Distribution Network Operator Innovation Roll-Out Mechanism (IRM) Submission Pro Forma Executive Summary

Executive Summary

To meet government decarbonisation targets our customers are being encouraged to adopt eco-friendly lifestyles, leading to an increase in the uptake of Low Carbon Technologies (LCTs). LCT uptake tends to occur in clusters, and is expected to increase even further in RIIO-ED2 and beyond, which will have a dramatic effect on our network. For example, on an estate of domestic customers where gas central heating is swapped for an electric alternative such as a Heat Pump (HP), and petrol or diesel cars are replaced with Electric Vehicles (EVs), we could see a total demand over six times larger than our network was originally designed to handle. Without intervention, this scenario will cause voltage levels to drop below statutory limits. At the same time an increase in Low Voltage (LV) generation, for example through the uptake of Photovoltaics (PV) by social housing landlords, will cause voltage levels to exceed statutory limits. It is vital that Electricity North West maintain voltages within these limits to avoid negatively affecting the performance of appliances belonging to our customers.

Electricity North West trialled a long-term solution to this emerging problem during the Low Carbon Networks (LCN) funded innovation project, 'Smart Street'. During the Smart Street trials we installed a variety of innovative technologies on our distribution network to create the first fully centralised LV control system in Great Britain (GB). The trials proved that controllable switching devices, when integrated into our Network Management System (NMS), will stabilise network voltages and prevent them from falling outside of statutory limits. The system allowed us to optimise voltage levels so that both customers' appliances and our network run as efficiently as possible, using a technique known as Conservation Voltage Reduction (CVR).

The trials demonstrated that controlling voltages provides a number of benefits to customers, including reducing customer energy bills, reducing carbon emissions, and facilitating the connection of LCTs to our network. Importantly, the trials have proven that it is possible to realise these benefits without impacting the quality of supply to our customers.

This approach ensures that DNOs act as a facilitator of a low carbon energy system, and do not prevent or slow down the adoption of LCTs due to limited network capacity and/or voltage constraints.

Now that the trials have concluded and the system has proven effective we are proposing a Relevant Adjustment under the Innovation Roll-out Mechanism (IRM) for £15.09m, as required by licence condition CRC 3D, to fund a targeted roll-out within RIIO-ED1.

This application from Electricity North West is for the targeted deployment of the Smart Street system to 180 distribution substations and the associated LV networks. At the heart of the system is the optimisation software which will use real time measurement and configuration data to manage the voltage and power flows of the LV network. The following technology proven during the trial will be installed as part of the IRM to enable the optimisation software to autonomously manage the network:

Distribution Network Operator Innovation Roll-Out Mechanism (IRM) Submission Pro Forma

Executive Summary continued

- Distribution transformers with On Load Tap Changers (OLTCs) will adjust the voltage level on the LV network as and when required by the optimisation software.
- LV Circuit Breakers (LVCBs) and LV switches will allow real-time network reconfiguration in line with optimisation software requirements.

The roll-out will focus specifically on the areas and customers that we believe would benefit the most. We will therefore target areas with a predicted high uptake of LCTs and, within this selection, will prioritise areas where we have identified a high level of fuel poverty.

It is important that we begin the roll-out within RIIO-ED1 to ensure that we are ready to meet the challenges posed by predicted LCT uptake in RIIO-ED2 and beyond, to continue to provide our customers with a system that meets their evolving needs. An initial roll-out in RIIO-ED1 is anticipated to stimulate the market to facilitate a cost reduction on Smart Street technology. This will enable us to be more confident on the costs for a more widespread application of the Smart Street system within our RIIO-ED2 business plan.

A roll-out of the Smart Street system meets all necessary criteria for IRM funding, as outlined in licence condition CRC 3D. As such, it is in the best interests of our customers that we apply for this adjustment to avoid delaying the roll-out and all associated benefits.

The roll-out will provide **long term value for money** to approximately **45,000 customers** by reducing annual energy consumption by up to 8%, which equates to a total estimated financial saving for these customers of **£2.74m per annum** through increased energy efficiency. The roll-out will also provide additional long term value for money to all customers by releasing network capacity and reducing losses. This will facilitate the future connection of LCTs and will allow deferred network reinforcement, which, in turn, will lead to a reduction in Distribution Use of System (DUoS) charges for all customers. We estimate that the combined total savings through releasing network capacity and reducing losses will equate to a financial **net benefit** for customers of **£16.55m by 2030**.

The roll-out will deliver **carbon benefits**, contributing towards the government's strategy for reducing greenhouse gas emissions, with a potential **carbon saving of 144,860 tCO_2e by 2055** across the 180 installations of the Smart Street system. The financial value associated with this carbon reduction is £7.09m; the main contributors to this figure are carbon savings through avoided network reinforcement, reduced energy consumption, and reduced technical losses.

We will receive **no commercial benefits** equal to or greater than the cost of the roll-out within RIIO-ED1, as evidenced in our Cost Benefit Analysis (CBA) and discussed further in Section 4.

Finally, if successful, IRM funding will only be used to roll-out the Smart Street system, which has been successfully trialled on our network and therefore meets the definition of a **Proven Innovation**.

The roll-out of the Smart Street system will be our first step into autonomous LV network management.

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Section 1: Application Summary

1.1 Application title

Smart Street

1.2 Estimated total cost

The total cost for the roll-out is £15.16m (£18.11m).

For the purpose of this document all figures are quoted in 2012/13 prices with 2019/20 prices shown in brackets.

1.3 Total funding request

Figure 1.1 sets out our proposed IRM adjustment in £m per annum across the RIIO-ED1 period. This brings our total funding request to £15.09m (£18.03m).

Figure 1.1: IRM adjustment per annum

	2020/21	2021/22	2022/23	Total
Proposed adjustment to IRM values per annum (£m)	4.64 (5.55)	8.20 (9.80)	2.24 (2.68)	15.09 (18.03)

1.4 Start date and end date of Relevant Adjustment

Project start date: 1 December 2019

Relevant Adjustment start date: 1 April 2020

Relevant Adjustment end date: 31 March 2023

1.5 Application executive summary

This application from Electricity North West is for an adjustment under the IRM for the targeted deployment of the Smart Street system to 180 distribution substations and associated LV networks.

At the heart of the system is the optimisation software which will use real time measurement and configuration data to manage the voltage and power flows of the LV network. The following technology proven during the trial will be installed as part of the IRM to enable the optimisation software to autonomously manage the network:

- Distribution transformers with OLTCs will adjust the voltage level on the LV network as and when required by the optimisation software.
- LVCBs and LV switches will allow real-time network reconfiguration in line with optimisation software requirements.

By combining the onsite equipment with the optimisation software the Smart Street system forms a unique arrangement of fully integrated equipment. Managing the network in this way increases available network capacity for the connection of LCTs, reduces losses and carbon emissions, and helps to reduce customers' electricity bills without any negative impact.

The roll-out will target areas where we have predicted high levels of LCT adoption and, within this selection, we will prioritise areas with high levels of fuel poverty. We expect there to be some overlap between these areas due to the uptake of PV on social housing in a number of areas within our network.

Section 2 of this submission provides a high-level description of the roll-out to clarify the improvements which will be achieved by the deployment of the Smart Street system. In doing so, the following topics will be discussed:

- The network challenge and issues associated with the transition to a low carbon energy system.
- The Smart Street innovative solution which can be applied to alleviate the impact of these issues.
- The impact of the roll-out on electricity customers.
- The process of adopting the technology into Business as Usual (BaU) practice during future price control periods.

Section 3 describes the Business Case required to justify the RIIO-ED1 roll-out. The business case has built upon the learning acquired from the Smart Street Second Tier LCN funded project which successfully demonstrated the benefits associated with the innovation and how it can be applied efficiently.

Section 4 presents our justification for the roll-out against the IRM Evaluation Criteria, including additional information on the CBA, the measures in place to ensure the roll-out is a success, and the organisational structure that will govern the project.

Section 5 confirms that the roll-out does not require any derogations or changes to regulatory arrangements, and also presents a summary of consultation with external stakeholders undertaken during the trials.

Section 6 contains the appendices which supplement the submission and provide more detail on aspects such as the CBA, project plan and risks.

For the purpose of this document, the Smart Street trials conducted under the LCN funded project will hereafter be referred to as the 'trials' and content concerning the IRM application will be referred to as the 'roll-out'.

Distribution Network Operator Innovation Roll-Out Mechanism (IRM) Submission Pro Forma

Section 2: Application Description

2.1 Background

Electricity North West's Smart Street innovation project, funded via Ofgem's LCN Second Tier funding mechanism, conducted trials over a two year period from January 2016 until December 2017 involving 9,500 customers across 38 distribution substations.

The project successfully trialled an integrated system comprising advanced optimisation software and network assets to simultaneously manage power flow and voltage on the High Voltage (HV) and LV networks in real time to release additional capacity for the connection of LCTs.

Why are LCTs a problem?

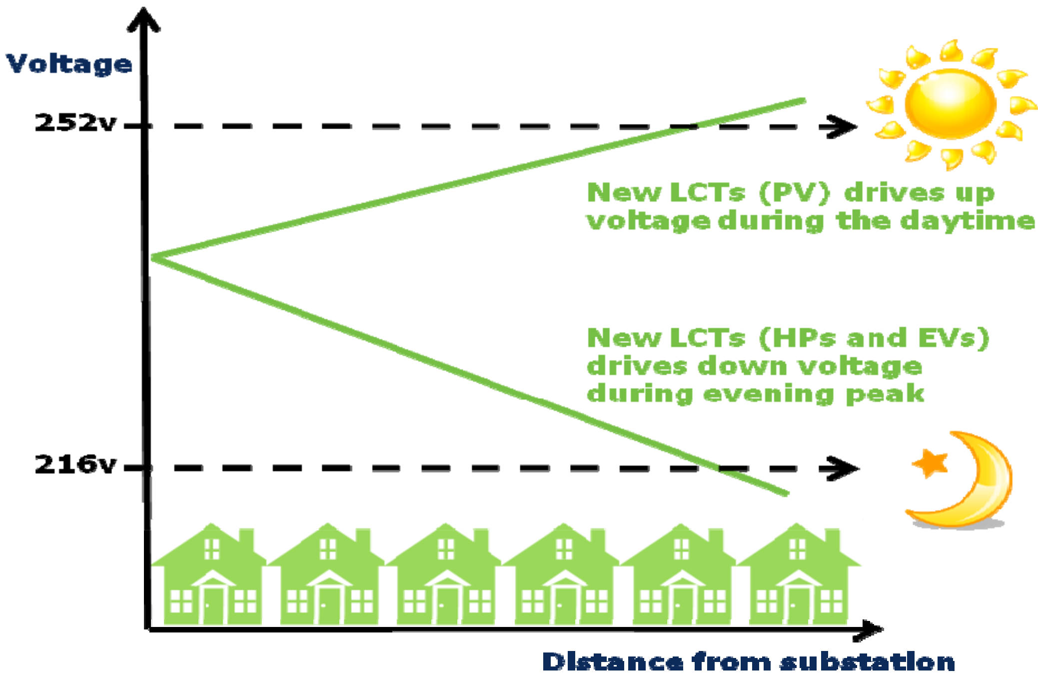
The United Kingdom's (UK) decarbonisation journey through to 2050 will see a reduction in the carbon footprint of heat, transport and electricity generation and as a consequence we will become more reliant on electricity as our main source of energy.

This transition will see network customers adopting a higher number of LCTs such as EVs, HPs and Distributed Generation (DG), placing an additional burden on to the electricity network. Often these technologies occur in clusters which can have a dramatic effect on the local electricity network.

For example, on an estate of domestic properties where gas central heating is swapped for an electric alternative, such as a HP, and a new EV is added to each property, the total load could reach over six times the peak demand that the network was originally designed for. Without intervention, this scenario would cause voltage levels to drop below statutory limits and the thermal capacity of network assets to be exceeded. Conversely, clusters of new sources of DG on the distribution network, such as PV, could push voltages above statutory limits. If voltage levels go outside statutory limits, the performance of customer appliances may be negatively affected. This effect is demonstrated in figure 2.1 below. We have experienced examples of these issues on our network with customers reporting that PV is not generating due to high volts.

Section 2: Application Description continued

Figure 2.1: Voltage profiles



The Smart Street trials demonstrated that it is possible to optimise voltage on LV networks to prevent statutory limits being exceeded whilst releasing additional capacity for the connection of further LCTs using network reconfiguration and a technique known as CVR.

What is CVR?

Electrical equipment, including household appliances and lighting, is designed to operate most efficiently in the region of 220 to 230 volts. If power is delivered at a voltage higher than these optimum levels, energy is consequently wasted. Excess voltage can also shorten the useful life of electrical equipment, since the excess energy is dissipated as heat. Therefore optimising network voltage reduces overall energy consumption, improves power quality and extends the life of customers' equipment.

CVR is a proven technology for reducing energy and peak demand and is implemented by controlling the voltage on a network to the lower end of the optimum range. It is implemented by the Distribution Network Operator (DNO) therefore the efficiency benefits are realised by customers without any intervention on their part.

During the trials the Smart Street system optimised the voltage across the distribution network so that all customers could benefit from CVR whilst maintaining statutory limits. This allowed for the peak load to be reduced, hence reducing annual energy consumption and creating additional capacity, to enable the further connection of LCTs.

The trials demonstrated that the system can deliver additional financial savings for network customers by reducing the supply voltage to an optimal level, allowing appliances to work more efficiently and use less energy. Analysis of the trial data demonstrated an energy consumption saving of up to 8% per customer, per annum, which was equivalent to £70.

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Section 2: Application Description continued

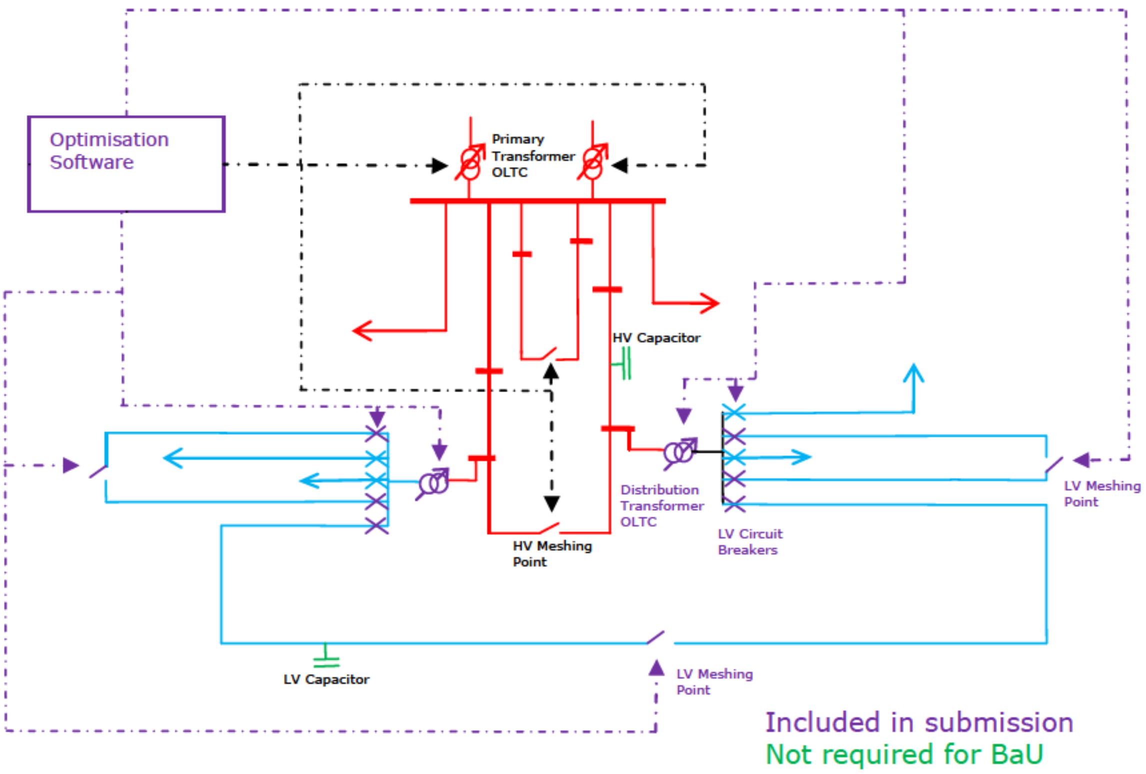
Optimising the voltage level and power flows via CVR and network reconfiguration increases available network capacity for the connection of LCTs, reduces losses and carbon emissions, and helps to reduce customers' electricity bills without any negative customer impact. Autonomously optimising the LV network using a centralised software system in this way is a novel practice in the GB electricity system.

2.2 What is the Proven Innovation?

Figure 2.2 shows the Smart Street system as installed in the trials. The trials were devised so that we could thoroughly understand the benefits and costs associated with each network asset and develop a detailed and proven business case for its future deployment.

The parts of the system highlighted in purple will enable Smart Street to be fully applied to the distribution network, and deliver the benefits proven during the trials.

Figure 2.2: Smart Street system



The system is comprised of the following:

- *Communications and optimisation software:* This is an integral part of the Smart Street system which will be used to actively reconfigure the network and change voltage settings using the deployed devices to respond to changing conditions throughout the day. This will improve the network's ability to cope with the wider voltage fluctuations associated with LCT clusters and ultimately facilitate the connection of more network load.

