Losses Discretionary Award Tranche 2 submission

28 February 2018

Steve Cox
Engineering & Technical Director
steve.cox@enwl.co.uk
07710 069573

1 Progress since Tranche 1

Introduction

The aim of the Losses Discretionary Reward (LDR) scheme since it was introduced has been to incentivise GB distribution network operators (DNOs) to better understand and manage electricity losses. Reducing losses is a continuing key part of Electricity North West's overall business strategy and we are pleased to present this submission to Ofgem for Tranche 2 of the LDR.

As we detailed in our Tranche 1 submission, our approach to reducing losses and delivering value to customers in an affordable manner, is based on a five-point action plan. This plan, which covers both technical and non-technical losses and identifies our initiatives, is the basis for an evolution in our approach to reducing losses. A summary of the plan is set out below:

Figure 1: Our five point action plan

These actions are part of our ongoing commitments to reducing losses and will deliver sustained benefits for our customers over time. Since our Tranche 1 submission, as a direct result of the additional initiatives set out in this document, we have delivered a set of measures which has materially improved our ability to identify and mitigate losses. As well as specific initiatives aimed at addressing losses, we have a renewed focus on losses under business as usual (BAU) activities, considering and quantifying losses within our normal decision-making processes.

Below is a high level review of developments since Tranche 1 which will be explained in more detail in our submission.

Action 1: Where to look

In line with our Tranche 1 submission, we have delivered on our commitment to invest in and develop our existing future capacity headroom (FCH) model. This has enabled us to better identify locations on our HV and LV (secondary) network that have high technical losses.

Looking to the future, we have considered various options as to how the visibility of losses issues can be improved and have now commissioned work to develop a successor to the FCH model that will interface with our new network management system (NMS).

The new FCH model is in the scoping phase, considering key inputs and requirements. Losses management and optimisation will be a core output requirement from the new

NMS, as will the interface between it and the new FCH model, to build a more accurate future projection of losses from 132kV down to our LV network.

We have used the existing FCH model to identify high loss transformers and LV feeders on our secondary network, and identified an initial 18 schemes which have been included in our investment programme for FY18/19. There is a further pipeline of schemes which are under evaluation and will be included in our investment programme when approved.

Action 2: Interventions

Having used the FCH model to identify high loss areas of our secondary network, we have assessed a range of smart solutions and traditional reinforcement methods to identify interventions that can be delivered in addition to the commitments made within our well justified business plan. We have identified an initial group of 18 new schemes with a combined value of over £300,000 that we will implement in FY 18/19. We have drawn upon existing projects and initiatives to ensure that our interventions take account of the full range of options available for tackling losses, from conventional fixes to new and innovative approaches.

Our innovation projects continue to have losses as a key consideration; in particular our NIC project Celsius, which is aimed at releasing capacity through cooling techniques, will also demonstrate a material impact on losses through the work carried out on asset temperature reduction.

We have also taken an enhanced losses approach to our BAU investment programme, carrying out new analysis on where high loss assets coincide with a range of other factors to build a case for delivering early replacement or reinforcement of assets that would not previously have been considered under BAU.

This new multi-vector approach combines investment drivers from across our outputs plan to allow investments to be made that could not be justified on the basis of any single driver or output. For example, early asset replacement may be justified on transformers when losses are included in the decision-making process.

Action 3: Real options decision-making

We have improved our investment decision-making and planning process, based on an enhanced real options cost-benefit analysis tool. In our Tranche 1 submission, we committed to the use of the real options CBA (ROCBA) model in our business as usual decision-making for all investments, including losses. The model uses a real options economic modelling approach to represent future demand and generation uncertainty.

Use of the ROCBA model in decision-making for grid and primary demand projects was transferred to BAU in 2017. The ROCBA model has been updated to include the latest base data and longer forecast scenarios, and we have delivered further developments to extend the scope of losses analysis. This means it can calculate the impact on losses across the range of potential interventions where historically we have only considered one traditional intervention.

Each of the additional losses-related reinforcement interventions identified by the FCH model has been run through our ROCBA model to quantify the losses effect of each intervention and highlighted those which give the best positive CBA for each intervention. We have used the value of losses which is used within the Ofgem CBA and this has given us a set of schemes which use traditional network reinforcement and smart methods to mitigate losses.

The annual losses benefit delivered by these schemes has an estimated losses benefit of between 62MWh and 169MWh[1]. We have also built a future pipeline of losses-related schemes using the ROCBA model including transformer replacements and cable overlays.

Action 4: Incentive mechanisms

We have taken forward the work carried out under the Smart Grid Forum (SGF) and the Technical Losses Task Force (TLTF) to inform a set of potential approaches and develop a set of proposed losses mechanisms that would appropriately incentivise all DNOs to reduce losses on a whole system basis.

The TLTF has delivered a significant amount of new learning in the identification of losses and the change in source of losses caused by the transition to low carbon technologies (LCTs). As this phase of work concludes and produces final results, the group has delivered findings from this work to Ofgem and is set to publicise the results of the research in early 2018. Electricity North West has delivered on its Tranche 1 commitment and tabled a set of proposed losses mechanisms, using this learning, at the TLTF working group.

The TLTF has agreed a schedule of work around a set of revised incentive mechanisms and work will continue in 2018 to refine and develop this set of options, giving Ofgem a view of how such an incentive could work in the future.

