NORTHERN POWERGRID

Ensuring an **efficient network**

Losses Discretionary Reward
Tranche Two / February 2018

Hello and welcome

Losses are the unavoidable, physical side effect of operating any electricity network. However, by improving our understanding of where they occur we may better meet our obligations to reduce them.

Electrical losses, unlike fluid leakage from pipes, are an unavoidable consequence of the physics of how electricity is carried through a conductor. Any conductor will warm up to some degree when electricity flows through it and that heating effect generates a small but finite loss of energy. The amount of heating that takes place varies dependent on several factors: the amount of current flow, the size of the conductor and the ambient temperature are some examples. Understanding how these factors combine and what combinations give rise to higher or lower losses help us to design networks that have lower losses. So although we can never eliminate them, the programme of work in this document sets out to enhance our understanding of losses in order to deliver efficient losses reduction actions in the 2015-23 period, as well as to establish a baseline level of losses and a further improvement plan for the period after 2023. We are implementing processes and exploring opportunities that have the potential to significantly shift the expectation of what we, as a distribution network operator (DNO), can do to efficiently manage losses in the context of the overall power system.

Our proposals focus mainly on improving understanding of so-called technical or engineering losses – i.e. the losses that, as outlined above, occur due to the laws of physics as opposed to those that arise due to theft, or apparent losses which are actually data inaccuracies. The national smart meter roll-out and the associated move to half-hourly market settlement processes will introduce more accurate metering point data such that the true technical losses may be more readily evaluated. This will be supplemented by the network monitoring we are rolling out as part of our smart grid enabling investment programme.

This is just one important strand of the benefits to be delivered by the smart meter roll-out that features as one of our highest innovation priorities for the current period. The way in which we are using and generating electricity is changing significantly as actions to decarbonise society progress. In particular, the increase in distributed energy resources such as solar panels means that we need to take a whole system view of efficiency and carbon reduction.

Distribution network operators are taking an increasingly central role in managing the connection and use of distributed generation and storage, as well as enabling new smart grid solutions such as demand side response. This action plan describes how we will be leveraging this central position to enhance our understanding of whole system losses including those that occur outside of our network – in particular within the transmission network as well as on the customer's side of the meter.

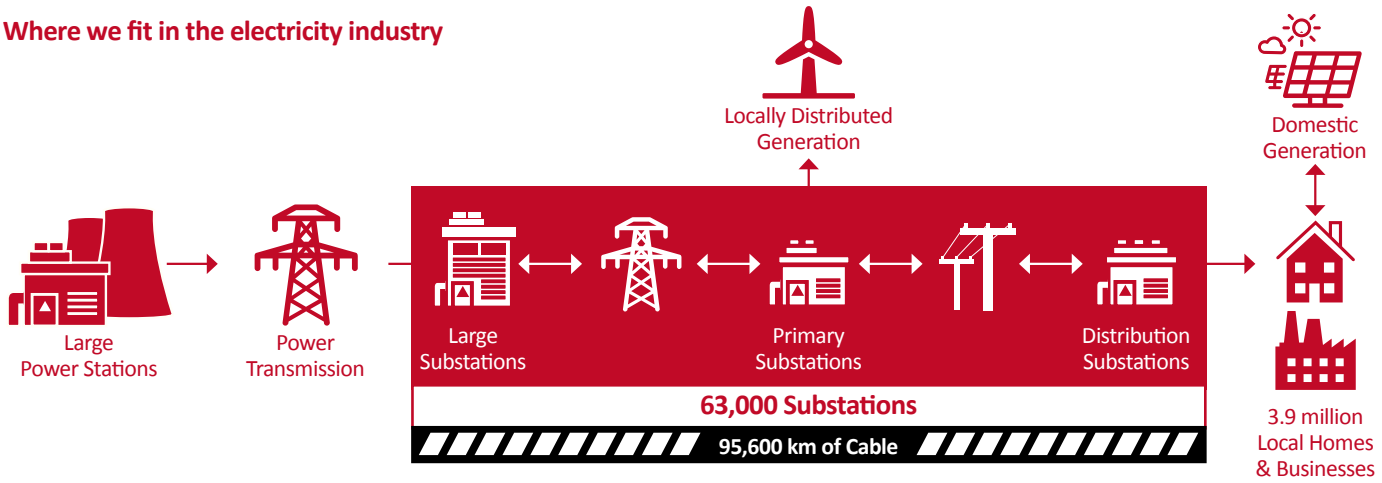
We are sharing these actions and the associated losses strategy with other network operators and the wider set of industry stakeholders. This will aid us to collaborate on projects and share best practice that will benefit customers across Great Britain and not only those that we serve in the Northeast and Yorkshire region.

