a looped service is shown in Figure 2-1 and consists of:

- an LV mains cable that is connected to the local secondary substation (typ. 11 or 6.6/0.4 kV);
- one service cable that is typically rated at 100-120A and connects the LV mains with the group of two or more looped properties;
- one or more cut outs depending on the number of properties looped that is/are typically rated at 60 or 100 A and connect(s) the adjacent properties with the service cable.

This arrangement has traditionally allowed domestic customers to absorb up to 60 A from the network, allowing for a couple of high demand domestic appliances (for example, an electric oven and washing machine), each typically drawing up to 25 to 30 A. As more customers adopt LCTs, a domestic EV charger would bring an incremental demand of around 7.5 kW (equating to 32 Amps) and a heat pump another 5 to 15 kW (equating to between 20 and 60 A). Therefore, if a domestic customer on a looped property installs a single EV charger rated at 7.5 kW then the total demand could easily exceed the 60 A rating of the cut out. With a second LCT installed on the same group of looped properties, the aggregated peak demand of both could exceed the 100 A rating of the service cable during coincident use of devices.

Apart from the real risk of exceeding the capacity of service cables, there are safety risks for domestic customers. More specifically, the full load of all the dwellings on the loop flows through the first section of the loop and the termination at the first cut out. Crucially, this equipment is effectively electrically unprotected. Consequently, there is a risk of overheating causing a fire, in contravention of the legal requirements of the ESQCR.

3.2 LCT forecasts – high certainty on high EV uptakes

As more national policies are supporting the adoption of LCTs in the UK's transition to net zero carbon by 2050, there is a need to provide adequate network capacity to all domestic customers that adopt LCTs and are supplied via looped services. Based on consumer choice modelling in our DFES 2020[1] forecasts that consider expected national policies for LCTs, it is expected that approximately 638,000 EVs will be registered in our license area according to the Central Outlook scenario, which is the high certainty scenario informing our RIIO-ED2 load related investment programme.

Apart from the high certainty scenario, the lower certainty scenarios in the DFES are indicative of the uncertainties in LCT uptakes and especially around the electrification of heating. The lower certainty

[1] Distribution Future Electricity Scenarios (DFES) 2020, Electricity North West Ltd, online: www.enwl.co.uk/dfes

scenarios which are used to inform the minimum-to-maximum investment range of our RIIO-ED2 load related investment programme have considered an accelerated decarbonisation to meet local early zero carbon targets in a large part of our license area before 2040. In these scenarios, the heat pump uptakes could be much higher than the Central Outlook scenario and increase, by around 50 times the FY20 levels, to reach 601,100 domestic customers units.

Table 3-1 Forecasts of LCT volumes in ENWL area for EVs and domestic heat pumps (HPs)

Scenario	FY20 Volume (1000s)	FY23 Volume (1000s)	FY28 Volume (1000s)
High certainty scenario *(Central Outlook: national policies driving electrification of transport, limited levels of electrification of heating)*	9.4 EVs 13.1 HPs	92.3 EVs 25.4 HPs	638 EVs 68.4 HPs
Low certainty scenarios *(accelerated decarbonisation: net zero met before 2040 in large part of region through electrification of heating)*		100.6 EVs 233.7 HPs	698 EVs 601.1 HPs

3.3 Estimation of EV charger volumes on looped properties

A cautious approach has been taken to estimate the number of properties in our region requiring unlooping during RIIO-ED2 period. To avoid double counting of requirements due to heat pumps adopted by domestic customers that have also an EV charger, unlooping is considered to be required only when EV chargers are connected to properties fed by looped services. To estimate the amount of EV chargers expected to be installed on looped properties we have followed a five-step approach:

- **Step 1:** electric vans and plug in cars were excluded and only the pure battery electric cars forecast during RIIO-ED2 were considered (note, vans and plug ins are forecast to account for 21 % of overall EV registrations during RIIO-ED2). For Central Outlook scenario this results in an estimate of 433,234 electric cars by 2028.
- **Step 2:** based on 19.5 % of services being looped and a homogeneous uptake of EVs across our area, the electric cars expected to be registered to owners living in properties with looped properties is calculated (19.5 % x 433,234) to be 84,481 for our Central Outlook scenario.
- **Step 3:** based on the percentage of customers in our region being connected to Independent Distribution Network Operators (IDNO) networks, we excluded these customers on the basis that the IDNO would be responsible for the unlooping if necessary, the forecast number of EVs connected to ENWL looped service was reduced to 80,088 electric cars (-5.2 % of domestic customers fed by IDNOs) for our Central Outlook scenario.
- **Step 4:** properties without access to off-street parking are excluded. Based on regional data from our Reflect NIA project 60 % of properties in our area have access to off-street parking. For Central Outlook this results in an estimate of 48,053 electric cars connected to looped services with access to off-street parking.
- **Step 5**: not all customers with access to off-street parking are expected to adopt domestic charging. To avoid overestimating the amount of services requiring unlooping it has been assumed that only two out of three domestic customers with access to off-street parking will

install a domestic charger. **For Central Outlook this results in a final estimate of 32,035 EV chargers.**

3.4 Assessment of requirements per unlooping type

Having assessed the amount of EV chargers that are expected to be installed on looped services, the next step is to define the suitability of unlooping interventions depending on the property type and the associated customer disruption. More specifically:

- **<u>Terraced houses</u>:** they are on average closer to the road and therefore closer to the LV mains cable. The disruption due to full unlooping of a service to a terraced house is like that of partial de-looping. Therefore, full unlooping is likely to be more acceptable to terraced homeowners even if associated with benefiting neighbours because much of the additional disruption will be in the pavement. Also, the loop between terraced houses may be within the homes, making partial de-looping an ineffective safety precaution because the service would remain within the property along with the risk of overheating if overloaded. For these reasons, full unlooping is the most effective solution for all terraced properties irrelevant of whether the first or second customer as shown in Figure 2-1 is installing the EV charger.

  <u>Semi-detached houses</u>: the most suitable unlooping interventions for semi-detached houses depend on customer acceptability. Our RIIO-ED2 unlooping activities will be reliant on customers accepting the disturbance associated with the unlooping. Their acceptability of the disturbance depends on whether they want the charger for themselves or whether the disturbance would be to permit their neighbours to install an EV charger. Depending on the number of properties in a loop the following approach has been applied:

  - **2 services looped:** there is a 50 % probability that the first customer is planning to install an EV charger and 50 % probability that the second customer wants the charger. Full unlooping for the second customer would require installing a new service from the LV main to the second customer's house, so they are likely to accept this because they want the charger. However, full unlooping for the first customer's EV would also require installing a new service for the second customer. There is a strong probability that the second customer would not accept the disruption of a dug-up driveway for the benefit of the first customer. Therefore, in this case, a safety first partial de-looping is most likely when the first customer wants to install the EV charger. It would only involve disruption on the first customer's land and this would not involve laying a cable along the full length of the route from the LV main cable to the customer's cut out.
  - **3 or more properties looped:** there is a 33% probability that the first customer is planning to install the EV charger and again a safety first partial de-looping is most likely. Full unlooping of the second or third customer due to their EV requirements would involve a new service with acceptable disruption to them. Therefore, there is a 66% probability that full unlooping will be undertaken if there are three or more properties looped together.
- **<u>Detached houses</u>:** they are not expected to have looped services and therefore no unlooping interventions are required.

From the above it is understood that the proper mix of unlooping interventions depends on the split in the number of services looped together and the split of the property types. For our demand modelling we use local data (all domestic and non-domestic buildings modelled) that cluster buildings based on size, age, location (urban/local) and heating fuel type. Even though this data is useful for demand modelling, it cannot provide the split between terraced, semi-detached and detached houses. Therefore, the split of the property types amongst those we shall unloop in RIIO-ED2 is assumed to follow the national split based on the housing review data as shown in Table 3-2.