- *Distribution transformers with OLTC:* These will be used to actively optimise the voltage across the LV network, maintaining it within statutory voltage limits as LCT adoption accelerates, whilst reducing customer energy consumption.
- *LVCBs and LV switches:* These will allow the LV network to be interconnected as required in order to release thermal capacity from existing assets, whilst minimising network losses.

Monitoring and control of HV meshing points and primary OLTCs are part of long established BaU practices and the inclusion of these in the optimisation software is not considered part of this IRM application.

The deployment of capacitors (highlighted in green) was shown in the trial to offer little benefit for networks in the short to medium term, therefore these devices will not be included in the roll-out.

2.3 What is the Smart Street roll-out strategy?

The trials have demonstrated that the Smart Street system is a technically and commercially sound alternative to conventional network reinforcement which can be disruptive, costly, and time consuming. It is now our intention to roll-out the Smart Street system to ensure value for money is secured for our customers and the network is prepared for the continued rise in the uptake of LCTs.

The business case shows that, in the short term, benefits would not accrue to the DNO and therefore there is no compelling cost efficiency driver for us to commence a roll-out during RIIO-ED1. However, given the significant customer benefit, we believe it is important to begin to implement the Smart Street system now.

IRM funding allows for an adjustment to the price control to be made to facilitate the roll-out of Proven Innovation, as defined in licence condition CRC 3D. By combining the onsite equipment with the optimisation software the Smart Street system forms a unique arrangement of fully integrated equipment.

For the above reasons we are applying for an adjustment under the IRM to ensure the benefits associated with the Smart Street system can be made available for customers as soon as possible.

Smart Street has high potential for deployment across a large percentage of the distribution network and is transferrable across GB. Electricity North West intends to focus and prioritise the roll-out in areas where we expect to see greatest benefits for our customers, within RIIO-ED1.

During the roll-out we will target network areas that are forecast to see clusters of LCTs develop. The roll-out will release extra capacity on the network and will therefore facilitate the connection of LCTs quickly, before we reach a point where reinforcement becomes necessary. This will deliver wider benefits for all customers who pay for network investment through DUoS charges.

We appreciate that this focus is likely to result in a larger target area than we can accommodate during RIIO-ED1. Therefore we intend to apply a secondary criteria of areas serving a high concentration of fuel poor customers, as the potential reduction of energy bills associated with lower energy consumption will have a more significant impact.

We recognise that the two target areas described above do not obviously appear to overlap as those in the poorest households are, in general terms, least likely to be in a position to own LCTs. However, there have been a significant number of investment programmes in the North West by local authorities and registered social housing providers (figure 2.3) involving large scale installation of HP and PV. We therefore expect that there will be sites available to satisfy both criteria.

Figure 2.3: PV installed on sheltered accommodation by Stockport housing

The roll-out will deliver benefits by reducing costs for customers, reducing both losses and CO_2 emissions, helping to protect customer appliances, and reducing customer disruption associated with voltage disturbance and network reinforcement. Therefore we expect the roll-out to deliver long-term value for money to customers in addition to substantial wider environmental benefits.

To ensure installation sites are consistent with the approach described above and deliver the anticipated benefits we have developed site selection criteria, detailed in Sections 2.6 and 3.3.

What is the scale of the roll-out?

The governance for the IRM states that all spend must be complete before 31 March 2023, which will give three years to complete the installation work.

Building on our experience delivering other programmes such as Customer Load Active System Services (CLASS) and Quality of Supply (QoS), as well as our wealth of knowledge in replacing assets for BaU, we have estimated that we will be able to install the Smart Street system at 180 sites during this period. This means that approximately 45,000 customers will be able to access the Smart Street benefit of reduced energy consumption.

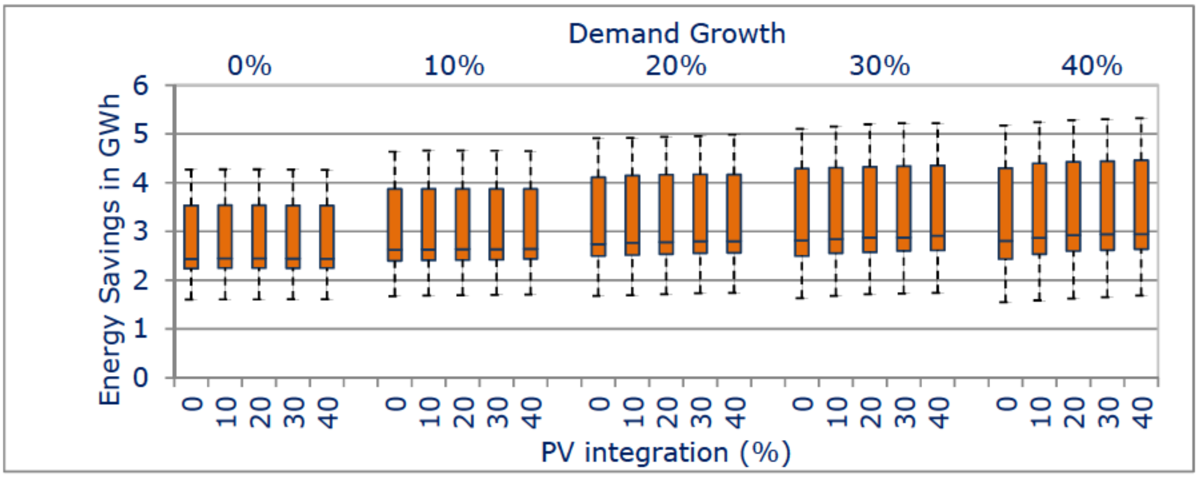
Appendix G contains the project plan we will follow to ensure we complete the roll-out within the timescales.

2.4 What is the outcome of the roll-out?

Capacity benefits

The trials demonstrated that this active control will allow an additional 30% of properties on an LV circuit to have LCTs connected before triggering a need for wider network reinforcement. In addition, the net energy savings associated with the Smart Street system increase as network demand (or penetration of LCTs) increases, as demonstrated in figure 2.4.

Figure 2.4: Annual energy savings across GB attributed to the Smart Street system



The ability to optimise the network configuration to adapt to changing conditions throughout the day will allow us to deliver energy savings to the customers fed from that network, which will translate into material cost savings.

Customer benefits

The trials demonstrated a saving of up to 8% of the energy consumed on the LV network. Together with a reduction in network losses and the reduction in future network reinforcement, the roll-out is expected to **deliver Net Present Value (NPV) benefits of £16.55m (£19.77m) by 2030 and £49.71m (£59.4m) by 2050**.

Academic analysis of the trial data, carried out by the Tyndall Centre at the University of Manchester, has shown that annual economic savings of up to £70 per customer can be achieved from energy savings derived from the deployment of Smart Street. This analysis has been reinforced within the roll-out CBA which has calculated annual savings of **up to £61 (£73) per customer**.

By pro-actively enabling customers to reduce their energy consumption, we can achieve a significant reduction in network load leading to a reduction in future network reinforcement costs, network losses and carbon emissions.

The combined effect will deliver a wide range of benefits including lower customer energy consumption and network bills. These, in turn, will bring additional societal and economic benefits to our customers.

Going forward we anticipate that we will continue to roll-out the Smart Street system so that the benefits can be accessed by more customers.

Carbon benefits

The roll-out also brings substantial environmental and carbon benefits for customers and society that would otherwise not be available. These carbon benefits will act as an important contributor to national carbon reduction targets, especially if IRM funding triggers the accelerated roll-out of the Smart Street system during future price control periods across all DNOs within GB.

The carbon impact assessment of the trials demonstrated that overall electricity system greenhouse gas emission reductions of 7% to 10% may be possible. The trials concluded that this reduction in consumption could lead to **savings in the order of 400 MtCO_2e between 2016 and 2060 for GB**.

The roll-out CBA has calculated a potential **carbon saving of 144,860 tCO_2e by 2055** for the 180 installations of the Smart Street system. The main contributors towards a reduction in carbon emissions associated with the roll-out are described below:

- *A reduction in energy consumption:* The Smart Street system enables optimisation of the voltage seen by our customers allowing appliances to operate more efficiently. This reduces the total electricity consumption on the network, resulting in an associated reduction of carbon emissions.
- *A reduction in network losses:* The Smart Street system reduces network losses through a combination of voltage optimisation and network meshing. This functionality can reduce network losses by up to 13% and avoids the associated carbon emissions.
- *Avoided network reinforcement:* The advanced functionality provided by the Smart Street system will provide additional capacity within existing network infrastructure. This leads to a reduction in network reinforcement which can be carbon intensive.

Cost/revenue benefits

As discussed, the roll-out will deliver significant energy savings directly for customers through a reduction in energy consumption. It is also anticipated to result in financial benefits to customers through a reduction in network reinforcement (although this will not materialise until after 2023).

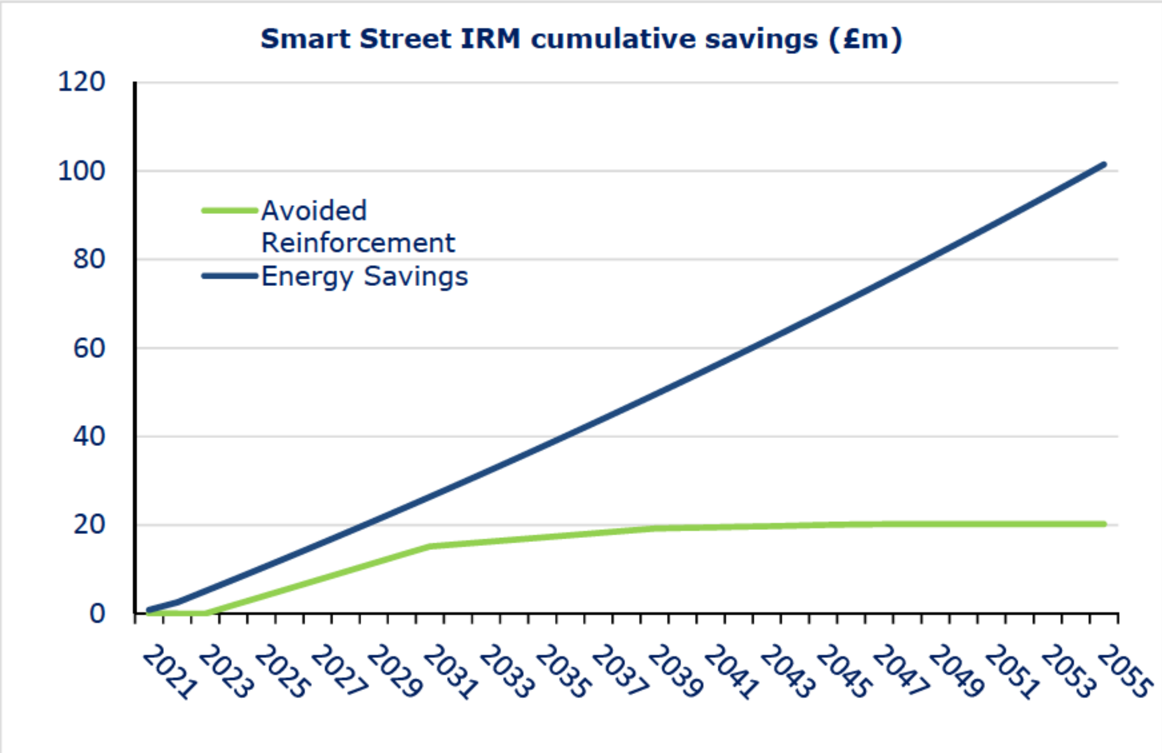
Sites will be identified which are predicted to require network reinforcement in future price control periods. This will allow immediate energy savings to be delivered for our customers, whilst securing a reduction in network reinforcement costs in the future.

This approach will also ensure that DNOs act as a facilitator of a low carbon energy system, and do not prevent or slow down the adoption of LCTs due to limited network capacity and voltage constraints.

We believe that the roll-out of the Smart Street system is justified on energy savings alone. However, as these savings do not accrue to us as a DNO, there is currently no business case to roll-out this approach within RIIO-ED1. IRM funding is requested to accelerate the adoption of this approach. The additional and significant benefits associated with avoided network reinforcement are also expected to be very important when considered over the longer term.

Figure 2.5 illustrates the cumulative savings (2012/13 prices) predicted for customers via reduced energy consumption and the savings associated with a reduction in network reinforcement for the 180 sites in the roll-out. It can be seen that the savings associated with reduction in energy consumption are very strong and can act as an important contributor towards reducing the fuel poverty gap.

Figure 2.5: Savings delivered by the roll-out



Electricity North West understands that using a distribution transformer with an OLTC incurs a higher cost than a standard transformer replacement. However, the solution must be viewed as a combined system which brings additional and valuable functionality to the distribution network, and cannot be compared directly with a standard transformer. This additional functionality delivers the benefits shown above and can avoid wider network reinforcement which is far more costly than the upfront cost associated with the individual technologies. This wider network reinforcement not only includes transformer replacement but often also requires a significant amount of LV cabling which is both expensive and disruptive for our customers.

As with other new technologies, the price competitiveness of the Smart Street technology will improve as the deployment of the technologies increases due to market competition and economies of scale. In fact, this limited roll-out of Smart Street technology will result in immediate cost benefits as we will place the order for all the equipment at the same time, giving at scale benefits.

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Section 2: Application Description continued

Changes to our BaU practices will lead to a wider targeted deployment of these devices which will further drive down the cost. We expect this to lead to a favourable cost differential, encouraging more DNOs to procure the devices increasing the usage and giving further reductions in cost.

Government policy

Greater Manchester Combined Authority (GMCA) has agreed ambitious plans [1] to become one of the leading green city-regions in the UK and Europe. The aim is to bring Greater Manchester's date for achieving carbon neutrality forward by at least a decade to 2038. As such, Greater Manchester is the first UK city to devise globally leading plans to become carbon neutral; reducing carbon emissions to tackle climate change and making its contribution to keeping global average temperature change below 2°C.

Consequently, Electricity North West must ensure that we can facilitate these ambitious plans to enable the electrification of heat and transport at a regional scale. Smart Street is a critical part of our strategy to release network capacity and facilitate this extra demand, assisting Greater Manchester in achieving its targets.

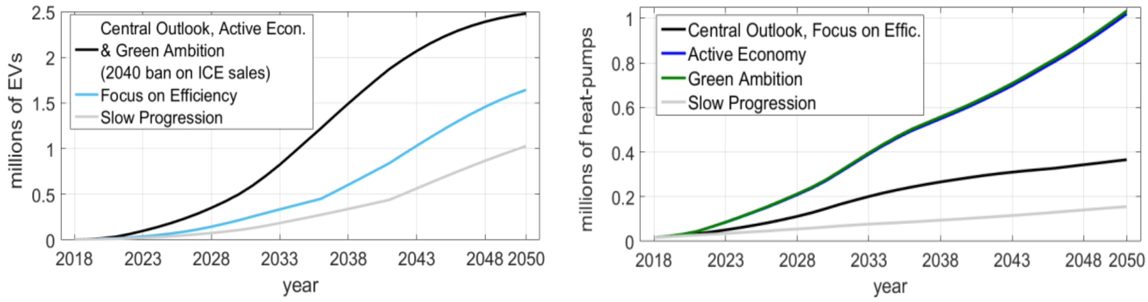
Furthermore the UK Government has a challenging target for all fuel-poor households to have an energy performance rating of C or above by 2030. Electricity North West has acted on the recommendation of the Energy Saving Trust to make the case to the government, Ofgem, the Energy Systems Catapult, energy suppliers, local authorities and other network operators, that electricity distributors should play an enhanced role in improving energy efficiency standards. Ofgem advocates "area-based solutions" involving local authorities and network companies. We continue to influence this debate and the Smart Street roll-out will be the first practical demonstration of a DNO deploying innovative techniques at scale to deliver energy savings to some of the poorest customers in GB.

Vision for the future

Our forecasts, published as part of our Distribution Future Electricity Scenarios [2] (DFES), indicate that the overall maximum demand across our region will increase by between 122% and 176% by 2050. Our forecasts allow us to understand the annual electricity consumption of each individual component of the demand and we believe that EVs and HPs will be key contributors to this future increase in electricity consumption.

Figure 2.6, taken from our DFES, shows that we could be driving up to 2.5 million EVs and 50% of our customers' properties could be warmed by a HP by 2050. In addition to the demand increase our forecasts also show that DG will increase by between 5.5 GW and 7.9 GW by 2050. Irrespective of the predicted scenario, trends show the uptake of these devices will start to dramatically increase in the next 5 to 10 years.

Figure 2.6: Forecast of EV and HP uptake



In order to accommodate this significant increase, we will need to offer more flexible services to our customers; this will require oversight and control of our LV network and the devices connected to it.

Deploying the Smart Street system will allow us to future-proof our network for LCTs and enhance our current "connect and manage" policy to larger clusters of LCTs as the rate of adoption accelerates. This policy (which was developed as part of the LCN fund First Tier project, Low Voltage Network Solutions) currently allows small clusters of LCTs to be installed without the need for extensive design and reinforcement.