Mark Drye
Director of Asset Management

Further, dialogue with colleagues in the wider Berkshire Hathaway Energy organisation is a prime route we are using to tap into relevant international experience. Ofgem will be assessing the progress on our tranche one proposals and the merits of our new proposals in parallel with this wider stakeholder dialogue. The feedback we receive through the industry dialogue and the outcome of that regulatory judgement will determine how we proceed with these proposals.

Please feel free to visit our losses webpage for more details of our plans for managing losses at *www.northernpowergrid.com/losses*

Where we fit in the electricity industry



What's inside **this document**

What we've been up to and what we are planning to do to better understand and manage losses.

Proud to be running **the network**

Northern Powergrid runs the only major electricity distribution network that provides power to customers in the Northeast, Yorkshire and north Lincolnshire – a population of some 8.3 million people.

We move electricity to and from homes and businesses over our network and the services we deliver impact on everyone who lives, works or even travels through these communities. As part of this vital service we look to ensure that the losses on our network are as low as reasonably practicable, as we realise that these electricity losses have a significant financial and environmental impact on consumers.

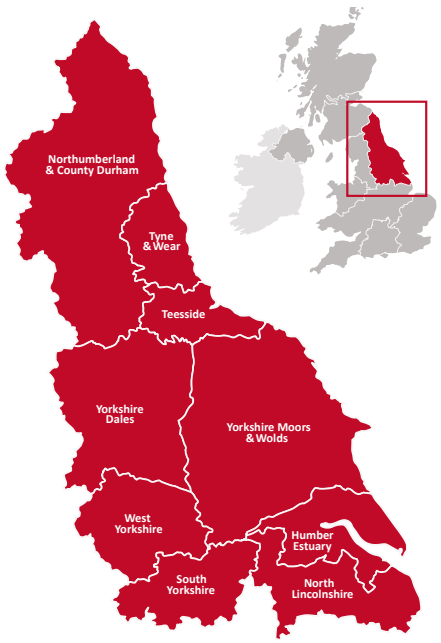
Our overall losses strategy for the RIIO-ED1 period can be summarised as follows:

- To seek losses reduction through the selection of equipment and installation designs across the full range of our engineering activity.
- To bring forward work programmes to target losses reduction when justified by cost-benefit analysis;
- To use the information flows from smart meters and network monitoring as they become available to build knowledge about areas of our network where losses are and may become high;
- To target both the use of demand side response (DSR) to reduce peak loads and existing reinforcement programmes, thereby reducing losses;
- To review network configuration, both in design and operation, to establish whether the network can be configured to reduce losses and, when necessary, make these changes;
- To work with energy suppliers, police forces and other stakeholders in our region to disconnect illegal and/or unsafe connections; and
- Develop our understanding of losses data sufficiently to consider the re-introduction of a financial incentive on losses performance in the RIIO-ED2 period.

Separately, in our losses strategy document, we describe the discrete actions we are taking to meet our obligation to reduce losses where reasonably practicable. The purpose of this document is to go beyond this minimum requirement and to propose the additional actions for process changes, technologies and engineering solutions that we will adopt as part of the Losses Discretionary Reward process, to better understand and manage electricity losses.

Ofgem will assess whether the work completed since our tranche one submission and future actions meets the criteria set out in its guidance. The tranche two assessment will particularly focus on an assessment of the actions that we are delivering to understand and manage losses while significantly shifting expectations of what we can do to reduce losses.