Table 3-2 Split of property types with unlooping requirements based on national housing data

Dwelling type	UK population (in million)	Potential to require unlooping	% of looped services
Small terraced house	9.77		
Medium/large terraced house	18.79	✓	41.9%
Semi-detached house	26.02	✓	58.1%
Detached house	17.39		

The 32,035 properties fed by looped services that are predicted to install a domestic EV charger in RIIO-ED2 (estimate from Section 3.3) are assumed to be split according to the number of large terraced houses and semidetached houses only, assuming that detached houses will not have loops and small terraced houses will not have off street parking and therefore not install EV chargers.

The numbers of each type of intervention and their costs are given in Table 3-3 where the percentage breakdown is based on the above rationale. It is also assumed that all terraced houses with looped services involve two properties and that overall, 86.6 % of looped services in Table 3-2 involve two properties. Hence the percentage breakdown for partial looping and full un-looping for semi-detached houses will relate to the percentage of 2 or 2+ property installations and their respective probability split (50/50, 66/34) for full unlooping/partial de-looping.

Table 3-3 Split of intervention types per property type and associated costs

	Full unlooping on medium/large terraced houses	Full unlooping on semi-detached	Partial de-looping on semi-detached	Total
% of interventions (to one decimal place)	41.9 %	31.3 %	26.8 %	100 %
Number of interventions	13,436	10,015	8,584	32,018
Cost of interventions	£35.46m	£26.42m	£8.09m	**£70.0m**

3.5 Costs per intervention

This subsection explains what the *per intervention* (per unit) costs are for the partial de-looping and the full unlooping. The total cost for each of these two intervention types are shown in Table 3-4 and are based on recent installations during RIIO-ED1.

Our RIIO-ED1 experience from actual installations has shown that in order to minimise customer disturbance, any reinstatement works require bringing the customer driveways and gardens as close as possible to their prior condition. Full unlooping requires a more severe intervention on customer driveways/gardens results in higher contractor costs which covers, in addition, the footpath reinstatement and cost of service cables. Whereas, for the partial de-looping intervention, the labour costs cover the expenditure for cable jointing, use of vehicles and managerial cost. These are higher than for full unlooping as they include excavation and reinstatement of any driveways/ gardens.

The material costs required are relatively lower, in both cases, than the labour/contractor costs and include the two cut-outs, jointing kits and cable.

Table 3-4 Split of intervention types per property type and associated costs

Cost Element	Partial De-looping (in £)	Full Unlooping (in £)
Labour	£617	£433
Contractors	-	£1,900
Materials	£240	£240
Related Party Margins	£86	£66
Total cost:	**£943**	**£2,639**

4 Optioneering

Four options were considered regarding service unlooping and are summarised as shown in Table 4-1 with further detail in sections 4.1 to 4.4.

Table 4-1 Summary of Options

Option	Description	Advantages	Disadvantages
1.	Do Nothing.	No cost.	Leaves network at risk of overload for some properties with potential risk of fire and safety risk to public. Does not support with our DFES load predictions. Does not allow us to support fully the increase in LCT technologies.
2.	Partial de-looping in RIIO-ED2: followed by full unlooping beyond RIIO-ED2.	Minimum customer disruption in RIIO-ED2 for mainly semi-detached properties where partial unlooping has most benefit. Removal of fire risk, increased public safety and facilitate LCT uptake.	Maximum overall cost based on CBA analysis. Long-term customer disruption if subsequent full unlooping is required.
3.	Mix of partial de-looping and full unlooping in RIIO-ED2: (focusing on balancing of network future proofing and minimum customer disruption)	Limited customer disruption for all property types. Low cost based on CBA analysis. Increased level of future network proofing. Removal of fire risk, increased public safety and facilitate LCT uptake.	Customer disruption occurs just in one intervention.
4.	Full unlooping of all properties: No partial de-looping in RIIO-ED2.	Full future network proofing. Minimum cost based on CBA analysis. Limits long-term disruption for medium/large terraced properties. Removal of fire risk, increased public safety and facilitate LCT uptake.	Maximum customer disruption for semi-detached properties who could benefit from less disruption through partial unlooping.

4.1 Option 1- Do Nothing

This option leaves the looped services in place and therefore does not provide any support for an uptake in Electric Vehicles or Electric heating. It also leaves the network open to overload and possibly fire risk if these additional LCTs were connected to the looped properties. For these reasons, this option is discounted.