Further roll-out of the Smart Street system

When funding through the mechanism ends the Smart Street system will meet the necessary criteria to be adopted into the normal business. Our DFES confirms that we are expecting the uptake of LCTs on our network to increase into RIIO-ED2 and beyond. We consider the Smart Street system to be a viable long term solution to this problem as it is a cost effective alternative to traditional reinforment which gives added benefits in reduced consumption to our customers.

Whilst the Smart Street system is already cost effective compared to traditional reinforcement we do expect to see a reduction in cost for the ongoing roll-out. Due to the market competition the initial roll-out is likely to create we expect that equipment prices will decrease. Furthermore, as the optimisation software will already be in situ there will be minimal cost associated with integrating additional sites, leading to an overall reduction in the cost per install.

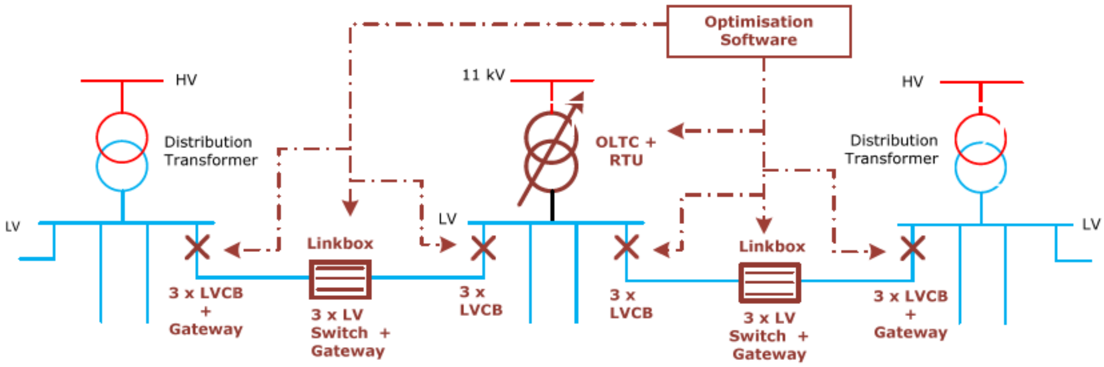
There is additional incentive to continue the roll-out due to the ongoing carbon reduction benefit which will assist Electricity North West's journey towards carbon neutrality.

2.5 Detailed technical description of the roll-out

The trials successfully demonstrated the benefits of using OLTCs and remotely controllable switches/circuit breakers along with optimisation software to actively configure the LV network. Managing both voltage level and power flow can result in financial and environmental benefits for the customer, and capacity benefits for the DNO.

A deployment of the Smart Street system on one network, shown in figure 2.7, is made up of a number of components. The following sections will explain each of the components in more detail.

Figure 2.7: A deployment of the Smart Street system for one network



Communications and optimisation software

The optimisation software is an add-on to Electricity North West's NMS. It is a fundamental part of the Smart Street system and allows the network devices to operate most efficiently, maximising the associated benefits.

The software runs various load flow calculations every 30 minutes using real time configuration data and measurements from the network. These calculations and algorithms then produce optimal set points for voltage and configuration, ensuring network parameters are within statutory limits whilst minimising customer energy consumption and network losses.

For the trials the communications structure was set up in such a way as to have little effect on the day to day running of the Electricity North West control system. This meant that the optimisation module supplied by Siemens was a standalone piece of software connected to our Control Room Management System (CRMS) by an Inter-control Centre Communications Protocol (ICCP) link. To allow the devices to be controlled from our new NMS we will need to configure the devices in the new system as part of the roll-out. We will also need to integrate the Smart Street system with our existing automation systems, e.g. Automatic Restoration Switching (ARS), to ensure that any potential conflicts are avoided.

Since the trials, Electricity North West has invested in a new NMS from Schneider Electric. The load flow software in the Schneider system is the same as that in the Siemens system, therefore the set up and learning from Smart Street is transferable to the new system.

Distribution transformer with OLTC

A tap changer is a component of a transformer which controls the transformer's output voltage by adjusting the winding ratio in discrete steps. Tap changing can be done manually or automatically when the transformer is energised (on load tap changer) or manually when the transformer is switched off (off load tap changer).

All distribution transformers have historically come with an off load changer which assumes a fairly static network of either demand or generation to enable a single voltage setting to be placed at the distribution substation.

Section 2: Application Description continued

In a low carbon energy system, where the levels of demand and generation change dynamically throughout the day, one single setting is no longer adequate and so active voltage regulation must be employed. This active regulation can be achieved using an OLTC (figure 2.8) which allows voltage levels to be changed automatically whilst the transformer is still energised thereby keeping all voltages within statutory limits.

Following the trials we added the option of an OLTC to our standard transformer specification. The OLTC specified is a nine step vacuum insulated tap changer installed on a standard distribution transformer to give active control of the voltage, with each step giving a 2.5% change in the voltage.

In order to integrate the OLTC with the optimisation software, communications equipment will be installed in the substation. This will allow the tap changer to be remotely controlled via the NMS.

Once we have active control of the voltages we can then apply CVR to the network. This will reduce the voltage to an optimum level at the distribution substation, catering for all demand and generation on the network whilst keeping all customers within statutory limits. This will reduce the energy consumption on the network, releasing capacity for the connection of LCTs.

The OLTCs currently available on the market use vacuum bottles for switching and are considered maintenance free, although the manufacturer does recommend replacement of the control unit after 20 years.

Figure 2.8: Distribution transformer with OLTC

It is not possible to retrofit an OLTC to an existing transformer so we will need to replace the existing transformers with modern smart transformers. It is our intention to use existing framework agreements where possible, otherwise we will carry out a competitive market tender when the funding is secured in order to achieve the best possible value for customers.

Once all the tender processes are complete we will modify existing installation and maintenance procedures for the new equipment, and carry out training for all Electricity North West operational staff. During the trials only designated employees, working in the trial areas, were trained. Therefore the roll-out requires training to be extended to cover personnel operating across the whole of Electricity North West's region.

Following this roll-out, our policy will be amended to include distribution transformers with OLTCs as an alternative to traditional reinforcement for the connection of LCTs. This approach will ensure that the substantial energy savings predicted are secured for all our customers, whilst adding extra capacity headroom within the existing network.

LV circuit breakers and switches

The trials demonstrated that interconnecting or "meshing" the LV network can be used to share power between adjacent circuits to help alleviate capacity issues and manage voltage levels. However, they also showed that permanently meshing existing radial networks can subject customers to increased risk of interruptions during a fault. Therefore the network will only be meshed when the optimisation software calculates a justifiable benefit in doing so.

To implement the learning it is necessary to open and close the meshing point as network loading conditions change. This interconnection may be opened or closed at the distribution substation via LVCBs or alternatively at the link box using LV switches, depending on the network loading requirements.

LVCBs

Historically fuses have been installed at distribution substations which offer no facility to open and close remotely. Therefore to facilitate remote meshing at substations controllable LVCBs (see figure 2.9) will be installed. These can be retrofitted into existing LV fuse boards instead of the standard fuse.

Figure 2.9: LVCBs installed in a distribution substation

To allow the LVCBs to be operated it will be necessary to install communications equipment which connects the NMS and the optimisation software to each device.

These devices may also result in an improvement in Customer Minutes Lost (CML) during transient faults. The LVCBs, such as those seen in figure 2.9, are capable of re-closing following temporary transient faults, allowing supply to be restored automatically without an engineer attending site. The potential benefits have been quantified within the CBA and are discussed further in Section 4.

We will relocate the LVCBs purchased for the trial where possible and then go out to tender for the remaining LVCBs in order to ensure best value for money. Following on from this roll-out there will be a contract in place for these devices and they will be available to purchase for the wider deployment of the Smart Street system.

LV switches

Historically, link boxes have been used to manually connect two circuits together using fuses to maintain supplies for faults or maintenance.

To facilitate remote meshing, controllable switches will be installed in link boxes (see figure 2.10). The link box switches can be retrofitted into most link boxes but due to their installation or configuration some link boxes may need to be replaced.

Figure 2.10: LV switches installed in a link box

To allow the LV switches to be operated it will be necessary to install communications equipment which connects the devices to the NMS and the optimisation software.

We will relocate the LV switches purchased for the trial where possible and then go out to tender for the remaining LV switches in order to ensure best value for money. Following on from this roll-out there will be a contract in place for these devices and they will be available to purchase for the wider deployment of the Smart Street system.

2.6 Site selection

Electricity North West believes the Smart Street system is applicable to the vast majority of our distribution network and will deliver strong benefits wherever it is deployed. However, to ensure the benefits associated with the IRM roll-out are maximised we have developed an initial site selection criteria to shortlist and prioritise potential sites which would benefit most from the technology. This is further discussed in Section 3. The following criteria will be used to select the most appropriate sites for the roll-out to ensure maximum benefits for our customers.

LCT uptake and future load growth

We will use our LCT database, which contains details of all known installations of LCTs, in combination with our DFES. The DFES forecasts future uptake of LCTs, and highlights areas that will benefit from the roll-out. We will target sites that are expected to require reinforcement in RIIO-ED2 and beyond to maximise the benefits associated with the Smart Street deployment.

Areas high in fuel poverty

It is our intention to prioritise fuel poor customers where possible during the roll-out. Once sites which require future network reinforcement have been identified, we will then use fuel poverty as a secondary filter to shortlist the potential installation sites.

Distribution Network Operator Innovation Roll-Out Mechanism (IRM) Submission Pro Forma

Section 2: Application Description continued

Electricity North West is working in collaboration with the Centre for Sustainable Energy to develop a detailed understanding of the location of vulnerable customers across our region. This vulnerability mapping shows almost 13% of households in the North West are characterised as fuel poor.

Anonymised local area level data will be supplied by Citizens Advice. Their records of client interaction are used to deliver advice, education and support across a diverse range of debt and complex energy issues.

The combination of both datasets will identify where the geographic clustering of poverty is likely to remain relatively constant over time, determining which LV networks are most likely to benefit from the roll-out and where the greatest opportunities exist to help fuel poor customers in our region.

Asset type

OLTCs are only available on ground mounted distribution transformers, therefore areas which are supplied from pole mounted transformers will be excluded from this roll-out. Until a proven and cost effective method to actively manage voltages is developed for pole mounted transformers, we will be unable to apply this technique to any network supplied from equipment of this type.

Loading

The energy savings and associated capacity release are a direct function of the loading on the transformer and LV circuits. We will therefore use historic measurement data to select the sites which will deliver the most benefit.

Availability of link box

The LV meshing points will only be deployed where link boxes already exist. Therefore not every LV circuit out of a distribution substation will be meshed. We anticipate that there will be an average of two available circuits suitable for meshing for every distribution substation in the roll-out.

Distribution Network Operator Innovation Roll-Out Mechanism (IRM) Submission Pro Forma

Section 3: Application Business Case

This section of the proposal describes the business case required to justify the roll-out. The business case has built upon the learning acquired from the trials which successfully demonstrated the benefits associated with the innovation and how it can be applied efficiently.

3.1 The case for IRM funding

We believe the Smart Street roll-out meets the requirements for IRM funding and the licence condition CRC 3D in which the funding should be used for the "roll-out" of "Proven Innovation" as described below:

The **intention of IRM** funding is to facilitate the roll-out of Proven Innovation which will deliver financial and environmental benefits to network customers where there is not sufficient funding available within the existing price control settlement. The roll-out of the Smart Street system will deliver clear financial and environmental benefits to customers and will do so with minimal benefits directly to Electricity North West. The standard Smart Street deployment, or baseline scenario, set out in Section 4 delivers a customer **benefit of £16.55m (£19.77m) NPV by 2030** with a payback period of only 2 years for the IRM funding request. Consequently, there are clear benefits to customers in rolling out the innovation within RIIO-ED1 and the benefits are proportional to the funding amount.

The **phased "roll-out"** refers to the incorporation of a Proven Innovation into Ordinary Business Arrangements. Currently, the Smart Street system is not considered an Ordinary Business Arrangement and is not used within GB as a standard approach to reduce either customer electricity bills or defer future network reinforcement. However, post roll-out, the technology will become a BaU solution and will be suitable to be rolled out in future price controls as a viable standard approach. The scale of the proposed roll-out will also result in adequate learning and development to position Electricity North West and the supply chain well to continue to implement the solution as BaU effectively.

Similarly, "**Proven Innovation"** is defined as innovation which has been successfully trialled or demonstrated on a distribution system or elsewhere and, as such, can support a proven business case for future deployment. The Smart Street system has previously undergone a detailed assessment and demonstration as part of an Ofgem funded innovation project. These trials have allowed a mature and proven business case to be developed which adequately demonstrates the technical and commercial viability of the system.

The innovation package within the RIIO framework has proven extremely successful at stimulating companies to focus on research and trials into areas that will drive benefit for customers that might not otherwise have been explored. The implementation and subsequent roll-out of Proven Innovations are a critical element to demonstrate the overall success of the stimulus package, and therefore the IRM is an appropriate part of the framework to allow companies to roll-out technologies that they may not otherwise do so within the RIIO-ED1 price control.

Some innovation may derive clear benefits for network company's savings in Total Expenditure (TOTEX) and therefore will flow to customers through the TOTEX Incentive Mechanism (TIM) or through other incentives. In this situation the company may elect to roll-out such innovation through their existing price control allowances with the expectation that any incremental costs incurred to roll the system out will flow back to the company through TIM or other incentive rewards. This is not the case for the Smart Street system, as the benefits during the current price control accrue mainly to the customer and not the network operator.

Ofgem has identified that IRM funding is suitable for “successful innovation which does not provide sufficient benefits for the company to fund its roll-out, even though it would provide wider environmental benefits”. Not all innovation may display such clear benefits to network companies, such is the case with the Smart Street system, where the majority of monetary benefits accrue directly to the customer through the energy efficiency achieved, and therefore directly via lower energy bills. In this case, due to the nature of how benefits present themselves in the energy system, there are insufficient network benefits to roll-out this Proven Innovation in the RIIO-ED1 period without the support of an IRM adjustment.

It is for the reasons stated above that the IRM is considered the most appropriate mechanism to deliver immediate benefits for customers and avoid deferral to a future price control period.

3.2 Why was this not considered within the original business plan?

Smart Street was a LCN funded innovation project mobilised in 2014 and was viewed as a long-term solution to the emerging challenges caused by growing network demand and the uptake of LCTs. During the project we installed a variety of innovative technologies on the distribution network.

The live trials began in January 2016 and were conducted over a period of two years, concluding in December 2017. As with all network innovation it was vital to thoroughly test and prove the effectiveness of the Smart Street technology before any further investment or large scale roll-out could be considered. As such, we did not allocate funding to facilitate the roll-out within our RIIO-ED1 business plan as the innovation was not proven financially or technically at that time.

Including the roll-out costs within the original RIIO-ED1 business plans would therefore have been premature until the trials were complete and a mature and credible business case could be demonstrated. Instead, we made the decision to direct funding into areas where customer benefits were guaranteed.

IRM funding allows for an adjustment to the price control to be made to facilitate the roll-out of Proven Innovation, as defined in licence condition CRC 3D. By combining the onsite equipment with the optimisation software, the fully integrated Smart Street system forms a unique arrangement of equipment. Autonomously optimising the LV network using a centralised software system is equally novel in the GB electricity system.

In addition, the roll-out of the Smart Street system will allow Electricity North West to address recent recommendations [3] made to the government by the Committee on Fuel Poverty, which identified that energy efficiency is a key area for investment to ensure that tangible, long-term improvement to fuel poverty are made in the low income and private rental sectors.

3.3 Roll-out evaluation criteria

As described in the roll-out strategy in Section 2.1 we will primarily target locations where a predicted high uptake of LCTs will result in the need for future network reinforcement, followed by areas where there is a high percentage of vulnerable customers living in fuel poverty.

To further ensure the predicted benefits are achieved we will target installation sites using the site selection criteria which have been developed specifically for the roll-out. These criteria will identify sites which represent maximum value for money and reflect the assumptions made within the CBA.

The specific CBA for the roll-out has identified that the Smart Street system can lead to savings directly to network customers through a reduction in network losses and energy consumption, as well as a significant reduction in network expenditure. The criteria in figure 3.1 have been defined to ensure the benefits highlighted within the CBA will be realised if funding is awarded.

Figure 3.1 Roll-out evaluation criteria

Criteria	Description
Need for future reinforcement due to increasing load of LCT uptake	We will target sites that are expected to require future reinforcement during RIIO-ED2 and beyond if the projected reinforcement can be avoided with the additional network capacity that is made available through the deployment of the Smart Street system. This will ensure that the full benefits listed within the CBA are realised including avoided reinforcement savings in addition to customer energy savings.
Transformer annual loading (MWh) - OLTC	The value of customer energy savings is dependent on the total loading at each substation. A minimum site loading of 30% is required so that the financial savings associated with CVR justifies the TOTEX on the OLTC and provides a return on investment. A maximum payback time of 5 years will be targeted; this has been calculated as the annual savings minus the upfront and annual equipment expense. This will allow sites which will benefit from the technology the most to be prioritised.
LV feeder annual loading (MWh) - meshing	The benefits associated with a reduction in network losses are dependent on the total annual loading on the feeders which are to be meshed. A minimum annual loading between the two is required to justify the expense of the LV switches.