Our nine operating zones



Section 1 Getting on with it

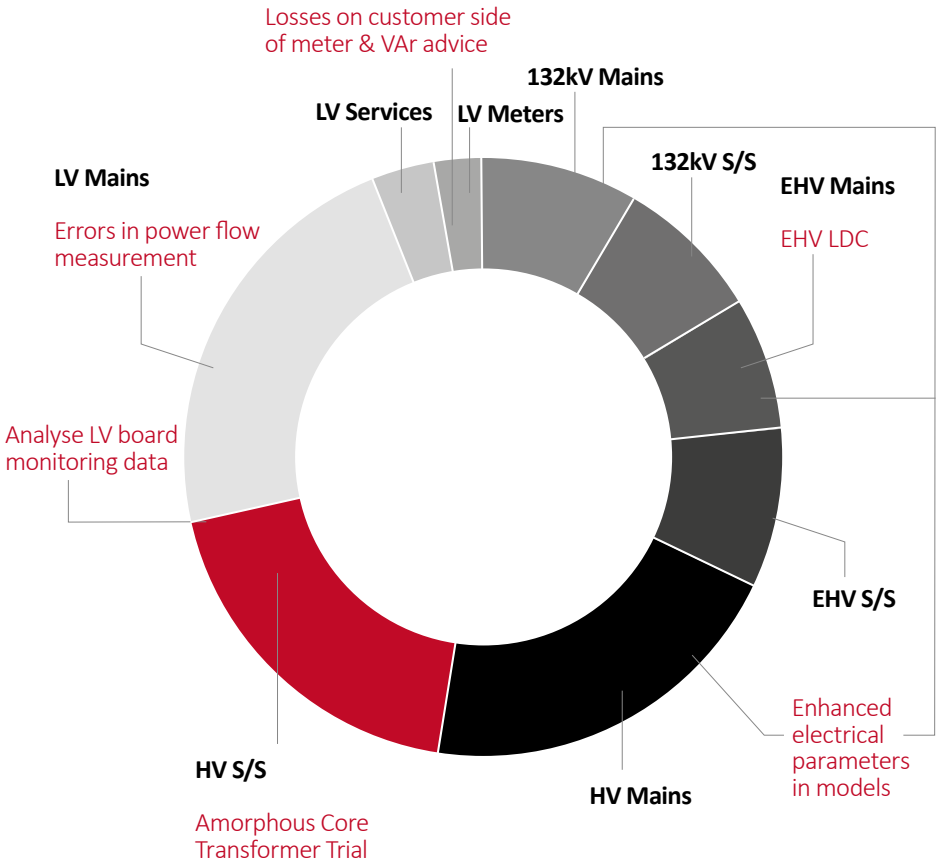
We set out in this section the work that we've done since our tranche one submission and the actions we will be carrying out during tranche two to enhance our understanding of losses and drive subsequent reduction in them.

This work is set out in the following sections:
- Understanding of losses;
- Effective engagement and sharing of best practice with stakeholders;
- Processes to manage losses; and
- Innovative approaches to losses management and incorporating approaches into 'business as usual'.

This section reiterates the original commitments we made for the tranche one submission and what we've done so far to meet the commitments. We've added links to relevant papers we've written and in some cases provided supplementary evidence in the appendix. The work we've done so far to better understand losses has been successful in that it has given us a greater insight into losses but has also raised many new questions which we are keen to investigate. This learning from tranche one, our discussions with our stakeholders[1] and other DNOs have helped us shape the work plan for tranche two.

Where we have included processes in this work plan that are also referenced in our Strategy for Losses, we have made it clear how these processes shift (or are expected to shift) the expectation of what we as a DNO can do to reduce losses. The work plan timeline we submitted as part of tranche one has also been updated with our new commitments.

Illustration of how our proposals are spread across the network – shown as a proportion of total losses



[1]Our recent losses consultation has led to the proposed actions within the section 'In-depth dialogue with expert stakeholders'

1.1
Understanding of losses

So far we have
- Mobilised a losses forecasting modelling project
- Delivered a smart meter data project
- Investigated losses on the customer side of the meter
- Used previous DNO research to inform our transformer procurement process.