4.2 Option 2 – Partial de-looping (followed by full unlooping after ED2)

In this option all domestic customers that are fed by looped services and who wish to install an EV charger would be partially de-looped, noting that this is not a practical solution for terraced houses. As explained in section 3.4, this type of intervention results in less customer disruption for semi-detached properties as there is less need to dig-up the whole length of the driveways of customers that have not adopted an LCT for the benefit of their neighbour who has adopted one.

Even though this option minimises customer disruption for semi-detached properties, it comes at a higher cost than any other option. More specifically, full unlooping would be required, as explained in section 3.1, to future proof the network as part of the UK transition to net zero carbon and allow all properties in a loop to adopt at least one LCT (EV charger and/or heat pump). The CBA analysis used to compare option 2 and an initial full unlooping (considered in options 3 and 4) is based on investment dates and avoided CIs and CMLs associated with the faults that would occur if a looped service failed due to becoming overloaded but excludes losses and social impacts. The initial partial de-looping is taken to happen in 2024 and it is assumed that all looped services will ultimately need to be fully unlooped by 2050 to achieve the net zero target. To simplify the CBA analysis, it is assumed that full unlooping occurs every five years after 2024 with the proportions of interventions in each year reflecting the uptake rate predicted in our Central Outlook scenario as shown in Table 4-2.

The CIs and CMLs will have an impact on the CBA analysis as initial full unlooping will avoid the possibility of an overload of the partial de-looped case which could occur if the two properties still looped together both operate an EV charger and one has a heat pump in addition to their existing demand. The combined probability of this situation is calculated using the individual probabilities of our customers adopting EVs and HPs in RIIO-ED2 as forecast in our DFES.

Table 4-2 Per intervention cost efficiencies of partial de-looping followed by full unlooping vs initial full unlooping

Efficiency comparison	Percentage uptake in 5 years groups (DFES Central Outlook)	Cost efficiency (CBA NPV - 45 years horizon)
Partial de-looping followed by full unlooping in 2029	24%	£599.9
Partial de-looping followed by full unlooping in 2034	35%	£214.7
Partial de-looping followed by full unlooping in 2039	26%	-£116.5
Partial de-looping followed by full unlooping in 2044	10%	-£402.1
Partial de-looping followed by full unlooping in 2050	2%	-£694.8
Total cost efficiency per intervention		**£136.5**

The CBA results show that option 2 is not the optimal approach and we should strive to fully unloop wherever acceptable to:

- futureproof the network and allow domestic customers with access to off-street parking to install EV chargers and/or install heat pumps; and,
- reduce overall customer disruption over the longer term as a single intervention instead of two would be required.

4.3 Option 3 – Proposed mix of partial de-looping and full unlooping

As described in detail in section 3.4, a mix of partial de-looping and full unlooping interventions is proposed dependent on the property type connected to the looped services. As shown in Table 3-3, the majority of interventions are for full unlooping (73.2%). The analysis of option 3 revealed that these full unlooping interventions futureproof the network at a lower cost than option 2, whilst reducing customer disruption in the longer term by avoiding a second intervention beyond RIIO-ED2.

The partial de-looping interventions of option 2 (26.8%) is targeted purely to customers of semi-detached properties that are part of a loop but where it is their neighbour that has adopted an LCT and triggered the need for the unlooping intervention rather than themselves. The disruption for these customers is minimised during the RIIO-ED2 period, but there is still a longer term need for a second full unlooping intervention before 2050 to facilitate their ability to adopt an LCT beyond RIIO-ED2.

Option 3 has taken a pragmatic approach: acknowledging not only the need for futureproofing the network at the lowest cost and avoiding multiple interventions, but also that an estimated proportion of customers will oppose a full unlooping intervention that requires digging up driveways.

Even though full unlooping is preferable due to its efficiency, the increased probability that customers will accept partial unlooping more readily means that option 3 is a more credible choice for the baseline (ex-ante) allowance in RIIO-ED2. However, if more customers accept full unlooping than we have assumed then additional costs would need to be covered by an uncertainty mechanism because of the benefits of not foreclosing future benefits. The uncertainty mechanism would need to cover the difference between the baseline and the cost of all unlooping interventions being of the full unlooping type rather than partial de-looping in RIIO-ED2.