Action 5: Non-technical losses

We have continued with and built upon our industry-leading initiatives to identify and address non-technical electricity losses, through our revenue protection team. We have delivered on our commitment in Tranche 1 to recruit additional resource to the team and pioneered a multi-agency approach to identifying and tackling electricity theft, engaging with a wider group of industry stakeholders to further raise the profile of non-technical losses. We have delivered new processes in our revenue protection team to better achieve the requirements of the National Revenue Protection Code of Practice and our policies have been updated to reflect this best practice approach. In 2016/17 we identified 150 cases of theft in conveyance with an associated estimated lost kWh value of £323,000 per annum, or over 2.6 GWh of avoided losses[2]. We have also identified a range of additional potential sources of non-technical losses and means of pursuing these are under development.

This submission demonstrates how, through our strategy and the initiatives it contains, we are continuing to shift the expectations of what we are capable of in terms of understanding and managing losses. A summary of our position at Tranche 1 submission, where we are now and what we plan to achieve in the future is shown in Figure 2 below.

---

1 Losses range across five demand growth scenarios up to 2050.

[2] Assuming an average unit rate of 12p/kWh

Figure 2: Our plan

	Previous	Now	Future
1. Where to look	FCH model for initial programme of capacity-related projects	Enhanced FCH model delivered for programme of capacity and losses-related projects	New FCH model to interface with new NMS to provide accurate losses projections
2. Interventions	Set of traditional solutions	Delivered a set of traditional and limited smart solutions	Set of traditional and full suite of smart solutions including DSR, flexible capacity, managed connections
3. Real options decision-making	Use Ofgem CBA to evaluate options	Rolled out real options CBA in BAU (incorporating losses)	Real options CBA models to include secondary networks (incorporating losses)
4. Incentive mechanisms	Help to develop incentive mechanisms	Drafted a proposed incentive mechanism for refinement and wider DNO input	Incentive mechanisms adopted for RIIO-ED2
5. Non-technical losses	Initiatives to identify and address non-technical electricity losses	Delivered additional resource, improved processes and found and rectified 150 cases of non-technical loss	New approaches for identifying losses, best-practice activity and innovation

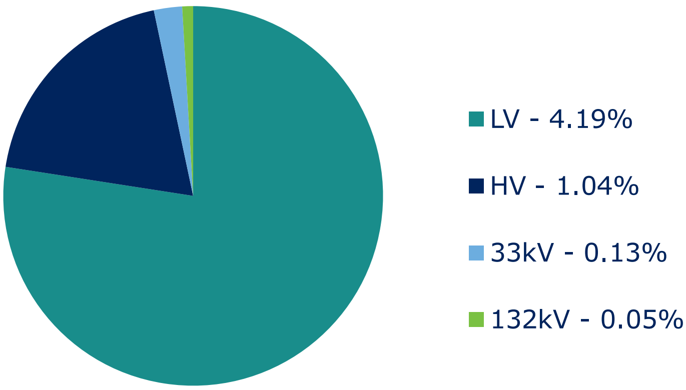
Understanding of losses

Understanding the level and source of losses is essential to reducing network losses. In this section, we will demonstrate the steps we have taken and the measures that we have delivered to improve understanding of losses on our network as the first part of our plan.

1.1 Where to look

In our Losses Strategy document we acknowledged that establishing a reliable baseline position for the accurate measurement of network losses is difficult without a much richer understanding of the load flows across our network. This is particularly true at the secondary network level, where most losses occur (see figure 3), and about which we have the least understanding.

Figure 3: Distribution network losses by voltage (5.41% total losses)



Our Losses Strategy, released in 2015 set out how we expected our understanding to be significantly enhanced by smart meter data and by the next generation of system modelling tools in development. It also details our concerns over the realisation of these benefits because of delays in the smart meter rollout programme.

To counteract this delay and ensure customers benefit from losses reduction initiatives, we have significantly improved our system modelling capability since our Tranche 1 submission and continue to do so, scoping our new network management system to take system losses into account and interface with our load forecasting tools.

In Tranche 1 we expected that we would be able to use smart meter data as a key tool to inform losses measurement and mitigation. As the smart meter rollout is still in progress, and given that there is currently no access to smart meter data for DNOs, we are yet to realise these benefits. This being the case, we are using the data that we have available and our projections of losses are based upon the best available state estimation techniques verified by field measurements. In addition, we are continuing to deploy substation monitoring where cost effective within our LV network, including gaining additional data from fault management devices on LV feeders.

Following our Tranche 1 submission, we have continued to develop our future capacity headroom (FCH) model (see Appendix A) to help us better understand the actual losses on our secondary network. Since Tranche 1 we have developed the FCH model to be used to estimate current and future maximum demand on each key element of our secondary network and it has been rolled into our business as usual (BAU) network investment decision-making as per our commitment in Tranche 1.

As we move to our new NMS system in 2019 we have begun scoping a purpose designed successor to the FCH model which includes the measurement of losses. Our new NMS system is now in the implementation phase and will give us full visibility of current losses from 132kV down to the 2.4 million meter points on our LV network. The new FCH model will incorporate further up-to-date asset data from our new NMS, and when available, smart meter data. This will enable the model to further refine our visibility of where losses on our network are likely to be highest in the future.