The objective of the proposal is to improve our understanding of losses based on developing further learning within the industry to identify the optimal solutions for our customers and other stakeholders.

We are using our own experts, experienced consultants and academics to critically review the work in this area and deliver the identified packages of work. The outputs should allow us to make better use of the existing data sources and we will ensure the outcomes are communicated in a manner that all the industry will understand and use to make changes as necessary.

How we are improving our understanding of losses

Losses measurement can be limited by the accuracy of data used in any analysis. Existing and future distribution networks will contain multiple measurement points at the network boundaries and within the network.

Each measurement point will have an error margin due to the information and communication technology (ICT) systems and on-site hardware used to sample, record and transmit the measured quantities. It is important in any measurement to assess and compensate for the degree of error in input data. Therefore, we have sought to quantify the error margins across the network so that the level of measurement accuracy can be properly understood.

Additionally, using multiple measurement points across the network allows us to more clearly understand the losses performance of network elements that can be used to adjust network models. We have used data from our own and other DNO innovation projects to help facilitate this.

How we are considering the network in the context of the energy system

The distribution network is part of the wider energy system that only exists to service the needs of our customers. Therefore, it would be wrong to consider the implications of a low loss distribution network in isolation. Actions undertaken by a network operator, for example to reduce voltage, may appear to reduce network losses but we do need to assess the impact on customer losses which is a function of the nature of customer load.

It is also a fact that the actions of a transmission system operator impact the distribution network and vice versa. Therefore, we have tried to understand better the losses performance of existing and future customers and how this is influenced by the operation of distribution and transmission networks.

Objective

Improving our understanding of the current level and sources of losses on our networks

Details of action	When
Enhanced losses forecasting model **What we said in Tranche 1** "Investigate the opportunity of producing an enhanced losses forecasting model which introduces increased sophistication into the losses calculation method and is based on the Balancing and Settlements Code (BSC) losses modelling; the current model used for the RIIO-ED1 business plan submission; smart metering data; and data from the existing Low Carbon Networks (LCN) fund projects. The objective is that any new models will more robustly quantify the losses on the network and allow us to forecast the impact on network losses of different investment solutions. We believe that this could form the basis for a losses measurement model to be used for RIIO-ED2." **What we've done so far** We are working with Newcastle University on a project to build a losses forecasting reference network model. This project runs from Q1 2018 until Q1 2020. The work packages are a literature review, Network Data Analysis and Technical Reports, Enhanced Losses Model Development and Validation, Future Network Scenarios and Solutions & Implementation in a Regulatory Framework. (See appendices for more information.)	Q1 2020
What we are planning to do The project is looking into the following areas: — Measurement errors. These will be incorporated into the model to give confidence limits. This will include building on our previous work with the University of Sheffield into smart metering errors (measurement accuracy, time series sampling errors, phasing and aggregation). The work will also look into the error introduced by protection CTs, VTs used for SCADA monitoring. — Categorising Northern Powergrid's network into several network types by voltage level and general topology. — A spreadsheet-based losses forecasting model will be constructed and delivered. The model will focus on forecasting losses movements in light of customer scenarios and DNO responses. — Validating the model against some sample networks with LV board monitoring, smart meter and SCADA data as well as our Balancing and Settlement Code and ED1 models. This will allow Northern Powergrid to model losses at a more granular level using future loading scenarios to enable better targeting of investment. Any learning will be fed into the ENA losses working group to influence proposals for common network models to be used in any future losses incentive mechanism.	Q1 2020

Errors in power flow measurement

What we said in Tranche 1

"Develop a better understanding of the errors in power flow measurement throughout the distribution system and the reliability of the losses data calculated upon it (i.e. understand where we are getting the data from and the associated sensitivity and how it impacts the accuracy of the losses calculations)."