4.4 Option 4 –Full unlooping

This option considers full unlooping during RIIO-ED2 for all domestic customers supplied by looped services and planning to install an EV charger. Option 4 is the optimal choice in terms of minimising the costs to futureproof the network's ability to facilitate primarily the electrification of transport and at the same time a potential electrification of domestic heating. These are key components of the UK's transition to net zero carbon by 2050. In addition, option 4 avoids multiple interventions before 2050 that would increase customer disruption.

However, as mentioned in option 3 and described in more detail in section 3.4 there is a real possibility that an approximately a quarter (26.8%) of interventions could be strongly opposed by customers who do not adopt an LCT during RIIO-ED2, but who are required to unloop to permit their neighbours to adopt an LCT. This limits the ability of option 3 to define the baseline (ex-ante) allowance for unlooping interventions in RIIO-ED2, but as explained in option 2 it can still be useful to quantify the potential investment that would be required as part of an uncertainty mechanism.

5 Analysis and Cost

As outlined in section 4, four options have been considered related to the issue of removing looped services on the network.

- Option 1 – Do nothing
- Option 2 – Partial de-looping followed by full unlooping
- Option 3 – Proposed mix of partial de-looping and full unlooping
- Option 4 – Full unlooping

The first option has been discounted as it leaves the network with no future proofing and increases the safety risk if several LCT technologies were connected to the existing looped services.

Options 2, 3, and 4 were then considered as they provide some level of futureproofing of the network to allow domestic customers on looped services to adopt LCTs and, in particular, an EV charger, given the high certainties in the electrification of the transport sector. At the same time network futureproofing by increase end of service network capacity by full unlooping allows these domestic customers to also benefit financially from:

- access to smart EV charging;
- access to flexible services and benefits from ToU tariffs for those customers adopting domestic batteries with solar PV and/or heat pumps.

Providing equal opportunities to all domestic customers to benefit from the above should be seen as a fundamental priority for DNOs to support UK's transition to net zero carbon by 2050.

Each of these options and their respective cost information is summarised in the Table 5-1. To allow a cost comparison between options 2,3 and 4, the results of the CBA summarised in Table 4-2 have been considered. More specifically, the £2,639 per unit asset cost for every full unlooping scheme during RIIO-ED2 is not followed by any other cost as there is no subsequent intervention required to meet net zero by 2050. Considering the CBA results showing that every full unlooping intervention is in average £136.5 more efficient than a partial de-looping in RIIO-ED2, the corresponding NPV equivalent per unit asset cost that needs to be considered for partial de-looping is £136.5 higher than the full unlooping cost. Therefore, to allow a NPV comparison between the two unlooping types a £2,775.5 per unit asset cost for partial de-looping should be compared with the corresponding £2,639 asset cost per full unlooping.

The main disadvantages for option 2 that make it less preferable than the other two is:

a. the increased cost as CBA analysis has revealed significant cost efficiencies in favour of full unlooping as this will be required to futureproof a network capable to facilitate electrification of transport at minimum (see section 4.1)
b. the increased customer disruption in the longer term as all customers would experience two interventions instead of one.

Option 4 is the most cost-efficient option based on CBA analysis. However, there is a risk that this option considers higher baseline (ex-ante) allowance asset costs in RIIO-ED2 given that an estimate of 26.8 % of interventions would face significant customer disruption in the case of full unlooping.

The optioneering analysis has revealed that option 3 is the preferred option given that the partial de-looping interventions, which have higher associated NPV costs (reduced efficiencies), are targeted only to customers expected to have significant disruption levels and are more likely to oppose a full unlooping intervention.