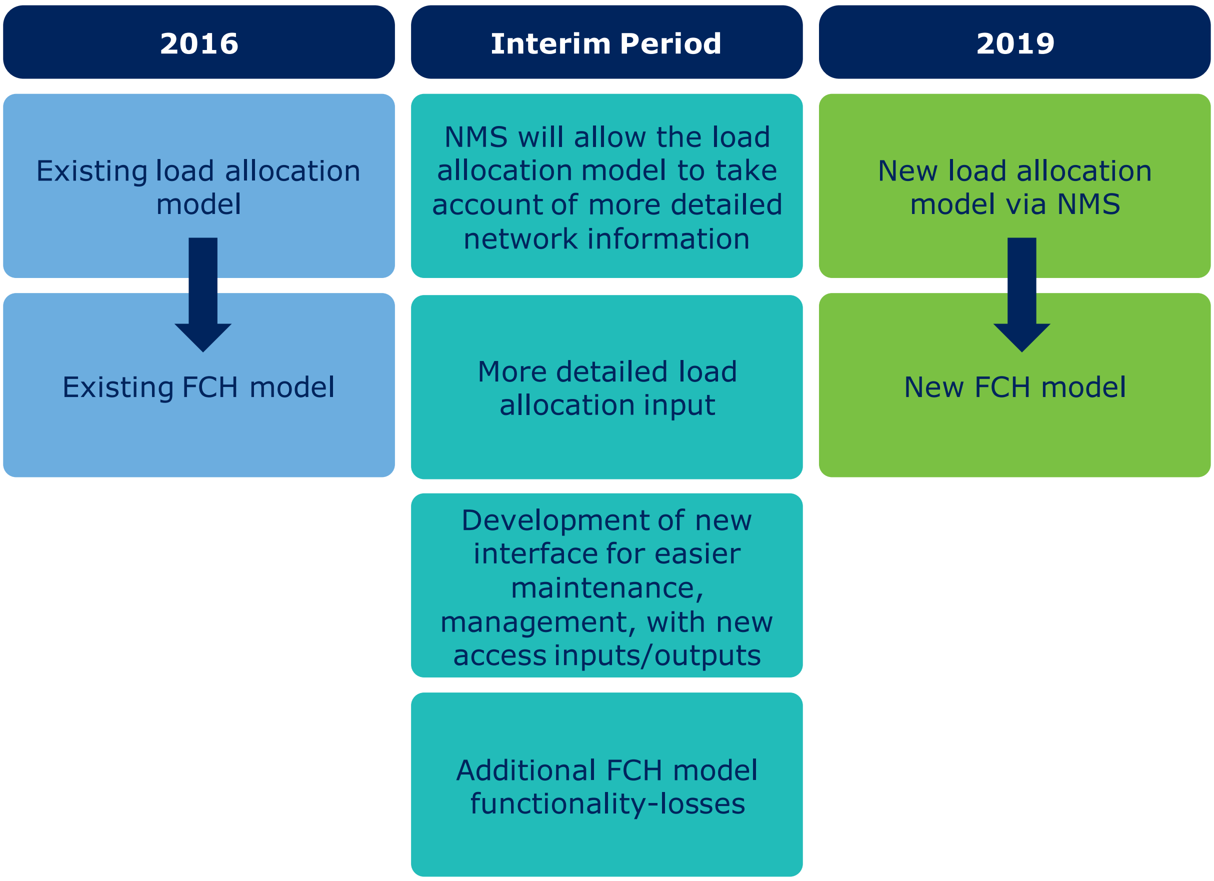
1.2 Development of the FCH model

The existing FCH model has given us a unique foundation and level of understanding, enabling us to deliver seven capital projects in 2017 with a combined losses benefit of 133.8 MWh per annum. When coupled with our new NMS system, the usability of FCH will increase, informing further losses interventions and maintaining our position at the forefront of DNO understanding and management of technical losses.

A core feature in the specification of our new NMS is our £4 million investment in the cleansing of existing network connectivity models and the provision of a load allocation methodology and software to enable us to identify and measure losses in our secondary networks. We are currently conducting monthly working groups with Schneider, the supplier of our new NMS system, to ensure that this functionality is delivered as early as possible in the project.

These new connectivity and load allocation models will be incorporated into the FCH model by the end of 2019 and these will dramatically improve our approach going forward. How quickly smart meter data will become available is still uncertain, but we have invested to ensure we are able to use the data as soon as it is available. Our FCH model in its existing iteration will continue to be usable in the interim, enabling us to continue to deliver benefits for customers.

Figure 4: Development of the FCH model



The FCH model enables us to identify parts of our network which exhibit (comparatively) high losses. This allows us to include an assessment of losses into proposed solutions to load related expenditure and non-load related expenditure. The FCH model is currently used to identify overloaded assets and helps us to define a secondary network investment programme.

1.3 An holistic approach – understanding how losses on our network affect others

It is important that our decision-making considers a holistic approach to losses, taking account of how our initiatives can affect others.

There are a number of approaches that can be taken on secondary and distribution networks which mitigate losses locally but can cause other unintended results for customers or elsewhere on the network.

We have taken a whole system view to our approach to losses, weighing losses reduction against other competing factors such as power quality, fault level, security of supply and asset lifespan. The uptake in LCTs and DERs (distributed energy resources) means that the load flows within our network are increasingly complex. Tools such as the FCH enable us to manage and analyse this complexity and we are committed to delivering a whole system approach to losses management, representing the needs of our customers, the TSO and wider stakeholders in our decision-making

We have continued to engage with the ENA Technical Losses Working group and have contributed to the recently published report from WSP, which was commissioned to examine the Impact of the Low Carbon Transition on Technical Losses. In 2018 we have committed to further work within the group to deliver improved understanding of losses while continuing to make more use of our existing network assets, managing the interaction between the connection of more LCTs, increase levels of demand side response (DSR), connection of more DERs and how these factors combine to effect losses. The research carried out by WSP, the findings of which have been delivered to Ofgem, will be collated into a report which will be published this year.

The report finds that while it is clear that the uptake of LCTs can significantly impact losses, it is difficult to quantify to what degree, as customer behaviour is a key driver behind this uptake and the speed of uptake is difficult to accurately forecast.