Criteria	Description
Complementary load profile between meshed feeders	Furthermore, the loading (current) across the two feeders must be different prior to meshing to reduce losses. This allows the current to be shared equally across the two feeders. Therefore, complementary load profiles are required where the minimum difference in the average loading across the two feeders is 30%.
Availability of link box	A suitable link box is required between feeders to allow the LV switches to be installed without significant additional expense.
Areas high in fuel poverty	To shortlist the potential installation sites, we will target areas of high fuel poverty so that the energy savings are provided to those that will benefit from a reduction in their energy bills.

3.4 Link to long term business changes

Our carbon plan

Our carbon plan [4]outlines our ambition to meet the region's carbon emissions target and sets out the range of initiatives and investments which will ensure we take a significant step on the road to achieving rapid decarbonisation.

It demonstrates how we recognise that EVs and the electrification of heat will provide a challenge and an opportunity for the electricity network. It details our investment plans to ensure the potential that this technology offers to the North West can be maximised and Smart Street forms part of these plans.

The transition to Distribution System Operator

In 2017, Electricity North West published its vision [5] to become a Distribution System Operator (DSO). We strongly believe that this transition is critical to ensure that network companies truly deliver value for money for network customers whilst facilitating the energy system of the future.

Creating an active and flexible distribution system

A critical element of the transition towards a DSO operating model is the need for a more intelligent and active distribution system. Currently, the majority of the LV network in particular is passive with little visibility or automated control. This is not sustainable in a low carbon energy system and we recognise the importance of introducing this functionality as soon as possible, particularly as network customers continue to adopt new and disruptive technologies such as EVs and HPs.

Whilst these technologies place a strain on the distribution network they are a critical enabler of a low carbon society. This is why we pursued innovation projects such as Smart Street, to develop a proven business case for key enabling smart technologies before the impact of LCTs accelerates exponentially.

Section 3: Application Business Case continued

Preparing for RIIO-ED2 and beyond

A key driver behind this IRM application is to stimulate the market for the Smart Street technologies and to drive down unit costs, whilst encouraging improvements in performance and functionality, before a larger roll-out in RIIO-ED2.

We believe an initial roll-out in RIIO-ED1 will prepare the market for a full scale roll-out in the subsequent price control periods across GB.

We intend to procure technology for the roll-out within a competitive market tender. This will continue to be the case in RIIO-ED2 and beyond. This initial tender and roll-out will demonstrate to the market that significant demand for the technology exists and will encourage vendors to continue to develop the technology and drive the unit cost down to increasingly competitive levels.

3.5 Analysis of costs

The costs proposed within this submission are based upon our previous experience procuring the technology and continued engagement with capable vendors to understand the impact of a large roll-out on unit costs. Electricity North West trialled the technology in the Smart Street innovation project, therefore we have attained a detailed understanding of the individual costs that make up the proposed solution. To mitigate inaccuracies in the costs we have consulted with vendors and used current day rates provided by contractors and our internal Finance team.

The Smart Street technology will be procured either from existing framework agreements or from the market through a competitive tender, as will any contractor support required for the installation and commissioning. We believe this approach will allow us to identify the most cost-effective options and to encourage future competition in the market to drive prices down further. A tender is also viewed as the most effective method to deliver any savings possible on the budget which has been proposed.

The total budget for the roll-out has been constructed by costing each element required to install and commission the Smart Street system at the number of sites intended. Equipment costs have been benchmarked against the actual costs incurred during our previous innovation trials and where possible from our existing BaU unit costs. Figure 3.2 shows the expected project costs associated with each workstream as per the project delivery plan; Appendix F details the full costs and volumes. The total project cost is considered proportional to the benefits associated with the roll-out which have been calculated to bring a positive NPV of £16.55m (£19.77m) in customer and network benefits by the end of 2030.

Figure 3.2: Project costs

Cost Category	20/21 (£m)	21/22 (£m)	22/23 (£m)	Total (£m)
Project Management				
Labour	[redacted]	[redacted]	[redacted]	[redacted]
Materials	-	-	-	-
Contractors	-	-	-	-
Planning				
Labour	[redacted]	[redacted]	[redacted]	[redacted]
Materials	-	-	-	-
Contractors	-	-	-	-
Site Installation				
Labour	[redacted]	[redacted]	[redacted]	[redacted]
Materials	[redacted]	[redacted]	[redacted]	[redacted]
Contractors	[redacted]	[redacted]	[redacted]	[redacted]
NMS Integration				
Labour	[redacted]	[redacted]	-	[redacted]
Materials	[redacted]	[redacted]	[redacted]	[redacted]
Contractors	[redacted]	[redacted]	[redacted]	[redacted]
Total	**4.64 (5.55)**	**8.20 (9.80)**	**2.24 (2.68)**	**15.09 (18.03)**

3.6 Recovery of costs

The requested funding takes the form of an adjustment to our regulatory allowances for RIIO-ED1. Following the terms of our licence we will then recover these costs through DUoS charges applied to all customers. This would result in an increase in the level of scaling which, under the current charging methodology, would result in slight unit rate increases for customers. It is expected that in this period the outcome from the Targeted Charging Review could be implemented with the initial proposals indicating that there could be small increases in fixed or capacity charges instead of unit rates. Ongoing capital and operational costs beyond the end of RIIO-ED1 are excluded from this funding request.

Section 4: Evaluation Criteria

a) Will deliver additional carbon, environment or any other wider benefits

The roll-out of the Smart Street system is expected to deliver both carbon and environmental benefits which will act as enablers of the central government's ambitious carbon reduction targets.

The Carbon Plan sets out the UK government's strategy to reduce greenhouse gas emissions. As a contributor towards these emissions, it is the responsibility of network companies to minimise the carbon emissions associated with distributing electricity to network customers. Through the trials, our Losses Strategy [6], and our carbon plan [4], we have identified areas where Electricity North West can have an impact on the volume of emissions associated with our activities.

The roll-out proposed is in line with our losses strategy and carbon plan and aims to provide the environmental benefits which are described in the following subsections.

Quantified environmental benefits

The carbon and environmental benefits of the roll-out described below have been quantified within the Ofgem CBA tool and are shown in figures 4.1 and 4.2 below, with the full breakdown by year in Appendix E. The methodology used to calculate the carbon benefits associated with the roll-out is shown within Appendix C, with the CBA assumptions detailed in Appendix D.

- *Energy consumption:* The system has been proven to reduce customer consumption by up to 8%. This reduction in energy consumption leads to a direct reduction in CO_2 emissions.
- *Avoided network reinforcement:* The roll-out of the Smart Street system releases additional capacity in the existing network. This additional capacity leads directly to a reduction in network reinforcement. This reinforcement can be carbon intensive and has been quantified in the CBA. Traditional network reinforcement, which is the only alternative solution, requires significant planning and onsite works which can be time consuming.
- *Technical losses:* There are two methods of reducing losses using the Smart Street system. Meshing feeders can reduce losses by up to 7%, and the reduction in losses attributed to the reduced energy consumption from CVR contributes up to an additional 6%. During the trials, analysis on the data demonstrated that a total loss reduction of up to 13% was possible, dependant on network configuration.

A sensitivity analysis has been carried out to give a high and low scenario in addition to the baseline values. The CBA inputs which have been varied to create these scenarios are shown in Appendix D.

Distribution Network Operator Innovation Roll-Out Mechanism (IRM) Submission Pro Forma

Section 4: Evaluation Criteria continued

Figure 4.1: Carbon benefit

Scenario	Carbon benefits (tonnes CO_2e) (cumulative)				
	2023(ED1)	2031	2039	2047	2055
Baseline	16,695	85,727	124,805	142,389	144,860
High	21,715	109,529	159,763	182,367	185,541
Low	12,323	64,693	94,004	107,070	108,887

Figure 4.2: Smart Street IRM roll-out carbon benefits (tonnes CO_2e)

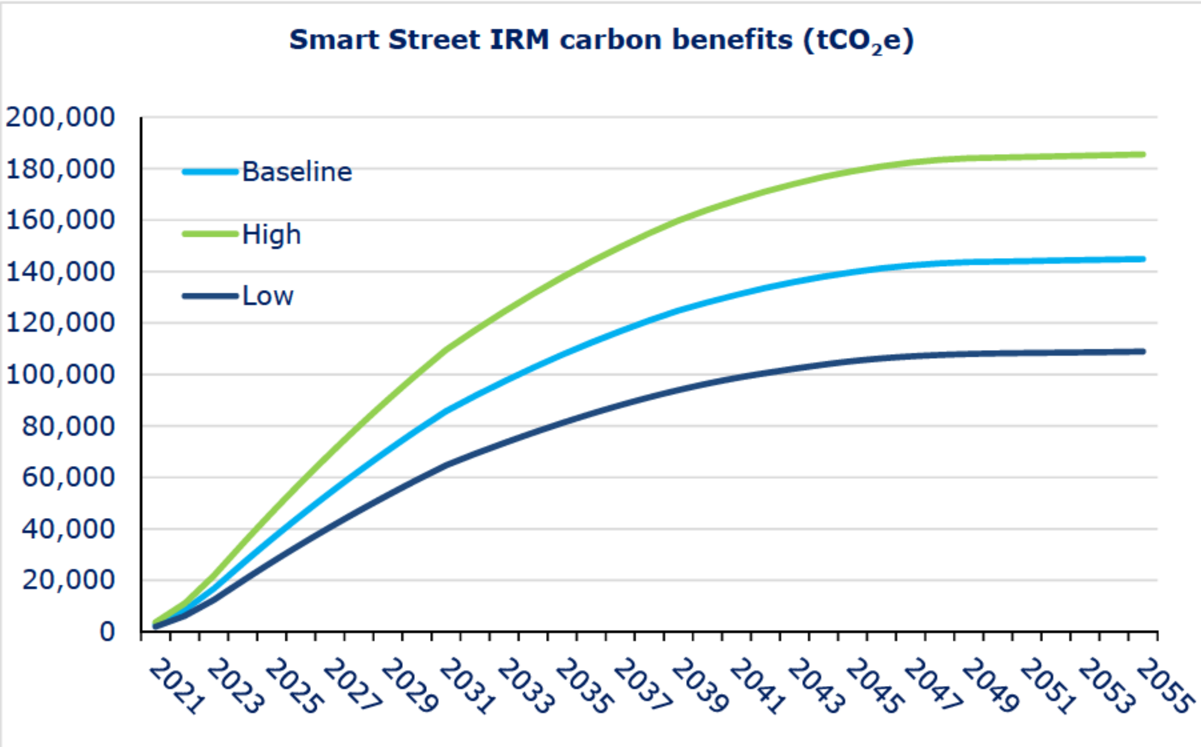


Figure 4.3 below shows the NPV (2012/13 prices) financial value associated with the volume of avoided carbon emissions based upon the traded carbon price (£/t) used within the Ofgem CBA tool.

Figure 4.3: Financial value associated with the carbon reduction

Scenario	Carbon benefits (£m 2012/13 prices)				
	2023 (ED1)	2031	2039	2047	2055
Baseline	0.96	3.83	5.97	6.92	7.09
High	1.22	4.86	7.59	8.80	9.01
Low	0.74	2.92	4.54	5.25	5.39

Section 4: Evaluation Criteria continued

b) Will provide long term value for money for energy consumers

Project Costs

The total budget for the roll-out has been constructed by costing each element required to install and commission the Smart Street system. The costs have been profiled based on the project plan (Appendix G). The first year is made up primarily of mobilisation, design and procurement activities with the initial installations beginning in October 2020. The second year covers the bulk of the installation, including deployment of the optimisation software, and the final installation phase takes place in year 3.

Equipment costs have been benchmarked against the actual costs incurred during our previous innovation trials and where possible from our existing BaU unit costs. Figure 4.4 shows the high level project costs; Appendix F details the full costs and volumes.

Figure 4.4: High level costs

Cost Category	20/21 (£m)	21/22 (£m)	22/23 (£m)	Total (£m)
Project Management	0.23 (0.27)	0.21 (0.25)	0.21 (0.25)	0.65 (0.77)
Planning	0.14 (0.17)	0.17 (0.20)	0.01 (0.01)	0.32 (0.38)
Site Installation	3.96 (4.75)	6.82 (8.13)	1.96 (2.34)	12.75 (15.22)
NMS Integration	0.30 (0.36)	1.00 (1.21)	0.06 (0.07)	1.38 (1.64)
Total	**4.64 (5.55)**	**8.20 (9.80)**	**2.24 (2.68)**	**15.09 (18.03)**

Our analysis of the costs demonstrates this investment will deliver long term value for money for network customers. These costs combined with the assumptions shown in Appendix D were used as inputs to the Ofgem CBA tool to quantify the financial benefits associated with the Smart Street system.

A sensitivity analysis has been carried out on the results to understand the impact on the potential benefits associated with the roll-out. The usage and pricing assumptions for the sensitivity analysis are detailed in Appendix D.

The methodology used to quantify the benefits within the CBA has built upon the financial assessment and network demonstrations carried out during the trials is described in Appendix C. As such, the benefits associated with the roll-out have been verified previously, which supports the figures presented within the CBA.

i) Quantitative benefits

The proposed solution will deliver immediate and long-term savings to customer electricity bills and is expected to lead to a deferral of network reinforcement during RIIO-ED2 and beyond.

The benefits described below have been quantified within the Ofgem CBA and are described in further detail within the following subsections. The benefits associated with the roll-out have been categorised as either "Customer Benefits" or "Network Benefits" both of which have been quantified and assessed separately.

Network financial benefits are savings in network expenditure due to a reduction in network reinforcement through the deployment of the Smart Street system. These benefits will also be reflected in customer bills through a reduction in DUoS charges. In addition, the impact of LV switching devices on the Interruption Incentive Scheme (IIS) has also been quantified and included within the CBA assessment.

Customer financial benefits come directly through a reduction in energy consumption, and indirectly through a reduction in costs associated with network reinforment and losses.

Figures 4.4 and 4.5 illustrate the total financial benefits associated with the Smart Street system as described above, and include all costs associated with the project and the roll-out of the technology. The full breakdown of these benefits by year is detailed in Appendix E. Figure 4.4 also shows the payback year for the full funding requested within this proposal for each scenario. The payback year is the point at which the total savings (including customer benefits) match the total cost of the roll-out. This demonstrates that the scale of the roll-out is appropriate in relation to the expected benefits.

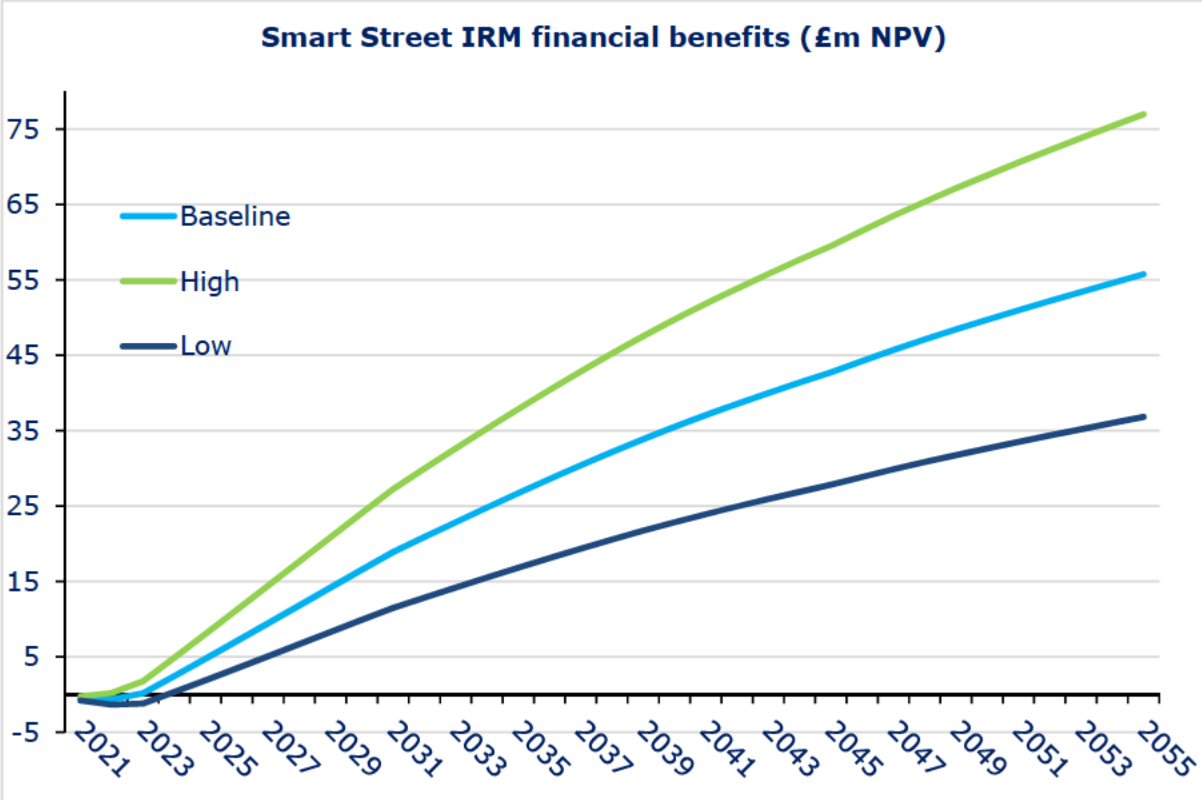
Figure 4.4: Total net financial benefits

Scenario	Total benefits (£m NPV 2012/13 prices)					
	2023 (ED1)	2031	2039	2047	2055	Payback Year
Baseline	0.15	18.89	33.88	45.70	55.73	2023
High	1.76	27.24	47.56	63.49	76.95	2022
Low	-1.20	11.48	21.74	29.87	36.81	2024

The financial benefits over time (£m NPV) can also be seen in figure 4.5 below for the baseline, high and low scenarios. All three scenarios demonstrate strong benefits associated with the roll-out of the Smart Street system.