Table 5-1 Outline of options and associated costs and benefits

Option	Description	Estimated Asset Cost (NPV)	Other costs / benefits considering CBA analysis	Comments
2	Partial de-looping followed by full unlooping.	£88.9m of asset costs taking into account that every partial unlooping has reduced NPV efficiencies based on CBA.		Not futureproofing network to facilitate long term electrification of transport and heating.
3	Mix of partial de-looping and full unlooping.	£85.7m of asset costs taking into account that every partial unlooping has reduced NPV efficiencies based on CBA	Futureproofing network for 73.2 % of interventions and allows them benefit through accessing flexible services (smart EV charging, flexible services provided by domestic batteries and PV etc)	Balanced approach that does not block network futureproofing and acknowledges minimal customer disruption during RIIO-ED2.
4	Full unlooping.	£84.5m of asset costs.	Futureproofing network for 100% of interventions and allows them benefit through accessing flexible services (smart EV charging, flexible services provided by domestic batteries and PV etc)	Not pragmatic approach for baseline allowance. Useful to define additional investment requirement through uncertainty mechanisms.

6 Deliverability and Risk

To deliver the proposed service unlooping programme (Option 3: Mix of partial de-looping and Full unlooping) and allow customers fed by looped service to adopt LCTs in RIIO-ED2, the high-level outputs shown in Table 6-1 are included in BPDT CV2.

It is anticipated that delivery will commence in FY24 with outputs delivered each year as recommended in Table 6-1. The proposed year-by-year allocation of interventions is following the uptake trend of EV volumes based on our Central Outlook scenario from DFES 2020.

Table 6-1 Regulatory outputs for option 3

Intervention	Quantity	FY24	FY25	FY26	FY27	FY28
Partial de-looping	8,570	13%	16%	20%	22%	29%
Full unlooping	23,448					

Our delivery track record in RIIO-ED1 has been on target and in alignment with budget.

Based on the high-level review and our existing experience in installation and use of the preferred service unlooping programme, there is low risk associated with the delivery of the recommended option (option 3). Contractor resource is likely to be employed for delivering the unlooping programme to mitigate the risks associated with the high volumes, and uncertainty in these quantities and their phasing.

7 Conclusion

As increasing volumes of LCTs, and in particular EVs, during RIIO-ED2 are expected, there is a need for domestic customers fed by looped services to be able to connect LCTs to their network without delay.

Two unlooping solutions are available and have been considered, specifically:

- partial de-looping that provides necessary capacity for a single LCT to connect in a loop and removes a potential safety issue for associated domestic customers; and,
- full unlooping that allows all domestic customers in a loop to adopt LCTs and futureproofs the network not only for the electrification of transport that has higher certainty, but also for the electrification of heating and other LCT adoption as part of UK's transition to net zero carbon by 2050.

Four potential options were considered:

- Option 1 – To do Nothing. This leaves the network with no resilience against the DFES predicted future loading due to the uptake of LCTs. In addition, there poses a safety risk if several LCTs are connected to the existing looped services. This option was discounted.
- Option 2 – Partial de-looping followed by full unlooping" was found as less attractive was discounted given that CBA analysis has revealed this is the highest cost option and highest customer disruption levels in the long term requiring two interventions for all customers associated.
- "Option 3 – Proposed mix of partial de-looping and full unlooping" was found the preferred option to define the RIIO-ED2 baseline (ex-ante allowance) given that:
    - full unlooping is applied for most customers and this is the most cost-efficient intervention type that futureproofs the network; and,
    - the partial de-looping interventions, which have higher associated NPV costs (reduced efficiencies), are targeted only to customers expected to have significant disruption levels and are more likely to oppose a full unlooping intervention.
- "Option 4 – Full unlooping" although this was found to be the most cost-efficient way of futureproofing the network, it is less preferable because some customers are likely to prefer partial unlooping. Option 4 was found to be a useful option to inform the level of investment to be funded under uncertainty mechanisms should more customers accept full unlooping. This option reveals the incremental asset cost that could be funded through uncertainty mechanisms to deliver full unlooping when undertaking all interventions in RIIO-ED2.

The preferred option was therefore found to be the proposed mix of partial de-looping and full unlooping (option 3) with an estimated total asset cost of £70m. This is based on 8,570 partial de-looping and 23,448 full unlooping interventions on loops where domestic customers will adopt LCTs.