Since our Tranche 1 submission we have demonstrated closer cooperation on losses between ourselves as a DNO and other market stakeholders. Our role as a DSO will require us to continue to collaborate closely with stakeholders, matching the technical capabilities of the network, including losses, to the changing needs of our customers using new service indicators.

Once a capacity need is identified our role will be to liaise with the relevant stakeholders and provide the additional capacity needed in good time in the most efficient manner. This will be via a variety of means including requiring new assets to be created, deploying efficient smart grid technologies or using commercial contracts with customers to release capacity. Some of these approaches, although they will release capacity in our network, have the potential to increase losses so we will always consider the value of losses in our decision-making.

We are continuing to work with other stakeholders, including Ofgem, to identify and mitigate (or remove) any counter intuitive incentives associated with a narrow, business-specific approach to the optimisation of losses. For example, as part of our ongoing discussions with National Grid we are considering the impact on losses for both parties and, more generally, how developments in the operation of the energy market might affect commercial interactions.

1.4 Non-technical losses

Since our Losses Strategy document and Tranche 1 submission we have delivered a number of industry-leading initiatives which are helping to identify and address non-technical electricity losses. While many of the DNOs have adopted a 'wait and see' approach to the reduction of non-technical losses, we have continued to work in collaboration with Ofgem, the energy suppliers, the police and local authorities to tackle electricity theft and the under-declaration of metered supplies.

We have developed relationships with a wider group of stakeholders, including UK immigration, HMRC, local licensing and environmental health departments to assist our approach. This broad multi-agency approach to the problem of theft and under declaration has enabled us to identify more potential cases of non-technical losses than ever before, gain access to a greater number of suspected premises and identify the highest number of cases of non-payment ever in our region. In 2016/17 we identified 150 cases of theft in conveyance with an associated estimated lost kWh value of £323,000, or over 2.6 GWh of avoided losses[3].

For example, in partnership with the police and environment agency, we have deployed specialist field teams to inspect suspected cases of electricity theft in restaurants and fast food outlets, alongside police investigators and food hygiene investigations. This partnered approach allows us access to the suspected premises quickly and without challenge. This approach has led to a number of successful discoveries of non-technical losses and also uncovered wider crimes such as licensing infringements, drug production and people trafficking.

We have identified the following additional potential areas of losses investigation and have added these to our BAU processes:

Supplies with no MPAN

Using our internal SCADA data overlaid against GIS data, we are able to generate a report identifying supply seeds with no associated MPAN or address. This means that there could be an illegal connection at this point with no meter installed, or illegal abstraction of some other kind. We have trialled further investigation and found an 8% conversion rate for cases of theft in conveyance. In March 2017 we had identified 200 instances requiring investigation in this area. Early estimations based upon projected conversion rates and units lost suggest that this approach would save the equivalent of 105MWh of losses per year[4] in our region.

Connections quotes requested and not taken up

Our energy solutions team identified that of almost 7,000 domestic new connection quotations issued, 40% of quotes are never taken up. A common theme is found in theft in conveyance cases where quotes have been requested and never taken up because the customer has turned to an unaccredited provider to provide the connection.

As quotes are valid for 180 days, investigations undertaken are typically for quotes six months and older. As these quotes have never previously been investigated, there is potential to investigate several years' worth of unaccepted quotes. We have identified a further 2,000 potential investigations, which based upon average case values could represent an additional potential £1.5m of non-technical losses per annum.

Unregistered MPANs

In March 2017, from an investigation of our internal systems, we identified around 2,500 unregistered MPANs, 600 of which were marked as overdue for registration. We have identified potential for theft in conveyance cases to be sourced in this area, although we

[3] Assuming an average unit rate of 12p/kWh
[4] Based upon an 8% conversion rate, an average theft case kWh value of £787 and an average unit rate of 12p/kWh.

have no specific statistics available on potential conversion rates. We intend to pursue this area further to identify potential scope.

2 Effective engagement and sharing of best practice with stakeholders on losses

2.1 How we have engaged with stakeholders to develop relevant partnerships which may help to manage losses (eg DSR)

Our approach has been to ensure that we are engaging with the right stakeholders, in the right way, at the right time, on the right issues. Losses touch many different areas of a DNOs responsibility and that of our wider stakeholders, and we have raised the issue of losses at a range of different forums to ensure that losses are always considered alongside other issues such as constraint management and management of assets.

As we set out in our 2015 Losses Strategy, we provide opportunities for engagement of interested parties in our approach to addressing electricity losses and extend an open invitation to work in partnership with any stakeholder. This approach has led to successful engagement with a wide range of organisations as shown in Figure 5 below.

Figure 5: Stakeholders

<table>
<tr><th>Technical</th><th>Non-technical</th></tr>
<tr><td colspan="2">Ofgem, DECC, Environment Agency, Other DNOs</td></tr>
<tr><td colspan="2">ENWL internal staff, desk and field based</td></tr>
<tr><td colspan="2">Energy Suppliers</td></tr>
<tr><td colspan="2">Independent Connection Providers</td></tr>
<tr><td>National Grid</td><td>Police, Fire and rescue services</td></tr>
<tr><td>Supply chain partners including manufacturers and contractors</td><td>Home Office, UK Border Control</td></tr>
<tr><td>Academic partners</td><td>Housing associations, private landlords and letting agencies</td></tr>
<tr><td>The Smart Data Communications Company</td><td>United Kingdom Revenue Protection Association (UKRPA)</td></tr>
<tr><td>Industry working groups</td><td>Environment Agency</td></tr>
</table>

We have set the terms of reference and clearly conveyed the aims and objectives of our stakeholder engagement to detail to interested parties what we are hoping to achieve. This has driven engagement and ensured our approaches remain inclusive when considering relevant partnerships.