Figure 4.4 shows that in the short term benefits would not accrue to the DNO, and therefore there is no compelling cost efficiency driver for us to commence a roll-out during RIIO-ED1. However, given the significant customer benefit, we believe it is important to begin to implement the Smart Street system now. For this reason we believe that the IRM is the most appropriate source of funding for the roll-out.

Figure 4.5: Smart Street IRM roll-out financial benefits (£m NPV)



Network benefits

Avoided network reinforcement

The primary benefit for the DNO associated with the roll-out is viewed as the network savings associated with avoided future reinforcement. As the uptake of LCTs and the electrification of heat and transport accelerates, significant reinforcement is expected in order to maintain supplies within operating limits.

Therefore traditional reinforcement has been used as a counterfactual within the CBA to compare Smart Street with the current BaU approach. The CBA has demonstrated significant savings associated with Smart Street when compared to BaU solutions. Whilst these savings are described as network benefits, they will ultimately be reflected within customer electricity bills through a reduction in future DUoS charges.

As per the roll-out strategy, we will target network locations which do not require reinforcement during RIIO-ED1 but are expected to require reinforcement during future price control periods to facilitate the uptake of LCTs or other growth in network loading. Therefore the CBA has assumed that all of the selected roll-out sites will require reinforcement at some point during future price control periods. This reinforcement has been distributed within the CBA between 2024 and 2047.

Based on avoided network reinforcement alone the roll-out of Smart Street is expected to **save approximately £45,350 (£56,520) per deployment** when the capital cost of the

Smart Street equipment is subtracted. Furthermore, this saving does not take into account the significant additional customer benefits associated with reduced network losses and customer consumption.

Interruption Incentive Scheme (IIS)

A secondary network benefit is the potential impact on the IIS associated with a reduction in CML and Customer Interruptions (CI).

In addition to a reduction in network losses, the switching devices used to mesh the LV network may also lead to a reduction in the frequency and duration of CI. The devices can automatically reclose on a transient fault and return customer supplies without any lengthy delays.

The potential financial impact of this functionality on the IIS has been quantified within the CBA as shown in figure 4.6 below. These values assume that the current IIS continues in its current form during future price control periods.

Electricity North West intends to reduce the cost of the project to account for any benefit received.

Figure 4.6: Benefits of improved IIS incentive

Scenario	Benefits (£m) of improved IIS				
	2023 (ED1)	2031	2039	2047	2055
Baseline	0.030	0.149	0.268	0.387	0.506

Customer benefits

There are two main quantifiable customer benefits associated with the roll-out which will deliver financial savings for electricity customers as described below. Whilst these customer benefits are counted as "societal benefits" rather than "network benefits" within the CBA, they must not be ignored or discounted.

The roll-out CBA has verified that each deployment of the Smart Street system can bring up to **£15,307 (£18,287) in savings each year** through a reduction in customer consumption alone. Depending on the number of customers fed from the substation this can equal up to £61 (£73) per customer, per annum. Therefore the **payback period associated with roll-out is only 2 years within the baseline scenario.**

Transforming our communities is central to Electricity North West's purpose and principles and as such we believe it is now prudent to roll-out this technology to directly address fuel poverty and deliver this benefit to our customers as soon as possible. This approach is aligned with the findings published by the Committee on Fuel Poverty regarding the need to take action to improve energy efficiency and will bring both immediate and long terms savings to our electricity network customers. Smart Street brings an opportunity to immediately reduce customer bills whilst securing a significant reduction in network reinforcement costs during future price control periods.

Section 4: Evaluation Criteria continued

1. Reduction in energy consumption

CVR is a proven method to reduce energy consumption by lowering the voltage supplied to customers. An OLTC can automatically reduce LV network voltage to a calculated set-point which allows customers' appliances to operate more efficiently.

When combined with the optimisation software CVR has been demonstrated to reduce annual consumption by up to 8%. Based upon an assumed average substation loading the annual savings have been calculated and subtracted from the OLTC deployment costs within the CBA. The annual savings associated with each deployment of the OLTC have been calculated as **up to £15,307 (£18,287),** or approximately **£61 (£73) per customer, per annum,** assuming 250 customers per substation. These calculations are in line with our learning from the trials.

2. Reduction in LV network losses

Network losses are proportional to the current squared. Therefore, losses can be reduced if the current across two LV feeders is shared equally by meshing the LV network. To maximise these benefits, the loading across the two LV cables must be different so that loading can be shared and the peak current reduced.

The trials have demonstrated that annual losses can be reduced by 7% across meshed LV circuits for sites which are identified as appropriate using the site selection criteria we have developed. In total the reduction in losses associated with the Smart Street system can bring upwards to **£343 to £640 (£397 to £741) in benefits each year** for each deployment.

ii) Qualitative financial benefits

The following benefits have not been quantified within the CBA but will be tracked and understood better as a result of the roll-out.

Reduction in fuel poverty gap: The potential for energy savings in the region of 8% for individual households can deliver modest financial savings and positively contribute to reducing the fuel poverty gap. These savings, when extrapolated, are likely to have a wider holistic and societal benefit to the local community, which are difficult to monetise or quantify.

Market benefit of additional low carbon generation: Smart Street will facilitate a higher penetration of low carbon renewable generation sources. This increase in market competition for generation may drive down wholesale electricity prices for customers, particularly as the cost of wind and PV continues to fall.

Demonstration of a smart & flexible energy system: In July 2017 BEIS (Business, Energy and Industrial Strategy) and Ofgem issued their joint publication entitled Upgrading Our Energy System: Smart Systems and Flexibility Plan[7]. The roll-out will further demonstrate the value of a smart and flexible energy system and inform important decisions that will be made during future price control periods.

Section 4: Evaluation Criteria continued

iii) Impact on wider energy operations

The existing distribution system was not originally designed to accommodate LCTs and DG. The potential impact of the electrification of heat and transport has been widely discussed and it is now clear that action must be taken. As the owners and operators of the distribution network, DNOs connect all stakeholders in the electricity industry together and must evolve to enable a low carbon future. The roll-out of the Smart Street system represents a significant step towards this goal and signals an evolution in how LV distribution networks are both designed and operated.

An active and responsive distribution network

The Smart Street system will enhance the existing network by facilitating the optimisation of the LV network in real time, and helping to create a network which is truly responsive to customers' needs. This will act as a major enabler to our DSO vision and allow us to build a flexible and active distribution network which will form the foundation for a future low carbon energy system.

The roll-out will significantly enhance existing networks and allow for the accelerated connection of clusters of LCTs, contributing to emissions reduction targets.

Building upon the learning gained from the trials, Electricity North West considers the roll-out to be low risk, transferrable, non-intrusive, and a viable alternative to traditional network reinforcement.

The adoption of new innovative technologies

Part of this new and responsive distribution network is the OLTC and network meshing technologies which were previously demonstrated within the trials. Under the direction of the centralised optimisation software these technologies allow the LV network to become truly intelligent and future-proof. The roll-out will be the first demonstration in GB of an intelligently optimised system allowing the LV network to evolve from passive, with little visibility or automation, to an active, responsive and controllable system.

Analysis of the trial data demonstrated that the voltage, thermal and harmonic problems created as LCTs connect to LV networks can be significantly reduced by the interconnection of LV networks. Safely transforming a radial LV network into an interconnected LV network will require the traditional substation and link box fuses to be replaced with intelligent switching devices. These meshing devices can be remotely controlled allowing both sensing of feeder flows and dynamic reconfiguration of the LV network. The devices will be integrated into the automation software in our NMS delivering additional benefits such as increased network resilience.

In addition, the centralised optimisation software will further maximise the potential of CVR to reduce customer energy consumption and the ability to reduce network losses through the intelligent meshing of the LV network. Both functionalities will deliver recurring financial savings for customers, without degradation to the quality of customers' supply.

Aligned with Electricity North West's long-term vision

Electricity North West is committed to assisting our region to meet their targets for carbon reduction. The roll-out of the Smart Street system is a key enabler for carbon neutrality by driving energy efficiencies and facilitating the connection of LCTs.

Electricity North West expects the Smart Street system can be rolled out to 64% of our distribution network and could release up to 220MW in additional network capacity for LCTs, based on our current peak demand of 4.3GW.

The roll-out brings carbon savings from a number of sources which all add to the carbon reduction targets.

- Increased numbers of connected LCTs
- Reduced energy consumption
- Avoided network reinforcement

In addition to carbon savings the roll-out of the Smart Street system can offer financial benefits to our customers from avoided network reinforcement and reduced energy consumption.

Smart Street is recognised in our carbon plan [4] as one of a number of initiatives we will roll-out in future price control periods to meet our carbon targets and deliver benefits to our customers.

The roll-out will enable the delivery of electricity to become more efficient and flexible, with a real focus on minimising carbon impact, whilst enhancing supply resilience and delivering benefits for customers.

iv) Assessment of Smart Street roll-out success

Electricity North West will ensure that the roll-out of the equipment is cost effective and that the success of the roll-out and the associated benefits is measured and recorded as described below:

Process to ensure the roll-out will be delivered at a competitive cost

Electricity North West will issue a competitive tender to identify the most cost-effective equipment available from the market which provides the full functionality required by the roll-out. We will do this by building upon the experience gained from the trials to allow us to identify and assess the best tender options and ensure that the technology chosen represents value for money.

From previous industry engagement we are already fully aware of the range of manufacturers and vendors that are able to supply the requisite technology. We have identified and compared the available options and are confident that a competitive tender would result in value for money for network customers.

Furthermore, to ensure that ongoing BaU activities are not impacted by the roll-out, specialist third party contractors will be recruited to carry out all installation activities. This resource will also be contracted through a tender process. The time required to undertake these procurement activities has been built into the project plan (Appendix G).

The external resource will be complemented by employees from within the innovation team to support, supervise and monitor certain aspects of the roll-out. This approach will allow us to take advantage of our previous experience and knowledge acquired when delivering the trial.

We will also assign a dedicated and experienced project manager with a track record of delivering similar projects against challenging output targets to ensure the project is effectively managed throughout its duration. The Electricity North West led delivery team will also ensure the critical Key Performance Indicators (KPIs) associated with the roll-out are regularly reviewed and progress against the targets is reported as required.

How will Electricity North West determine if the roll-out of the innovation has been successful and delivered the expected customer and network benefits?

Electricity North West proposes that the success of the roll-out be determined against the number of customers directly benefitting through a reduction in their electricity bills.

The objective is to install the Smart Street system at 180 sites over a 2.5 year period. Therefore a key measure of successful roll-out is to track the rate at which the system is rolled out.

We will also consider the roll-out a success where the apparatus has been installed in areas where we predict high uptake of LCTs and have identified a high level of fuel poverty where, without the roll-out, we would expect a requirement for future network reinforcement. As previously discussed, these sites will be short-listed using the site selection criteria to ensure each installation delivers the benefits required to justify the roll-out.

In addition, both deployment volumes and expenditure will be tracked against our roll-out strategy on a monthly basis to ensure the project is being delivered on schedule and within our defined budget. Table E8 in Annex J of the Environment and Innovation pack in the Regulatory Instructions and Guidance (RIGs) tables will be used for our official annual reporting. The benefits achieved through implementation of the Smart Street system will be recorded using Table E6 Annex J of the Environment and Innovation pack of the RIIO-ED1 RIGs tables.

We will also keep track of the customer count from sites where we have applied the system to show the number benefitting and potential savings realised by the technology.

As previously described, network customers will start to see benefits from the roll-out immediately after the Smart Street system is installed through a reduction in energy consumption. However, to ensure the roll-out as a whole has been successful, we also plan to keep track of the following:

Section 4: Evaluation criteria continued

Figure 4.7: KPIs for roll-out

KPI type	KPI name	Description
Internal	Roll-out of Smart Street technology installations	Monthly tracking of the progress of installation of Smart Street technology at distribution substations against project plan
Internal	Roll-out of integration into NMS	Tracking of the integration of Smart Street optimisation technology into NMS against project plan
Internal	Roll-out costs	Monthly tracking of the roll-out costs across the programme
Internal	Customer numbers	Tracking of customer numbers fed via roll-out sites
Internal	Potential customer savings	Calculation of saving based on demand reduction from applied voltage reduction and average unit cost of electricity
Regulatory reporting	RIGs Table E8	Annual reporting of IRM costs against allowance
Regulatory reporting	RIGs Table E6	Track benefits achieved through roll-out of the Smart Street system

c) Will not enable the licensee to receive additional commercial benefits which are greater or equal to the cost of implementing the Proven Innovation

The roll-out CBA has quantified the potential benefits associated with an improvement in performance against the IIS through a reduction in both CML and CI.

However, as seen in figure 4.6 the benefit associated with this increase in performance against the incentive scheme does not exceed the cost of implementing the LV network meshing technology. It is Electricity North West's intention to reduce the cost of the project to account for any benefit received.

We do not therefore expect any commercial benefits to be attained from the roll-out which are greater than or equal to the cost of implementing the Proven Innovation.

The potential impact on the other existing RIIO-ED1 incentives are expected to be minor and are discussed below:

- **Incentive on Connections Engagement (ICE):** Smart Street is a viable alternative to conventional network reinforcement which makes network capacity available faster. As a result, our ICE performance may improve by making capacity of low carbon distributed generation available earlier than otherwise possible.

Section 4: Evaluation criteria continued

- **Broader Measure of Customer Satisfaction (BMCS):** Smart Street has been demonstrated to significantly reduce customer electricity bills which justifies the upfront cost associated with the equipment and the impact on future DUoS charges. Actively taking action to reduce customer bills may consequently improve our BMCS performance.

We will maintain a separate cost control centre during the roll-out to allow accurate reporting of costs and volumes as per the RIGs documentation. This will also ensure that only costs incurred in line with total IRM funding will be passed to customers through DUoS charges.

d) Will not be used to fund any of the Ordinary Business Arrangement of the licensee

The roll-out is not considered an Ordinary Business Arrangement, as defined within CRC 3D. Smart Street technology has only previously been used in this capacity during the trials. From discussions with our peers no other DNO is using the Smart Street system as BaU, and therefore it does not fall within the definition of an Ordinary Business Arrangement.

This application for an adjustment under the IRM is for the costs associated with the delivery of the Smart Street roll-out only and therefore will not contribute towards any Ordinary Business Arrangement.

Electricity North West has identified a potential overlap between the roll-out and the transformer replacement programme, which sits within our network investment plan as an Ordinary Business Arrangement. Once we have completed our site selection we will identify whether any proposed site appears on the transformer replacement programme. If any duplication is identified, we will credit the cost of a standard transformer change to the project, thereby reducing the total project cost which will be reflected in the following year's relevant adjustment. This will ensure that IRM funding does not go towards any Ordinary Business Arrangement.

The funding awarded via the IRM to cover the roll-out of the Smart Street system will be managed from a dedicated cost control centre and kept separate from any other allocations. Our cost estimates have been developed from our existing framework agreements and through dialogue with various suppliers to ensure that we have made sufficient allowance for all potential expenditure.

Electricity North West will run a robust financial tracking and reporting system in line with our current internal policies and frameworks. In addition the project will be overseen by one of our directors who will undertake regular reviews of progress against the project plan. This will ensure that all the relevant learning from our innovation projects and our experience delivering other programmes of work is embedded within the roll-out. This supervision will enable us to identify any potential cost variances early and take measures to avoid or mitigate them. The governance structure is depicted in Appendix H for clarity.

Enhancing Competition

Analysis carried out in advance of the trials indicated that the Smart Street system is applicable to 64% of GB networks, which for Electricity North West equates to approximately 21,000 distribution substations.

We aim to use the IRM to demonstrate an at scale deployment which should act as an example to encourage other DNOs to adopt the system. If the solution is rolled out to the other DNOs the number of deployments could increase to approximately 294,000.

This level of deployment would offer manufacturers a significant and currently untapped market. Some manufacturers have been following the innovations being trialled and have already developed suitable products. The scale of the anticipated market will encourage other entrants and increase competition, which is expected to further reduce unit costs.

e) Involves Proven Innovation and warrants limited funding support

Funding requirement

The CBA shows that, in the short term, benefits would not accrue to the DNO and therefore there is no compelling cost efficiency driver for us to commence a roll-out during RIIO-ED1. However, given the significant customer benefit, we believe it is important to begin to implement the Smart Street system now.

By combining the onsite equipment with the optimisation software, the Smart Street system forms a unique arrangement. The effectiveness of this system was demonstrated within the trials and is therefore considered a Proven Innovation, as defined within licence condition CRC 3D.