What is clear from our engagement is that our stakeholders support further investment in losses reduction where beneficial and hence the expansion of our investment plans through both direct losses reduction investments and multi-vector as outlined above.

We have adopted a consultative approach to engagement, feeding back input from our stakeholders into our processes. For example, learning from and partnering with organisations such as HMRC and the Environmental Health departments, we have refined our internal processes and been able to deal with more theft cases in 2017 than ever before.

In the last year our revenue protection team has presented at over 15 different internal and external forums, delivering training on how to identify illegal connections, processes to follow when a suspected case is identified, the channels for referral of theft cases and the important safety aspects associated with electricity theft. These presentations were made to a diverse range of stakeholders including the fire service, environmental health officers, customs officers, our own desk and field based colleagues and the UK Revenue Protection Agency.

2.2 The processes we have in place to share our own best practice with relevant stakeholders

Our approach to effective engagement and sharing of best practice recognises specific audiences and stakeholder groups and draws upon experience gained through delivery of successful innovation projects. Below are the stakeholders with whom we have had interactions with since our Tranche 1 submission on the effective and efficient management of losses.

- **Customers**: our customers are a crucial part of our agenda as customer behaviour can directly impact the level of losses incurred on our network. There are a number of customer groups with whom we engage, ranging from domestic households to large industrial and commercial customers. Our involvement at the Distributed Energy Resource (DER) forum has informed our learning on losses, by developing our understanding of what consumers and generators expect from the service we provide.

- **Energy industry participants**: our industry stakeholders, including generators, network operators (ie DNOs, IDNOs, and TOs etc.) retail suppliers, aggregators, technology vendors, equipment manufacturers, NETSO and the balancing settlement organisations all have a part to play in informing our approach to losses. The six GB DNOs have agreed to optimise losses stakeholder engagement in 2018 and 2019 through alignment of local communications and industry-wide event collaboration.

  This has the potential to enhance knowledge share and facilitate future collaboration while improving the experience for our stakeholders. Additionally, to aid development of future losses projects and transfer to BAU, a workshop for the subject matter experts in each network organisation has been agreed in principal and is expected to be organised via the ENA Technical Losses Task Group in 2018.

- **Industry groups**: The main industry group audience includes the Energy Networks Association, the Smart Energy Demand Coalition, Energy UK and industry groups such as Smart Grid GB. These groups have a key role in the dissemination of best practice and Electricity North West leads many of the technical, regulatory and commercial sub groups. We continue to lead the Distribution Code Panel and represent all UK DNOs on the Grid Code panel.

- **Government and regulator**: BEIS, Ofgem and other policy makers have a key interest in the outcomes of the initiatives, particularly where these have the potential to advance industry best practice for managing and reducing losses. We have presented to Ofgem on the findings of the research commissioned by the TLTF, and will be continuing to work with Ofgem on scoping out a future losses incentive mechanism.

We will tailor our dissemination to best match the interest and structure of each of the stakeholders identified above. Our approach will be pragmatic, simple and targeted, and will use a number of different dissemination approaches to enable stakeholders to maximise their learning through their preferred communication and learning style.

In addition to the above, we have delivered a dedicated area on our website specifically to address losses and providing information and links to our Losses Strategy and Tranche 1 losses submission.

All of the stakeholder engagement actions outlined have a specific focus on losses and are not included in any previous submissions under the Stakeholder Engagement Incentive.

3 Processes to manage losses

3.1 Monitoring and smart meter data

Our Well Justified Business Plan (WJBP) and Tranche 1 submission laid out how we will use smart meter data to refine our understanding of technical and non-technical losses on our network and how this will deliver further benefits to our customers.

We continue to have dedicated resources engaged with the relevant stakeholders in the smart meter rollout, working to ensure that DNOs are able to realise the benefits of smart meters as soon as possible. In December 2017, after undergoing rigorous independent security assessments of our systems, policies and processes to ensure we are compliant with the Smart Energy Code, all stages of the User Entry Process were completed, and we delivered on our commitment to become a live Data Communications Company user. This means that we have invested in the relevant hardware and software infrastructure to begin to start receiving and securely storing data from the latest smart meters installed in our customers' properties.

The ability of smart meters to feed meaningful data back to DNOs has proven to be a major barrier to realisation of the benefits of smart meters. We are working closely with the DCC to establish if a SMETS[5] 1 meter can communicate usage data at the granularity needed to enable us to calculate system losses. We have also engaged with the relevant stakeholders including the DCC to ensure that enhanced functionality is included in the new SMETS 2 meter specification and any associated data privacy issues are overcome.

There is currently only one SMETS 2 specification meter installed within our region and this meter is undergoing testing due to communications problems. Our latest projection based upon current deployment rates suggests that there will be a 43% deployment of smart meters within our region by 2020 across both SMETS 1 and 2 specifications. Considering the above we believe that the smart meter benefits we planned may be deferred or reduced in value, and we have focused our attention on other areas until further progress is made.

The inclusion of losses analysis and optimisation functions in our new NMS is testament to our material preparations and planning for intelligent monitoring and control systems on our distribution networks in order to measure and manage losses. We recognise that without such systems the accurate measurement and mitigation of losses on the distribution system will continue to be difficult.

[5] Smart Metering Equipment Technical Specification

3.2 Incentive mechanism and recognition of losses

Electricity North West has continued to investigate how a revised losses incentive mechanism may be structured in the future. We have written and tabled a detailed paper with our proposed approach to a losses incentive at the Technical Losses Task Force. This work builds on our earlier work under work stream six of the Smart Grid Forum and it has been agreed that this will be used as the main focus of the group's future incentive development work.

Collaboration between DNOs is a key issue and one that has been discussed at length at various events including WPD's Losses Strategy Consultation Event in 2017. It is accepted that sharing knowledge and best practice was intuitively the right approach, so that we can build upon the experiences of others to accelerate progress to minimising losses. There is continued collaboration between DNOs both in the relevant working groups and through dissemination events, but this dissemination can be improved in the future to realise greater benefits. We have held similar discussions with SSE and have a number of collaborative events with other DNOs scheduled for 2018, where best practice on losses will be shared.

In addition to this collaboration, we have championed the review of the national network planning standard, Engineering Recommendation P2. We have collaborated closely with the stakeholder working group on this major licence condition to allow the inclusion of losses and the innovative network technologies developed under the LCN Fund at the centre of this review.

The revised version of P2 was approved by the stakeholder working group in December 2017, the Distribution Code Review Panel on 4 January 2018 and will be submitted to Ofgem for formal approval by the end of February 2018. The changes put forward mark a major industry shift, recognising the needs of the network of the future, allowing distributed energy resources such as storage, distributed generation and demand side response to be used to mitigate losses and meet capacity requirements as alternatives to circuits and transformers.

In our Tranche 1 submission we identified a number of methodologies that will be possible to enhance the management of losses by using the capability of smart meters to record half-hourly consumption data. These approaches include:

- **Gross volume assessment**: This is a simple count of the total number of units of energy delivered into the distribution network from NG interfaces, interconnectors and embedded generators minus metered outflows to customers. Smart meters will give a more accurate measure of where energy is leaving the system. SMETS 1 specified meters potentially could provide the data to carry out this methodology.

- **Bottom out model**: In this methodology the metered flows out of any given part of the network are known via smart meters (and other sources as detailed above) and hence the quantum of technical losses arising from these flows can be derived using a load flow model of the relevant network.

- **Load allocation model**: In this methodology all known energy flows are used to allocate load within a total network model (or indeed a subset of such a model eg by GSP). This is similar to the 'bottom out model' being driven by smart meter data; however unmetered power abstraction points are represented by assumed energy flows.

- **Representative network model**: An alternate approach is to use smart meter data to determine a representative load distribution curve for each feeder type and the associated peak demand. Smart meter data can be used as the basis for a detailed analysis of the power flows on each feeder type and all feeders can have a type allocation.

We still believe the above methodologies for the identification and measurement of losses are valid, will be usable when the teething problems of the smart meter rollout are overcome, and even more so when the SMETS2 smart meter specification is finalised and rolled out at scale. We are committed to continued thought leadership associated with the use of smart meter data to reduce losses for our customers.

4 Innovative approaches to losses management

We have placed an ongoing focus on finding novel solutions to losses reduction, building on our Losses Strategy and Tranche 1 submission. As well as employing conventional approaches, we have drawn upon the experience of our own innovation projects and those carried out by other DNOs to ensure that we capture the full range of options available to minimise losses.

In this section we present our innovative approaches to losses management with direct reference to our plan.

4.1 Interventions

We have focused our efforts since Tranche 1 to identify areas where we can make a positive case for implementing schemes for a losses benefit. Following analysis carried out using the FCH model, we identified a list of assets which were approaching or over their rated capacity. We then shortlisted further based on asset age and transformer type to single out those which will deliver the greatest losses benefit.

From that list, we identified 18 potential schemes with a scheme value of £342,000. We carried out analysis to identify 18 transformers rated between 500 and 750 kVA manufactured between 1949 and 1966 that show MDI percentages between 104 and 141% using our load forecasting models. We have then drawn up schemes for replacement of these assets, with the proposed solutions representing an associated losses benefit of 133.8 MWh per annum. These schemes will be implemented in FY18/19 and represent the first phase of our losses-related intervention. We expect to continue this implementation and will look to ramp up deployment volumes over the remainder of RIIO-ED1.

Our continued work in improving the FCH model has significantly advanced our ability to understand the source and magnitude of electrical losses on our secondary network which has provided focus for our losses management activities. The FCH model has enabled us to look beyond our normal asset replacement criteria to consider losses as a factor upon which to make asset replacement decisions. As such we have identified a set of overloaded assets that fit within a set of criteria to build a case for asset replacement. These assets will be put forward to further checks and selected schemes will be put forward into our asset replacement schedule in FY 2018/19.

Through the development of the FCH model, we are building an improved understanding of the source and magnitude of electrical losses on our secondary network which is providing focus for our losses management activities. We will continue to review and analyse projects funded through the innovation mechanisms, and more widely across the industry and internationally. This will help us to identify proven techniques to create a toolkit of solutions, including traditional solutions that can be applied to reduce losses in a range of scenarios.

For example, Celsius, our 2016 Network Innovation Competition funded project, is exploring the use of low cost cooling techniques to release capacity in constrained secondary transformers, but this technique, if proven, could equally be deployed to mitigate losses where a positive CBA of such an approach could be built.

We continue to take a holistic whole system view of losses, considering losses alongside our obligations to our customers for value for money, security of supply, making efficient use of our assets and facilitating the DSO transition. With this in mind, our new NMS is being designed with in-built functionality to optimise our network across these competing factors to ensure that we deliver the optimum level of service while mitigating losses as far as possible.

4.2 Real options CBA

When exploring any initiative with the aim of losses reduction, we must ensure that the intervention will deliver real value for customers over a range of potential future scenarios. In developing our thinking on losses we identified that the Ofgem CBA model does not adequately test how the value of a given investment may vary dependent on which of the various future demand and distributed generation scenarios occur. Therefore in our Tranche 1 submission we introduced our real options CBA model as a decision-making tool.