We are therefore applying for an adjustment under the IRM to ensure the benefits associated with the Smart Street system can be made available for customers as soon as possible.

Technology readiness

The technology proposed for roll-out within this submission is considered Technology Readiness Level (TRL) 9 having been demonstrated within the trials. In addition, the roll-out is both innovative and is not viable under BaU operations within RIIO-ED1 without additional IRM funding.

The Smart Street LCN funded innovation project was awarded £8.438m of electricity customer funding in November 2013. The project was completed in April 2018 and successfully delivered all of its objectives. It is now important that the innovation which was successfully demonstrated within this project is rolled out as early as possible to begin to deliver the significant customer benefits.

This submission builds on the learning that has been acquired from the Smart Street trial. During the project, a proven business case was developed for the deployment of the technology which is now proposed for roll-out within this application. The trials allowed us to test the technologies and provided an in-depth understanding of where the Smart Street system delivers most benefit for customers. It also allowed us to identify which technologies do not deliver sufficient benefits at this point in time and exclude them from the roll-out. More specifically, the trials concluded that the following technologies delivered significant benefits and were considered “proven” innovations:

Section 4: Evaluation Criteria continued

Included in the roll-out:

- The OLTC is sufficiently developed at TRL 9 and can deliver significant cost savings to customers when deployed.
- The LV switching devices provide valuable flexibility to the LV network reduce losses and have been proven to perform well at TRL 9.
- The optimisation software has been developed and proven to efficiently control the Smart Street network devices to maximise the benefits. The software combined with the existing in-house NMS is considered TRL 9.

In addition, we have also developed various internal processes and specifications to ensure the efficient, wide scale roll-out of the system as soon as funding is made available to facilitate its deployment. It is now understood how the technology operates, its impact on wider network operations, and under which circumstances it should or should not be deployed.

The deployment of OLTCs and LV network switches in combination with the sophisticated optimisation software is now considered to be TRL 9; the application of the technology is in its final form and the technology has been proven to deliver financial, environmental, and social benefits. Electricity North West does not expect any further development of the core technology to be required before the roll-out is feasible.

f) Is ready to be rolled out, with all funding provided being used within the price control period

As discussed in previous sections, the technology proposed for roll-out within this proposal is considered TRL 9 and is ready for mass adoption by network companies as soon as funding is made available. The technology is widely available from various vendors and a roll-out within RIIO-ED1 would serve to further increase competition in the market and drive down costs ahead of future price control periods.

We will also build upon the learning acquired from the trials which has allowed the business to understand how best to deploy the equipment efficiently and how to identify sites that will maximise the benefits associated with the technology.

To further demonstrate that the project is ready to be rolled out the project plan and risk mitigation measures are described in more detail below:

Project plan

If this application for an adjustment under the IRM is successful our intention is to install Smart Street technology at 180 sites across our distribution network. The precise locations will be identified using the site selection criteria as discussed in Sections 2.6 and 3.3.

The Smart Street roll-out will have two phases. The first phase will involve the installation of the technologies at the feeder substation, which is estimated to take up to five days to complete per site. The second phase will enable the full integration into our NMS. This second phase is expected to start later due to the complexity of the Information Technology (IT) integration. However, once the initial sites are integrated further sites can be added within a day of commissioning on site.

Section 4: Evaluation Criteria continued

To complete the roll-out within the RIIO-ED1 period we will mobilise the project team by the end of December 2019 to allow us to commence site selection and tendering in January 2020. We will order all necessary equipment by the end of April 2020.

To ensure we are ready to order the equipment in April 2020 we will need to start tender processes and initial site selections as soon as we are notified that the application is successful. The costs incurred, estimated at [redacted] for this preliminary work will be covered by Electricity North West under existing allowances.

Once initial deliveries of the equipment have been completed we will begin a series of training and familiarisation courses for the installation and operational teams. A limited number of Electricity North West personnel were trained for the trials. This training will need to be repeated and extended to capture all operational employees and contractors.

We will commence the first phase of the installation process by October 2020. We expect the roll-out to take approximately two years which will give us three months contingency until the end of RIIO-ED1, in case of any delays. Appendix G details the full project plan.

The roll-out will be managed by internal resources, with delivery support from external parties where necessary. Please see below figure 4.8 for an overview of the necessary resources.

Figure 4.8: Required resources

Task	Resource	Timescales
Project management and scheduling resource	Innovation team (internal)	Available immediately and throughout project
Technical support	Innovation team (internal)	Available immediately and throughout project
Project management office	Innovation/Finance team (internal)	Available at project start and throughout
Tender process	Innovation/Procurement team (internal)	Available at project start for 5 months
Site selection	Innovation team (internal)	Available at project start for 3 months
Planning	Innovation team (internal)	To be seconded from planning for 2 years
Site installation	Contractor staff (external)	From existing framework contractors for 2 years
	Telemetry team (internal)	Available at project start for 2 years
NMS integration	IT team (internal)	Available at project start and throughout
	Software provider (external)	Available at project start and throughout

Section 4: Evaluation Criteria continued

Project risks

Electricity North West's approach is to engineer out risk wherever possible through early dialogue with suppliers and detailed advance planning. The roll-out of the Smart Street system will employ the successful Risk and Issues process currently used within the company. We have included a copy of the project risk register and a detailed explanation of the methodology in Appendix I.

In addition, the project will be overseen by one of our directors who will undertake regular reviews of progress against the project plan. This will ensure that all the relevant learning from our innovation projects and our experience delivering other programmes of work is embedded within the roll-out. This oversight will enable us to identify any potential issues early and take measures to avoid or mitigate them. The governance structure is depicted in Appendix H for clarity.

g) IRM funding request meets the materiality threshold

The IRM funding requested within this proposal is £15.09m (£18.03m) which is above the materiality threshold of £6.21m (2012/13 prices) for Electricity North West, as stated within Licence Condition CRC 3D Appendix 1.

Distribution Network Operator Innovation Roll-Out Mechanism (IRM) Submission Pro Forma

Section 5: Regulatory Issues

The proposed roll-out will not require any derogations or changes to the current regulatory arrangements. If the need for any derogations or changes should become apparent Electricity North West will ensure that we engage appropriately.

Stakeholders

The Stakeholder Engagement Customer Vulnerability (SECV) incentive scheme, introduced in the current price control, encourages DNOs to engage proactively with stakeholders to anticipate their needs and deliver a customer focused, socially responsible and sustainable energy strategy.

As part of the SECV obligation we have demonstrated how we have consulted stakeholders and introduced a range of initiatives to support vulnerable customers, including those in fuel poverty. This strategy has fostered a number of partnerships with key stakeholders. For example, the Centre for Sustainable Energy, who are developing tools to support vulnerable customers, and Citizens Advice, who will provide us with access to anonymised data to support our site selection for the roll-out. Both charities fully support the roll-out due to the tangible benefits it can deliver to customers, see Appendix K.

Engagement with relevant stakeholders is at the heart of our governance and, as such, the proposal to roll-out the Smart Street system was endorsed by our dedicated Stakeholder Advisory Panels (specifically the Affordability & Sustainability Panels in July 2018). This endorsement is on the basis that the roll-out can be implemented without customer impact and will deliver energy savings, particularly for those in greatest need.

This approach aligns with Electricity North West's customer vulnerability strategy [8] and demonstrates that we have listened to the views of our communities, to ensure that our day-to-day service delivery and future network strategies are driven by social impacts as well as technological requirements.

Customers

A robust customer engagement strategy was adopted during the Smart Street trials to ensure that any change or decline in power quality on trial circuits was captured. This included the launch of a general awareness campaign, embedding a complaints procedure, and direct engagement with customers across the trial regions.

The work carried out to engage with customers during the trials confirmed the hypothesis that "customers in the trial areas would not perceive any change in their electricity supply associated with the method". This outcome demonstrated that the roll-out can be implemented without any detriment to power quality.

The customer research methodology and key findings are reported in the final Engaged Customer Panel report [9], and the Closedown report [10].

It was highlighted during the trial analysis that a reduction in energy consumption as a result of the Smart Street roll-out will lead to a reduction in DUoS income. For the roll-out we have assessed the effect this will have on our customers.

Within the price control DNOs routinely target specific areas of the network for reinforcement and asset replacement, including, for example, "worst served" customers.

Section 5: Regulatory Issues continued

Whilst only these specific customers will benefit from such work, the costs are socialised across all customers via DUoS. Reallocation of the predicted DUoS shortfall due to the roll-out will lead to an increase of approximately 12p per annum for all customers up to the end of RIIO-ED1. This figure is based on our Current Charging Distribution Methodology (CDCM) Model for 2020/21.[11]

The Institute of Engineering and Technology (IET)

During the project a consultation was held in conjunction with the IET to allow Stakeholders to engage and raise potential concerns. This consisted of a month long consultation period followed by an event to review the outcomes. This event was recorded and published on the IET.tv website, a copy of the recording [12] and the subsequent report[13] are available on the Smart Street project website. The consultation focused on the changes that would be seen at the customer's property, primarily in terms of fault level and earth loop impedance. In summary, the results of the process demonstrated that whilst the Smart Street methodology would have minor impacts in both of these respects, it would not be sufficient to cause any issues with customer installations.

Section 6: Appendices

Appendix letter	Title
A	Bibliography
B	Glossary
C	CBA Methodology
D	CBA Sensitivity Analysis
E	Breakdown of CBA Calculated Values
F	Project Costs
G	Project Plan
H	Project Organogram
I	Risk Register
J	Relevant Adjustment
K	Letters of Support

Section 6: Appendices continued

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Section 6: Appendices continued

Appendix B: Glossary

Abbreviation	Term
ARS	Automatic Restoration System
BaU	Business as Usual
BEIS	Business Energy and Industrial Strategy
BMCS	Broad Measure of Customer Satisfaction
CAPEX	Capital Expenditure
CBA	Cost Benefit Analysis
CDCM	Common Distribution Charging Methodology
CI	Customer Interruptions
CLASS	Customer Load Active System Services
CML	Customer Minutes Lost
CRC	Charge Restriction Condition
CRMS	Control Room Management System
CVR	Conservation Voltage Reduction
DFES	Distribution Future Electricity Scenarios
DG	Distributed Generation
DNO	Distribution Network Operator
DSO	Distribution System Operator
DUoS	Distribution Use of System
ENWL	Electricity North West Limited
EV	Electric Vehicle
GB	Great Britain
GMCA	Greater Manchester Combined Authority
GW	GigaWatt
HP	Heat Pump
HV	High Voltage
ICCP	Inter-control Centre Communication Protocol
ICE	Incentive on Connections Engagement
IIS	Interruptions Incentive Scheme

Section 6: Appendices continued

Abbreviation	Term
KPI	Key Performance Indicator
kWh	kiloWatt Hour
LCN	Low Carbon Network
LCT	Low Carbon Technology
LV	Low Voltage
LVCB	Low Voltage Circuit Breaker
MWh	MegaWatt Hour
NMS	Network Management System
NPV	Net Present Value
OLTC	On Load Tap Changer
OPEX	Operational Expenditure
PV	Photovoltaic
QoS	Quality of Supply
RIG	Regulatory Instructions and Guidance
RIIO-ED*	Revenue = Incentive + Innovation + Outputs *ED is the Electricity Distribution specific review period
SECV	Stakeholder Engagement and Customer Vulnerability
TIM	TOTEX Incentive Mechanism
TOTEX	Total Expenditure
TRL	Technology Readiness Level
UK	United Kingdom

Section 6: Appendices continued

Appendix C: CBA Methodology

This appendix describes the methodology used within the Ofgem NPV CBA template to quantify both the financial and environmental benefits associated with the roll-out of the Smart Street system and the counterfactual used as a comparison of the Smart Street approach with BaU network reinforcement.

As discussed in Section 4 the following benefits are all elements of the Smart Street system and have been quantified within the CBA. The methodology used to calculate the benefits are described in more detail individually below:

1. CVR driven customer energy savings
2. Reduction in losses by network meshing
3. Avoided network reinforcement (counterfactual)
4. CML/CI savings to IIS

CVR driven customer energy savings

Simply put, the benefits associated with the individual roll-out of an OLTC were calculated as the annual energy savings per substation minus the upfront and operational costs associated with installing the equipment.

The unit cost for an individual OLTC was established through close engagement with potential vendors and our experience procuring the equipment during the Smart Street trials. The installation and on-going annual maintenance costs were also ascertained in the same way.

To allow the OLTC technology to operate efficiently, and to maximise the value of the CVR, central optimisation software is required. A share of the cost to implement the optimisation software has therefore been included for each installation. For the purpose of the CBA this cost has been distributed across the 180 sites included for the roll-out and we have assumed an additional 1000 sites will be replaced by Electricity North West from the start of RIIO-ED2 onwards. This gives a total estimated upfront cost of [redacted] per site, including the procurement and installation of the equipment and an Operational Expenditure (OPEX) cost of [redacted] per year.

Within the baseline scenario, the annual savings for each deployment were calculated as a 7% reduction in the quantity of energy (kWh) provided by a 500kVA distribution transformer each year with an average loading of 35%. This value was then multiplied by a retail price for electricity of £0.13/kWh to give an annual saving for each deployment of £14,001 (£16,211). The upfront and annual costs were then subtracted from this annual saving to give the cumulative benefit associated with the roll-out of this technology specifically.

The reduction in network losses associated with reducing consumption and loading was also included within the calculation based upon a price to procure losses of £48.42/MWh, as prescribed by the Ofgem CBA.

Section 6: Appendices continued

Reduction in losses through network meshing

As with the OLTC, the annual savings associated with a reduction in network losses by network meshing were offset against the TOTEX costs associated with the roll-out of the LV switching devices required to mesh two LV feeders together.

Again, the TOTEX costs were estimated based upon previous experience in procuring the technology and continued engagement with capable vendors. The total Capital Expenditure (CAPEX) for each installation was calculated as [redacted] The OPEX costs were applied every 10 years with an initial cost of [redacted] per device.

In the baseline scenario the assumed level of LV network losses was estimated to be 4% of the energy delivered across both meshed LV feeders over the course of a year. An annual reduction of 6% was then applied to this level of losses to quantify the savings associated with network meshing in kWh. A 6% reduction in losses is realised when two feeders are meshed with an average difference in loading of 36% over the course of the year.

This calculation gives a potential saving in losses of £452 (£555) each year when the quantity of saved losses (kWh) is multiplied by a retail price for electricity (£/kWh). As before, this annual saving was then offset against the TOTEX cost within the CBA to quantify the cumulative benefits as shown in Section 4.

CML/CI savings to the IIS

As discussed in Section 4, the LV switching devices also provide a potential network benefit associated with an improvement in the quantity and duration of CI.

IRM governance states that the DNO must not receive additional commercial benefits which are greater than or equal to the cost of implementing the Proven Innovation. To show compliance with this requirement, the CBA has calculated the potential impact of the roll-out on the IIS.

The LVCBs that would be installed within the substations to allow the network to be meshed are also capable of improving CML and CI measures by automatically closing in on transient LV network faults and returning customer supply without the need for an engineer to visit the substation and replace a traditional fuse.

To estimate the financial impact of this functionality on the IIS the CBA took an estimated number of faults per year, per LV feeder, and multiplied this by the average cost associated with each LV fault. Over the previous year, 13.125% of our distribution substations had faults, of which 26% of these faults were transient. Our average supply interruption duration for LV faults is 140 mins which would reduce to sub 3 mins with the LVCBs installed.

The average CML/CI savings associated with the LVCBs were then subtracted from this value to give an estimated savings per installation, per year. This was then multiplied by the number of units that are intended to be installed to give the total improvement in the financial incentive acquired by Electricity North West through the IIS.

As seen within the CBA results in Section 4 the financial savings associated with the IIS is not greater than the cost to implement this innovation. The savings associated with all 180 installations are expected to deliver CML/CI benefits of approximately £14,880 (£17,230) each year. Due to the installation profile we will receive a portion of this annual benefit in the first two years as well as the full benefit in the final year, giving a total IIS benefit to 2023 of £29,760 (£34,460).

Avoided network reinforcement

As described within the site selection criteria in Section 3, we will target sites that are expected to require reinforcement in future price control periods. The roll-out in these locations will release capacity in the network to avoid the need for this expensive reinforcement.

To quantify this benefit, a counterfactual reinforcement base case was established as an alternative to the Smart Street system. Figure C.1 shows an 11kV/LV substation which requires reinforcement. The increase in LCTs and load growth has led to a peak in thermal loading above the rating of the 500kVA transformer and a daily fluctuation in voltages along the LV network out with the statutory limits of +10% and -6%.