The primary advantage of this tool is that it encompasses the risk associated with uncertainty in future load growth forecasts within the financial analysis. Other models assume a given load scenario and are not able therefore to appropriately ensure that customers are not exposed to inefficient costs, or conversely, do not benefit from investments that could be made.

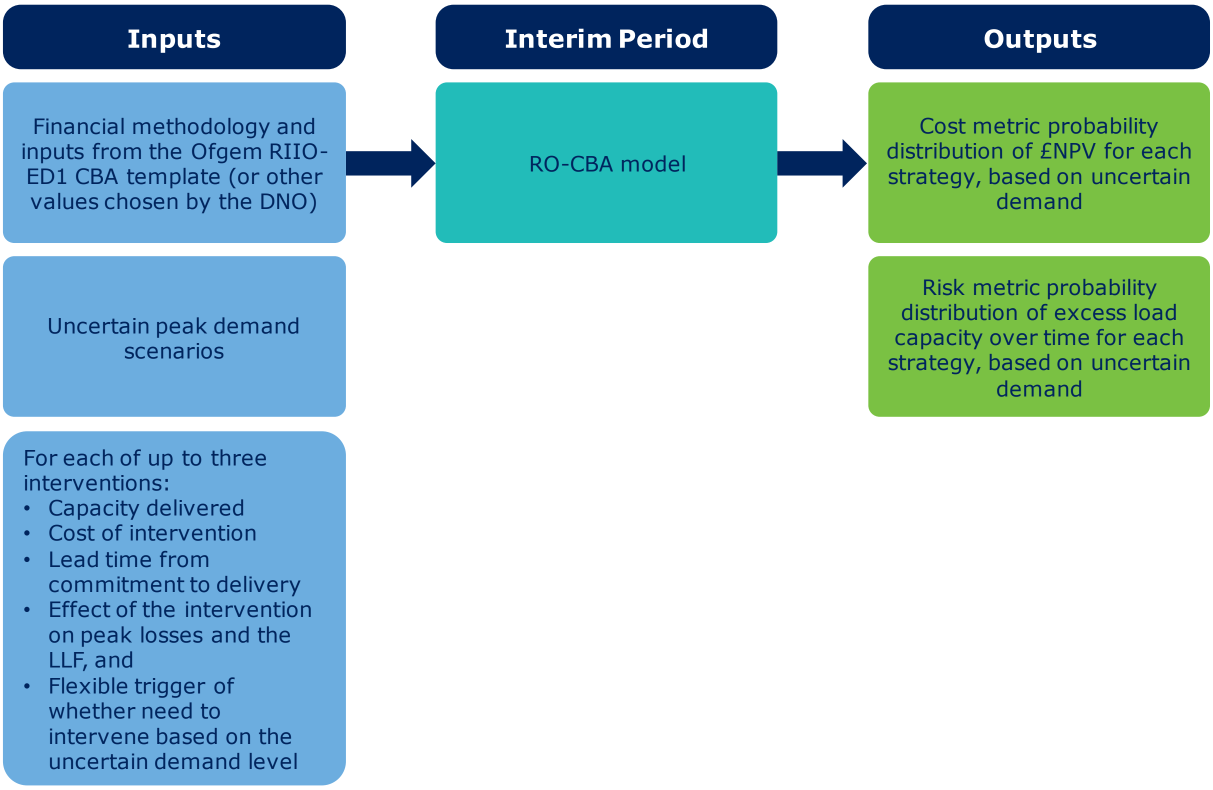
The first iterations of the ROCBA were created under a joint project with the University of Manchester. In the last two years the ROCBA has undergone significant development to be made suitable for use under business as usual.

The ROCBA model is an internally developed CBA tool which provides cost and risk metrics to allow comparison of different intervention strategies, to provide information to support decisions on how to most efficiently develop our network. For example, options considered may be small or large traditional reinforcement, or with or without post-fault demand side response; this may include enacting a managed or flexible network connection as explored in our Capacity to Customers (C2C) trial.

Crucially, the analysis uses our own load scenarios and so reflects uncertainty in demand. This is opposed to Ofgem’s own CBA template which assumes that the exact time and scale of future intervention costs are known. The value of losses used by the ROCBA is the same as the Ofgem CBA.

The ROCBA was built based on producing probability-weighted demand forecasts for various future energy scenarios and local economic activity forecasts as inputs to the options model. A summary of the approach is presented in Figure 7 below.

Figure 7: Real options cost benefit analysis



The investment options have been considered across five future demand growth scenarios which therefore present a range of possible lifetime losses dependent on the local prevailing demand growth conditions. In the work completed to date the losses modelling has primarily been utilised to appraise the lifetime cost efficiency of replacing existing transformers with their nearest modern equivalent units (which could result in a reduction in firm capacity if smaller units are specified) or by increasing the size of the transformers and hence reducing lifetime losses. It should be noted that in a number of the projects listed below, DSR solutions (if available) were considered in combination with reducing the transformer size. In the asset replacement projects we implemented the recommendation of the ROCBA tool was to install larger 11.5/23MVA units instead of 7.5/15MVA units – a recommendation which was supported by the reduction in lifetime losses.

We first used the ROCBA to inform BAU decision-making in February 2016, to inform purchase of DSR at one of our primary substations, with losses analysis included in the decision-making process. Use of the ROCBA model in optioneering for grid and primary demand projects was briefed to the business and transferred to BAU in September 2017, so we are now in the beta phase of that BAU deployment. Since the ROCBA was included in our BAU process we have delivered five transformer upgrades on our network, using losses as a direct driver in our decision-making. The total combined losses benefit of these transformer upgrades is 133.8MWh per annum.