Figure C.1: Substation which requires reinforcement

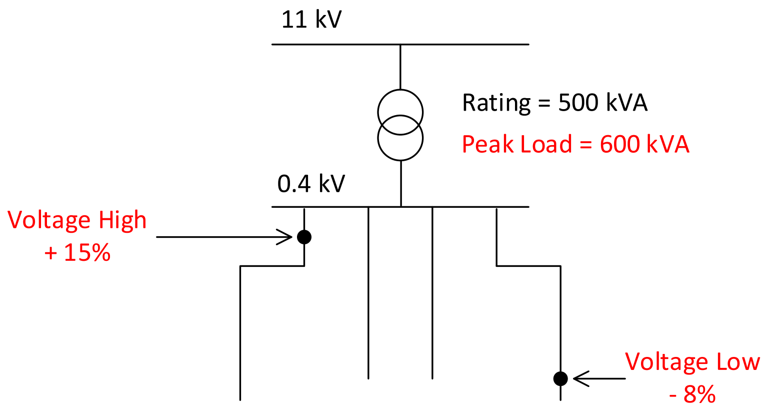
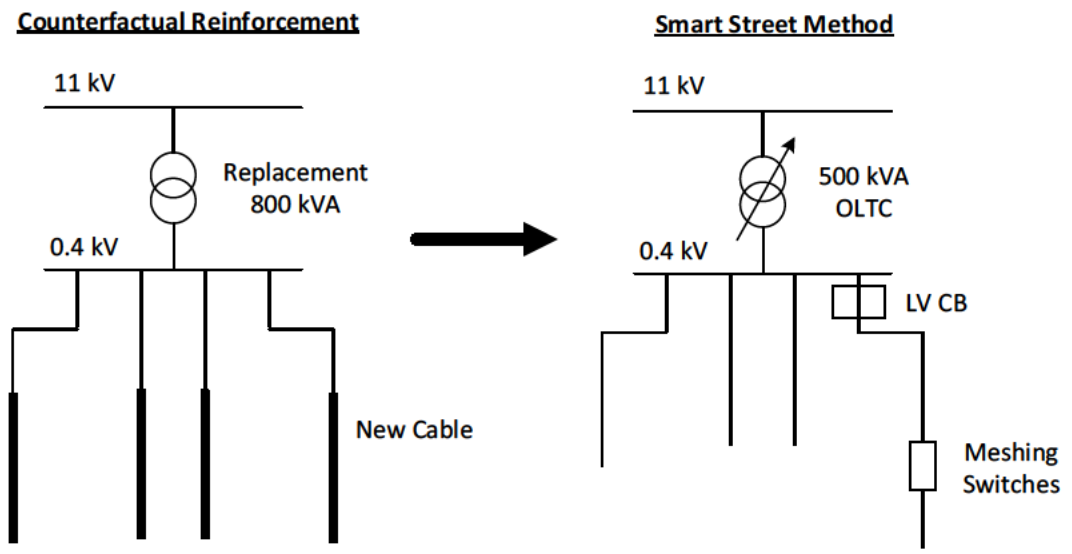


Figure C.2 illustrates the Smart Street system alongside the counterfactual of conventional network reinforcement. As seen the deployment of the OLTC alongside the network meshing devices acts as an alternative to the replacement of the existing transformer and the laying of new LV cable.

Figure C.2: Smart Street and counterfactual solutions



The unit costs which have been used to quantify the counterfactual have been taken from the Electricity North West investment category evaluator. The main driver behind the cost is the need to overlay the existing tapered LV cable with new cable which has an increased cross-sectional area.

The unit cost chosen within the baseline was [redacted] which is consistent with the value within our investment category evaluator and our charging methodology[14]. However, this cost is dependent on the specific reinforcement case. In fact, the cost associated with new LV cable in densely populated areas through certain types of pavement and road can be significantly higher. In addition, the existing 500kVA transformer has been replaced with a larger unit to provide additional thermal capacity at a cost of [redacted] This gave an initial counterfactual CAPEX of [redacted]

Meanwhile, the total cost to implement the Smart Street system is a summation of the OLTC, network meshing devices and the optimisation software. The baseline CAPEX used within the CBA was [redacted] with an additional yearly OPEX of [redacted] for the OLTC and [redacted] for the meshing switches.

Furthermore, the CBA also factored in this decrease in network losses associated with counterfactual by deploying a cable with a thicker cross-sectional area. As losses are inversely proportional to cable area a reduction in network losses from 4% to 3.52% was calculated and included each year within the CBA. This saving in losses was applied against the Smart Street system throughout the duration of the CBA.

Carbon savings

Within the CBA the following elements contributed towards the total carbon benefits associated with the roll-out:

1) The avoided carbon footprint associated with the counterfactual network reinforcement. A carbon cost of 95 tCO_2e/km was used for LV cable and 2 tCO_2e for a replacement conventional transformer.

2) The reduced consumption associated with CVR was converted into tonnes of CO_2e.
3) As above, the reduction in losses associated with OLTC and network meshing was converted into tonnes of CO_2e for each year.
4) The avoided but lower losses associated with the thicker cables used within the counterfactual were subtracted from the carbon benefits.
5) The carbon cost of the Smart Street equipment was taken from the studies undertaken by the University of Manchester and subtracted from the carbon benefits within the CBA.

Appendix D: CBA Sensitivity Analysis

To add further credibility to the results presented from the CBA a sensitivity analysis was carried out to determine the financial and environmental benefits in a low and high scenario.

To create these scenarios key inputs into the CBA were adjusted compared with the baseline values. The key CBA input values are shown in figure D.1 and are highlighted where they have been adjusted for each scenario.

A conversion factor of [redacted] has been used to convert from today's costs to 2012/13 prices. This value has been provided by the Electricity North West Regulatory Finance team, based on HM Treasury data, as the value used by the business for regulatory reporting.

Figure D.1: Smart Street IRM CBA key input for each scenario

CBA input	Scenario			
	Baseline	High	Low	Justification for increase and decrease
2012/13 conversion factor from 2019/20	[redacted]			Not applicable to vary as part of sensitivity analysis
OLTC unit cost	[redacted]	[redacted]	[redacted]	Based on our experience from the trials and subsequent vendor engagement
OLTC installation cost	[redacted]			Based on our installation experience and cost well understood
Optimisation software	[redacted]			Based upon estimated roll-out volumes up until the end of RIIO-ED2
OLTC annual maintenance	[redacted]			Based upon manufacturer engagement Very low maintenance expected through lifetime
OLTC CVR reduction in consumption	7%	8%	6%	Based upon high to low values demonstrated within the trials

OLTC carbon footprint	4.450 tCO_2e			Learning from the trials Well understood value
Retail price of electricity	£0.1305/kWh increasing 1% per year			Value taken from current offering from an energy retailer
LVCB unit cost + gateways (per installation)	[redacted]	[redacted]	[redacted]	Based on our experience from the trials and subsequent vendor engagement
LVCB maintenance cost	[redacted]			Based upon manufacturer engagement Value is reduced every 10 years
LVCB carbon footprint	0.094 tCO_2e			Learning from the trials Well understood value
Link box switch unit cost + gateway (per installation)	[redacted]	[redacted]	[redacted]	Based on our experience from the trials and subsequent vendor engagement
Link box switch maintenance cost	[redacted]			Based upon manufacturer engagement Value is reduced every 10 years
Link box switch carbon footprint	0.125 tCO_2e			Learning from the trials Well understood value
Reduction in LV losses by meshing	6%	7%	5%	Based upon high to low values demonstrated within trials
Carbon price	As per Ofgem CBA tool			As per Ofgem CBA tool

Tonnes of CO_2e per kWh	As per Ofgem CBA tool			As per Ofgem CBA tool
Counterfactual reinforcement cost	[redacted]	[redacted]	[redacted]	Based on real high and low values from our "cost to connect" customer documentation
Initial LV network losses	4%			Kept constant as other variable deemed more significant to vary
Reinforcement LV network losses	3.52%			Calculated value Kept constant as other variable deemed more significant to vary
LV network average loading	35%	40%	30%	Based on average loading of secondary substations These values can be significantly higher which would increase benefits

To ensure that the CBA outputs are credible and represent the true benefits that can be expected from the roll-out, the critical CBA inputs were reviewed individually. This approach was used to maximise the chance that the benefits described within the CBA are attained during the roll-out.

Further discussion on each of the key CBA inputs used within the Baseline scenario are described in figure D.2 below. Again costs are shown in 2012/13 prices and 2019/20 prices in brackets:

Section 6: Appendices continued

Figure D.2: Justification for critical CBA input values

CBA input	Baseline value	Comments
CVR reduction in consumption	7%	Based upon demonstrated benefits during the trials which showed a reduction in consumption exceeding 8%
Reduction in LV losses by meshing	6%	Based upon demonstrated benefits during the trials which showed a reduction in losses of 6% due to meshing
Counterfactual reinforcement cost	[redacted]	A combination of values taken from our investment category evaluator for RIIO ED1 and our charging methodology [14]
OLTC CAPEX	[redacted]	Based on close vendor engagement and expected costs when buying at volume Price could reduce through competitive tender Includes installation costs and share of optimisation software
OLTC OPEX	[redacted]	Based on vendor engagement very little maintenance is required specifically on the OLTC
LVCB CAPEX	[redacted]	Includes all telecommunication and LVCBs for two ways and two substations Unit prices based upon previous experience procuring the technology and recent vendor engagement
LVCB OPEX	[redacted]	This is based upon vendor engagement for 3 phases Maintenance is required once every 10 years This cost is expected to reduce due to economies of scale
Link box switch CAPEX	[redacted]	Includes all telecommunication and devices for two ways and three phases Unit prices based upon previous experience procuring the technology and recent vendor engagement
Link box switch OPEX	[redacted]	This is based upon vendor engagement for 3 phases Maintenance is required once every 10 years This cost is expected to reduce due to economies of scale

Appendix E: Breakdown of CBA Calculated Values

This appendix includes the CBA results produced for the IRM roll-out of the Smart Street system as described within the main body of this proposal.

Financial benefits

Figure E.1 below shows the cumulative financial benefits associated with the roll-out of the Smart Street system in 2012/13 prices for all three scenarios produced by the CBA. The benefits are a combination of:

- Avoided future LV network reinforcement
- Reduced customer energy consumption
- Reduced LV network losses
- Reduced CML and CI

Figure E.1 Annual cumulative Smart Street roll-out benefits (£m NPV 2012/13)

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Baseline	-0.6	-0.6	0.2	2.4	4.7	7.1	9.4	11.8	14.2	16.6	18.9	20.9	22.8	24.8	26.7	28.6	30.4	32.2
High	-0.2	0.2	1.8	4.9	8.0	11.2	14.4	17.6	20.9	24.1	27.2	30.0	32.6	35.3	37.8	40.4	42.8	45.2
Low	-0.8	-1.4	-1.2	0.3	1.9	3.5	5.1	6.7	8.3	9.9	11.5	12.8	14.2	15.5	16.8	18.1	19.3	20.6

	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055
Baseline	33.9	35.5	37.0	38.5	40.0	41.4	42.7	44.2	45.7	47.1	48.4	49.7	51.0	52.2	53.4	54.6	55.7
High	47.6	49.7	51.8	53.8	55.8	57.7	59.5	61.5	63.5	65.4	67.1	68.9	70.6	72.2	73.8	75.4	76.9
Low	21.7	22.8	23.9	24.9	25.9	26.9	27.8	28.9	29.9	30.8	31.7	32.6	33.5	34.3	35.2	36.0	36.8

Carbon benefits

Figure E.2 below shows the cumulative carbon benefits associated with the roll-out of the Smart Street system in 2012/13 prices for all three scenarios produced by the CBA. The benefits are a combination of:

- Reduced carbon emission associated with reduced customer energy consumption
- Reduced carbon emission associated with a reduction in LV network losses
- Reduced carbon emission associated with avoided future LV network reinforcement

Figure E.2: Annual cumulative Smart Street roll-out carbon benefits (ktonnes CO_2e)

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Baseline	3	8	17	27	36	45	54	62	71	78	86	92	97	103	108	112	117	121
High	4	11	22	34	46	58	69	80	90	100	110	117	124	131	138	144	150	155
Low	2	6	12	20	27	34	41	47	53	59	69	69	73	77	81	85	88	91

	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055
Baseline	125	128	131	134	136	138	140	141	142	143	144	144	144	144	144	145	145
High	160	164	168	171	174	177	179	181	182	183	184	184	185	185	185	185	186
Low	94	96	99	101	102	104	105	106	107	108	108	108	108	108	109	109	109

Appendix F: Project Costs

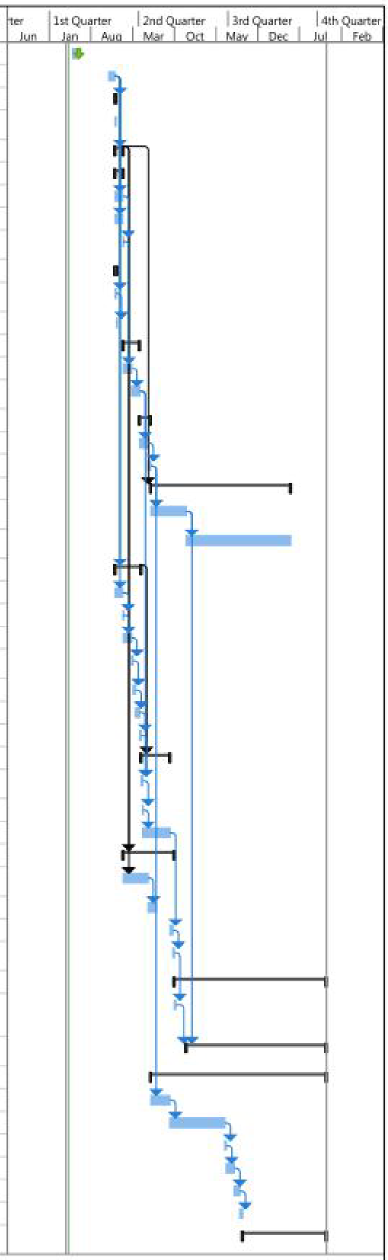
Task Description	Volume	Day/Unit Rate £	Cost Per Year £m			Total Cost
			FY21	FY22	FY23	
Project & Technical Management - Labour			[redacted]			
Project Manager	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Technical Support	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
SLT Manager	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Director	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Project Management Support - Labour			[redacted]			
PMO time	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted])
Finance Support	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Procurement Activities	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Planning - Labour			[redacted]			
Site Specific Design	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Site Installation - Labour			[redacted]			
SAP Support	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Install Remote Control Units	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Site Installation - Materials			[redacted]			
Purchase Link box Switch	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Purchase of LV RTU	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Purchase LV CB	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Purchase Remote Control Units	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Purchase On Load Tap Changing Tx	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Section 6: Appendices continued

Task Description	Volume	Day/Unit Rate £	Cost Per Year £m			Total Cost
			FY21	FY22	FY23	
Site Installation - Contractor			[redacted]	[redacted]	[redacted]	[redacted]
Install Link Box Switch	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Installation of LV RTU	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Install LV CB	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Install Tap Changing Tx	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
NMS Integration - Labour			[redacted]	[redacted]	[redacted]	[redacted]
IT Project Management	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
NMS Integration - Materials			[redacted]	[redacted]	[redacted]	[redacted]
Purchase of Optimisation Software	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Licences	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
NMS Integration - Contractor			[redacted]	[redacted]	[redacted]	[redacted]
NMS Provider Project Management	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Configuration	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
System Testing	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Training and Documentation	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Post Go Live Support	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total			**4.64 (5.55)**	**8.20 (9.80)**	**2.24 (2.68)**	**15.09 (18.03)**

Appendix G: Project Plan

ID		Task Mode	Task Name	Duration	Start	Finish
1			IRM Submission	23 days	Wed 01/05/19	Fri 31/05/19
2			IRM Decision	21 days	Fri 01/11/19	Fri 29/11/19
3			**Project Readiness**	**5 days**	**Mon 02/12/19**	**Fri 06/12/19**
4			Design, develop and issue the Project Implementation Document	5 days	Mon 02/12/19	Fri 06/12/19
5			**Mobilise Project Team**	**31 days**	**Mon 02/12/19**	**Mon 13/01/20**
6			**Project Resource**	**31 days**	**Mon 02/12/19**	**Mon 13/01/20**
7			Internal resourcing	30 days	Mon 02/12/19	Fri 10/01/20
8			Contractor resourcing	30 days	Mon 02/12/19	Fri 10/01/20
9			Confirmation and mobilisation meeting	1 day	Mon 13/01/20	Mon 13/01/20
10			**Finance and Contractual**	**10 days**	**Mon 02/12/19**	**Fri 13/12/19**
11			Identify and implement project budget controls within ENW	5 days	Mon 02/12/19	Fri 06/12/19
12			Financial controls established	5 days	Mon 09/12/19	Fri 13/12/19
13			**Site Selection**	**60 days**	**Tue 14/01/20**	**Mon 06/04/20**
14			Develop Network Design Methodology	30 days	Tue 14/01/20	Mon 24/02/20
15			Apply site selection methodology to select appropriate networks	30 days	Tue 25/02/20	Mon 06/04/20
16			**Installation Plan**	**40 days**	**Tue 07/04/20**	**Mon 01/06/20**
17			Define Installation Plan	30 days	Tue 07/04/20	Mon 18/05/20
18			Approve Installation Plan	10 days	Tue 19/05/20	Mon 01/06/20
19			**Planning and Design**	**450 days**	**Tue 02/06/20**	**Mon 16/05/22**
20			Apply Design Policy to selected networks Stage 1	120 days	Tue 02/06/20	Mon 30/11/20
21			Apply Design Policy to selected networks Stage 2	330 days	Tue 01/12/20	Mon 16/05/22
22			**Tender for equipment**	**96 days**	**Mon 02/12/19**	**Mon 13/04/20**
23			Write Specifications & Approve	30 days	Mon 02/12/19	Fri 10/01/20
24			Issue ITT Documentation	1 day	Mon 13/01/20	Mon 13/01/20
25			ITT Period	30 days	Tue 14/01/20	Mon 24/02/20
26			Tender Commercial & Technical Evaluation	5 days	Tue 25/02/20	Mon 02/03/20
27			Sign off of Award Recommendation	10 days	Tue 03/03/20	Mon 16/03/20
28			Conform Contract	15 days	Tue 17/03/20	Mon 06/04/20
29			Obtain contract signatures	5 days	Tue 07/04/20	Mon 13/04/20
30			**Order equipment**	**96 days**	**Tue 14/04/20**	**Tue 08/09/20**
31			Confirm required equipment and volumes	5 days	Tue 14/04/20	Mon 20/04/20
32			Place order	1 day	Tue 21/04/20	Tue 21/04/20
33			Delivery of apparatus	90 days	Wed 22/04/20	Tue 08/09/20
34			**Resource Training**	**176 days**	**Tue 14/01/20**	**Tue 29/09/20**
35			Write Codes of Practice and Procedures	90 days	Tue 14/01/20	Mon 18/05/20
36			Authorisations and Health and Safety	30 days	Tue 19/05/20	Mon 29/06/20
37			Operational staff install familiarisation	10 days	Wed 09/09/20	Tue 22/09/20
38			Incorporate feedback from training into COP and procedures	5 days	Wed 23/09/20	Tue 29/09/20
39			**Work Stream 1 - Installation on site**	**494 days**	**Wed 30/09/20**	**Mon 14/11/22**
40			Confirm resources, apparatus, installation plan and COP/procedures in place	5 days	Wed 30/09/20	Tue 06/10/20
41			**Commence phase 1: installation on site**	**450 days**	**Tue 01/12/20**	**Mon 14/11/22**
222			**Work Stream 2 - NMS integration**	**571 days**	**Tue 02/06/20**	**Tue 15/11/22**
223			Finalise optimisation software spec	60 days	Tue 02/06/20	Mon 07/09/20
224			Configuration of optimisation software	180 days	Tue 08/09/20	Mon 14/06/21
225			FAT	5 days	Tue 15/06/21	Mon 21/06/21
226			Post FAT configuration	30 days	Tue 22/06/21	Mon 02/08/21
227			SAT	10 days	Tue 03/08/21	Mon 30/08/21
228			Sign off software acceptance	10 days	Tue 31/08/21	Mon 13/09/21
229			**Commence phase 2: NMS integration**	**276 days**	**Tue 14/09/21**	**Tue 15/11/22**

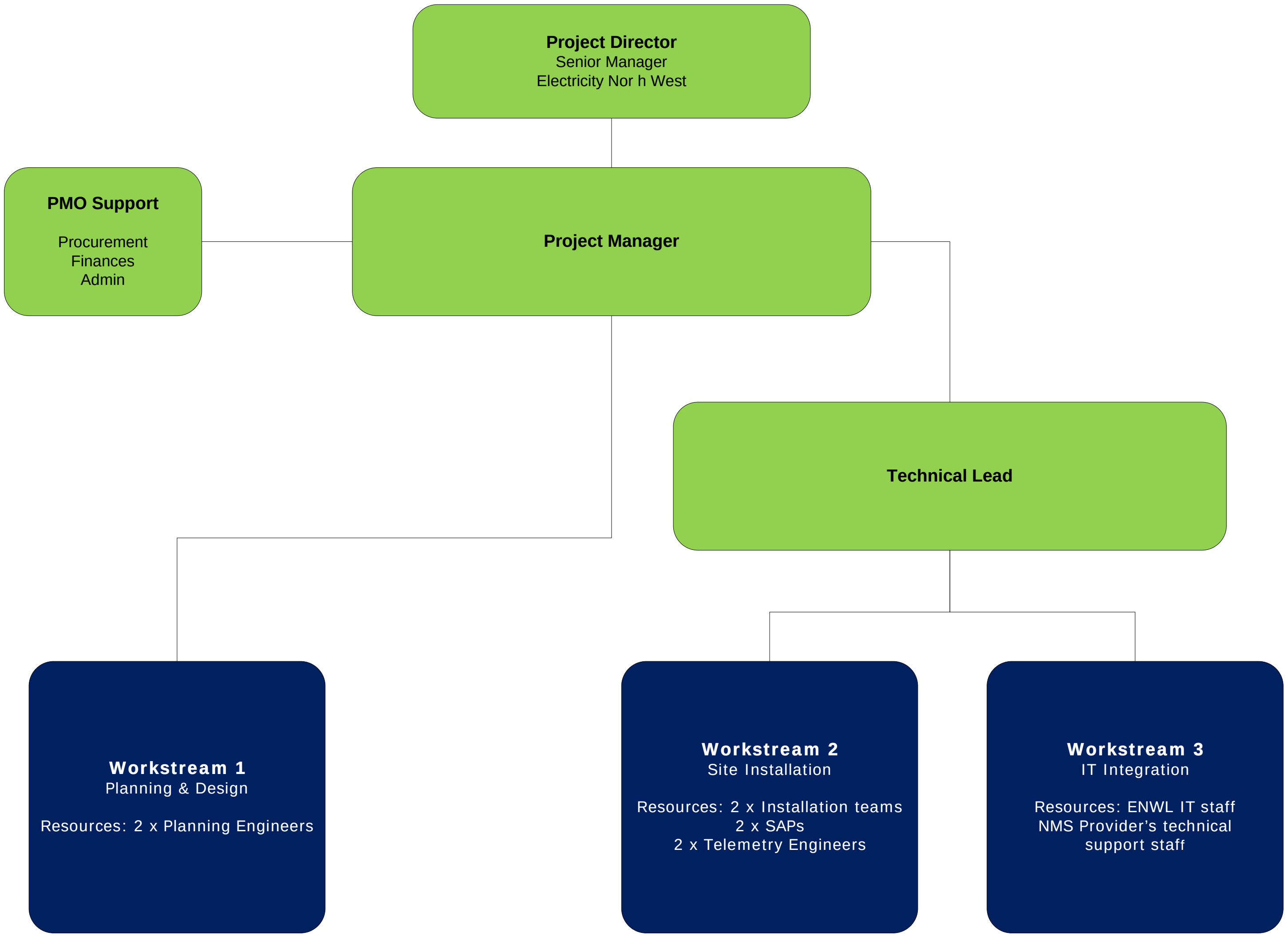


Project: Smart Street Rollout De
Date: Tue 09/04/19

Task	Inactive Summary	External Tasks
Split	Manual Task	External Milestone
Milestone	Duration-only	Deadline
Summary	Manual Summary Rollup	Progress
Project Summary	Manual Summary	Manual Progress
Inactive Task	Start-only	
Inactive Milestone	Finish-only	

Page 1

Appendix H: Project Organogram



Appendix I: Risks and Issues Register

Risk impact areas have been categorised into time, cost and scope/quality which are given a score of 1 to 5 along with the likelihood of occurrence. The resulting product of these two ratings is used to score and rank the risks on the project. The format of the Electricity North West Innovation Risk Scoring Matrix is below.

Risk impact descriptors

RISK AREA	1 Negligible	2 Minor	3 Moderate	4 Significant	5 Serious
Time	There will be no impact on deliverables. No re-planning necessary.	Any delays are likely to be small ie <1 week and manageable. Minor re-planning necessary.	Some delays likely to Project/ Programme milestones, but the overall Project/ Programme delivery date will not be affected. An element of re-planning will be necessary.	There is likely to be a delay which causes the overall Project/ Programme delivery end-date to slip. Significant re-planning will be essential.	There is likely to be a delay which causes the overall Project/ Programme delivery end-date to slip. Serious re-planning will be essential.
Cost	£0	<£10k	<£20k	<£50k	>£50k
Scope/ Quality	There will be no impact on the overall quality of the deliverables in the Project/Programme. All requirements will still be met.	There will be negligible impact (if any), on the overall quality of the deliverables in the Project/Programme. Most, if not all requirements will still be met.	Some requirements will not be met, or a small number of business process(es) will need to be modified to accommodate shortcomings in the delivery.	A significant number of requirements will not be met, or business process(es) will need to be modified to accommodate shortcomings in the delivery.	Major requirements, key to the success of the delivery are not likely to be delivered as planned.

Risk probability descriptors

5	Almost Certain	>80%
4	Likely	60-80%
3	Moderate	30-60%
2	Low	10–30%
1	Rare	<10%

Risk score

Impact						
	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
		Probability				

The following potential risks have been identified. These risks have been based on the scoring matrix set out above and linked to the project phase or workstream in which they will likely occur.

Project phase	Description	Probability score	Impact score	Mitigating action	Revised probability	Revised impact score
Mobilisation	ENWL is not able to mobilise their resources in time because of other commitments This may lead to a delay in achieving key milestones and deliverables	4	5	1. A comprehensive project plan with clearly defined timescales and milestones has been agreed 2. Liaison with internal teams to negotiate transfer of staff for project start 3. Use of existing framework contractors for installation	2	5
Site selection	Availability of sites restricted due to other work and network conditions	2	2	1. Co-ordination between project delivery team and other sections to ensure no crossover	1	2
Procurement	Unit cost more expensive than budget	4	5	1. Early engagement with suppliers pre-submission 2. Used current framework agreements	2	5
Procurement	Suppliers unable to meet project timescales	4	4	1. Clear timescales as part of tender 2. Possible split award of contract 3. Stagger deliveries in batches to match roll-out	2	4

Project phase	Description	Probability score	Impact score	Mitigating action	Revised probability	Revised impact score
Procurement	Agreement of terms and conditions may lead to a delay in delivery	3	4	1. Use of existing framework contracts where possible 2. Flexibility built into plan to allow for delays in contract negotiation	2	4
Procurement	Actual product delivery lead times may be greater than planned due to supply constraints	3	4	1. Flexibility built into plan to allow for delays in delivery	2	4
IT integration	The vendor does not achieve delivery and installation of the Optimisation software on time	3	4	1. Flexibility built into plan to allow for delays in configuration of the software 2. Use of existing supplier team responsible for delivery of ENWL's NMS	2	4
IT integration	Previously unseen software bugs impact system performance after go live	3	4	1. We will develop rigorous testing with all other NMS functionality to capture issues in test phase 2. Use of existing supplier team responsible for delivery of ENW's NMS	2	4

Project phase	Description	Probability score	Impact score	Mitigating action	Revised probability	Revised impact score
Site installation	Adequate communications may not be available at all sites	3	4	1. Assess during site selection 2. If necessary install larger separate aerials	2	4
Site installation	Benefits may not be realised	3	5	1. Sites appropriately selected as per learning from trials	2	5

Appendix J: Relevant Adjustment

Figure J.1: Proposed IRM adjustment

	2020/21	2021/22	2022/23	Total
Proposed adjustment to IRM values per annum (£m)	4.64 (5.55)	8.20 (9.80)	2.24 (2.68)	15.09 (18.03)

Figure J.1 sets out our proposed IRM adjustment in £m per annum across the RIIO-ED1 period. We have based these numbers on the approach of recovering IRM costs in the same regulatory year in which they occur.

Licence condition CRC 3D.13(g) requires the licensee to propose revisions to the IRM values that the licensee considers should be made to implement the Relevant Adjustment. This section fulfils that requirement.

Appendix K: Letters of Support

citizens advice Manchester

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www.citizensadvicemanchester.org.uk

Mr Paul Turner
Innovation Manager
Electricity North West
Technology House
Lissadel Street
Salford
M6 6AP

5 May 2019

Dear Mr Turner

Letter of support for Electricity North West Limited - Smart Street roll-out.

Citizens Advice Manchester is pleased to support Electricity North West's targeted deployment of new 'Smart Street' techniques across the North West, under the Innovation Roll-out Mechanism.

Through our engagement with the company, we have learned that Smart Street allows Electricity North West to operate its network more efficiently. We recognise this can avoid the cost and disruption of traditional solutions to upgrade electricity infrastructure, which will become a more pressing concern as we move towards a zero carbon economy.

Citizens Advice Manchester is delighted that the Greater Manchester region will benefit from these new techniques, which will help to improve the affordability and sustainability of energy.

We understand that Electricity North West's strategy places a strong focus on networks serving some of the poorest communities in this region. We will therefore assist in identifying areas where fuel poverty is prevalent, to help ensure that communities in greatest need are amongst the first to benefit from these new solutions.

We believe Electricity North West's bid demonstrates its commitment to ensuring that fuel poor households benefit from investment and are helped to access secure, affordable energy. Citizens Advice Manchester therefore supports this initiative on the basis of its potential to provide customers with energy savings, which can help to reduce the fuel poverty gap for some of the most vulnerable households in this region.

Yours sincerely

Andy Brown
Chief Executive
Citizens Advice Manchester

centre for sustainable energy

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We help people change the way they think and act on energy

Mr Paul Turner
Innovation Manager
Electricity North West
Technology House, Lissadel Street
Salford, M6 6AP

9 May 2019

Dear Paul

Letter of support for Electricity North West Limited - Smart Street roll-out.

The Centre for Sustainable Energy (CSE) is an independent national charity with a mission to share knowledge and practical experience to empower people to change the way they think and act about energy. CSE is working with Electricity North West to develop tools to support vulnerable customers and deliver improvements to its social programme.

We understand that Electricity North West's Smart Street trial proved that by controlling voltage, it can deliver customer benefits from reduced energy consumption and carbon emissions. This improves the affordability and sustainability of energy and helps to keep costs down for electricity consumers.

The areas that will be amongst the first to benefit from the roll-out include some of the most vulnerable communities in the North West, based on the mapping tools we have developed for you. This means that households in greatest need are at the forefront of investment decisions and are helped to access secure, affordable energy. We believe that this approach aligns with Electricity North West's customer vulnerability strategy and its commitment to support fuel poor households.

CSE is therefore delighted to support Electricity North West's bid, under the Innovation Roll-out Mechanism, for the deployment of Smart Street technologies; it demonstrates the company's commitment to invest in network solutions that support the transition to a low carbon economy and the threat of climate change while also ensuring the benefits are shared with more vulnerable households. We particularly endorse your approach of targeting some of the most vulnerable communities in the North West, a focus which has the potential to reduce the fuel poverty gap by improving energy affordability in those areas.

Yours sincerely

Simon Roberts OBE
Chief Executive

Direct line: 0117 934 1441
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GMCA GREATER MANCHESTER COMBINED AUTHORITY

Mr Paul Turner
Innovation Manager
Electricity North West
Technology House
Lissadel Street
Salford
M6 6AP

11 April 2019

Dear Mr Turner

Letter of support for Electricity North West Limited - Smart Street roll-out

Greater Manchester Combined Authority is delighted to support the targeted roll-out of Smart Street, across Greater Manchester and the wider North West region, under the Innovation Roll-out Mechanism (IRM).

The successful trial of the Smart Street voltage management techniques, funded under the Network Innovation Competition, demonstrated that by combining innovative technology with existing assets, Electricity North West can operate its electricity network more efficiently. This new approach to managing local networks can avoid the cost and disruption associated with traditional solutions to facilitate load growth and renewable generation. This method also has the benefit of improving the efficiency of customers' appliances, which helps them to save energy and money.

Energy efficiency is extremely important in reducing carbon emissions and Electricity North West has demonstrated its commitment to becoming one of the leading organisations helping Greater Manchester's pioneering ambition to reduce carbon to near-zero by 2038.

We are delighted that our region will benefit from the targeted roll-out of Smart Street and are confident that this initiative will play an important role in accelerating our carbon reduction targets.

The roll-out will ensure that customer and environmental benefits are maximised by allowing Electricity North West to manage local networks more efficiently and meet the challenges that will arise from electrification of transport and heat. This will help to improve the affordability and sustainability of the electricity network, encourage renewable generation and make it easier and quicker for customers in our region to adopt low carbon technologies.

GMCA GREATER MANCHESTER COMBINED AUTHORITY

We understand that this innovative approach is the first demonstration of a network operator deploying network management techniques, at this level, to deliver energy savings for consumers. The strategy also places a strong focus on network serving some of our poorest communities, which will ensure that households in greatest need are amongst the first to benefit from these new solutions.

Greater Manchester is leading the way in delivering radical new approaches to the decarbonisation of energy and we are pleased that the Smart Street roll-out aligns with our Smart Energy Plan. We believe this initiative will provide the stimulus that can enable the deployment of these techniques, at scale, by distribution network operators across Great Britain.

In our view, Electricity North West's focus supports Greater Manchester's path to carbon neutrality and demonstrates its strong social and moral commitment to ensuring that fuel poor households benefit from its investments and can access secure, affordable energy.

We therefore commend Electricity North West's roll-out of Smart Street in Greater Manchester and believe that this approach can help us transform our local communities and lead us towards a greener and carbon neutral city region. We support the IRM bid which has the potential to reduce the fuel poverty gap for some of our most vulnerable households and could deliver direct benefits to individuals, local communities and our regional economy.

Yours sincerely

Mark Atherton (Asst. Director Environment)
For and on behalf of Cllr Alex Ganotis, GM Green City Region Portfolio Leader