			Losses range across five demand growth scenarios (up to 2050)	
Project	**Primary Substation**	**Works**	**Min Losses Reduction (MWh)**	**Max. Losses Reduction (MWh)**
50017837	Hattersley	Replace 2 x 10/14MVA units	7,178	17,323
50011725	Littleborough	Replace 2 x 10/14MVA units	2,117	41,837
50016522	Winifred Road	Replace 2 x 10MVA units	28,836	55,376
50016524	Campbell Street	Replace 2 x 11.5/23MVA units	15,459	33,654
50004596	Shaw	Replace 2 x 11.5/23MVA units	8,604	14,727

Losses analysis is now included as standard in any ROCBA analyses and the model was updated in September 2017 to include a new base year and to accept a longer timeframe of load scenarios produced as part of the ATLAS NIA project. There is now a standard template for inputs and a summary of outputs from the model is produced, to be used as supporting evidence to the needs and high-level scoping solution paper which is used for solution approval.

The ROCBA crucially uses the same value of losses as the Ofgem CBA and allows network planners to conduct probability weighted demand scenario based optioneering, comparing traditional reinforcement with smart alternatives such as DSR. In its recent uses, the ROCBA model has built a robust case for non-traditional alternatives, while always considering losses against network cost benefits.

Losses inputs to the ROCBA are structured as follows. This is applied for the existing network and after a traditional investment.

		Fixed losses after investment	0.013	MW
		Peak resistive losses after investment	0.107	MW
		Calculated at peak load of	13.73	MVA
		Loss load factor	0.33	

The model calculates the approximate annual losses in MWh in each intervention strategy and load scenario. This financial treatment of losses and carbon valuation factors in the RIIO-ED1 CBA template are used convert this MWh figure to a £ value, which can then be fed into a CBA.

There is currently no business case for developing ROCBA-style models for other investment decisions, such as capacity for generation, secondary networks or fault level; though this may be developed in the future. A ROCBA approach is most relevant when we can capture the uncertainty level in an investment trigger. In the coming months, there will be work carried out to further extend the scope of losses analysis in the ROCBA so that it can calculate the impact on losses of a succession of traditional interventions where historically we have typically only considered one traditional intervention.

4.3 Non-technical losses

We believe that our revenue protection team is leading the industry in understanding and managing non-technical losses. We are committed to continuing to spearhead best practice activity and innovative thinking in this area, and to support Ofgem and other stakeholders as part of this work.

All of the processes and initiatives described below have been developed since the submission of our Losses Strategy document and Tranche 1 submission. Through the integration of these processes and initiatives into our BAU decision-making, we will continue to enhance our understanding of non-technical losses and reduce their level on our system.

Revenue protection

- Our field-based investigations team has partnered with representatives from HMRC, Environmental Health, UK Visas and Immigration and the police and emergency services to investigate an unprecedented number of cases in 2017. This multi-agency approach multiplies the benefit of these investigations, as when a theft of electricity is suspected, often there is wider illegal activity taking place, and vice versa. Our team works effectively with these stakeholders to assist suppliers to investigate, detect and prevent illegal abstraction of gas and electricity and tackle theft.

Theft in conveyance

- We have revised and implemented new policies governing the pursuit of theft in conveyance cases, to take a tougher stance and refer cases on to outside agencies if it is appropriate to do so. This includes timescales for disconnection, and defining responsibilities for back charges and cost of rectification.
- We have delivered training to our desk based and field colleagues on how to identify cases of theft, the appropriate channels through which to report these cases and how to deal with these instances ensuring that the relevant equipment is safe for the customer and that our colleagues are not placed in danger when working with the damaged equipment.
- We have continued to work closely with the UKRPA, presenting at a number of their events on behalf of energy networks and raising awareness of the problem of electricity and gas theft.

Appendix A: Future capacity headroom model

Our future capacity headroom (FCH) model was used to estimate the load on each key element of our secondary network in preparation for our RIIO-ED1 business plan. At present our losses driven investments are in line with our no regrets upsizing and transformer replacement programmes as outlined in our Losses Strategy. Our load reinforcement plans for secondary networks are reactive to customer connections and the adoption of LCTs.

The use of the FCH model to assess losses driven investment is based on the following four stages which are discussed in more detail below:

- **Stage 1:** Use load allocation to identify current loading per LV feeder by half hour on peak day
- **Stage 2:** Create growth assumptions per LV feeder in 2016 and 2023
- **Stage 3:** Combine growth assumptions per LV feeder in 2016 and 2023
- **Stage 4:** Analyse capacity headroom for LV feeders, distribution transformers and HV feeder sections.

The purpose of FCH is to estimate the counts and likely location of overloaded assets in given future years, by combining the current state of the Electricity North West network with predictions about future changes in customers' usage patterns and uptake rates of new technologies.

We use our load allocation model to calculate loads on all assets for a given period by analysing the entire network, half hour by half hour and then feeder region by feeder region. The model also uses actual switching conditions to properly represent the network and mitigate the effects of load transfers and fault conditions that would otherwise distort its results.

The FCH takes the results from the load allocation model for the days in which it is interested, applies its algorithms to each region, and produces its own results. The results produced consist of detailed asset results and summaries of various counts of asset overloads and other information relating to the state of the network and that in any given year.

The results represent current asset loadings versus thermal ratings and voltage capacity and are used together with the FCH growth scenario inputs to forecast future year load and voltage levels.