What we've done so far

The University of Sheffield delivered a project[2] on Smart Data on behalf of Northern Powergrid. The primary goals were to determine how a DNO can derive business benefit from smart meter data, whilst providing key recommendations into how this can be done. One of the three primary areas of study was how losses can be more accurately modelled given the constraints around phasing uncertainty, consumption aggregation and time resolution of the data. The data set used for the study included Northern Powergrid's CLNR Smart Meter data sets, assigned to some representative networks. Statistical methods for managing big data were then used to analyse the data sets.

The original smart meter data was not aggregated and was of high time resolution so that this data could be used as a control group for 'lower quality' higher customer aggregation and higher time resolution to be compared against.

The key findings in terms of losses were:

— Increasing the time resolution of customer demand data can under-estimate losses. For example using 30-minute average demand data (the de-facto industry standard) can lead to losses under-estimation by 23% compared to one-minute average data.
— Aggregating customer demand data can over-estimate losses. For example aggregating 6 customers' consumption can lead to losses over-estimation by 130% compared to no aggregated consumption.

Complete

What we are planning to do

The findings from the University of Sheffield's smart meter project will form the foundations of our Enhanced losses forecasting model and help develop future proposals for an ED2 losses incentive mechanism.

As part of our roll-out of LV monitoring we've chosen to use a time resolution of 10 minutes to accurately identify losses hotspots on LV networks. Also to get the highest benefit for our customers, we are continuing to lobby for the lowest smart meter customer consumption data aggregation possible.

Q1 2020 as part of Enhanced losses forecasting model

Analyse project data

What we said in Tranche 1

"Analyse data from the Electricity North West (ENW) Customer Load Active System Services (CLASS) and Western Power Distribution (WPD) low-voltage (LV) Templates projects to understand losses performance. We will also consider any other relevant industry learning that is published".

What we've done so far

We've used the findings from the following projects:

— ENW's CLASS in our project on understanding of losses on the customer side of the meter. This work allowed us to look at the voltage dependencies on consumption of customer appliances (ZIP coefficients) which allowed us to analyse the losses impact on the customers' installations at varying voltages.
— We've also used our smart meter data set from CLNR to create different Loss Load Factors (LLF) for pole mounted and ground mounted transformers[3] which allows us to concentrate our expenditure on ground mounted transformers which experience longer durations at high utilisation and loss levels. (See appendices for more information.)
— The smart meter data set from CLNR was used for the University of Sheffield's Smart data project (see section 'Errors in power flow measurement')
— Our innovation project DS3 monitoring data has been used to assess the losses associated with imbalance, harmonics and reactive power flows on LV networks. This has led to us focusing more on imbalance due to the higher losses experienced there compared with harmonic and reactive power flows.

End 2019

What we are planning to do

We are planning on using the data from WPD's LV Templates and ENW's CLASS projects to feed into Enhanced losses forecasting model which will enable the model to be validated against real network data.

Q1 2020 as part of Enhanced losses forecasting model

"We are proud of the vital role that Northern Powergrid plays in the infrastructure of the North of England."

Phil Jones
CEO

[2]http://cired.net/publications/cired2017/pdfs/CIRED2017_0654_final.pdf
[3] IMP/001/103 Code of Practice for the Methodology of Assessing Losses https://www.northernpowergrid.com/downloads/4034

Analyse low voltage board monitoring data

What we said in Tranche 1

"Utilise the data from Northern Powergrid's low voltage (LV) board monitoring, which was installed to understand reinforcement requirements, to better understand the distribution of losses at the high voltage (HV) and low voltage network level."

What we've done so far

We've started the roll-out with initially 60 LV monitors on our heavily loaded and likely losses hotspots. The data from these devices is returned to our iHost server for designers and planners to assess. The LV monitoring builds on the similar type of equipment we used as part of CLNR[4] and more recently our DS3 project[5]. We are looking at reactive power flows and imbalance using the DS3 data and will continue to analyse the data as more monitoring comes online. Although the DS3 site may not be representative of our general LV network, it has high LCT penetrations and may be more representative of future networks (see appendices for more information).

So far we've found the following:

— Power factor is >0.98 (consistent with upstream primary substation). This would likely mean the reactive power losses are not high enough to warrant the installation of power factor correction equipment.
— High neutral currents. This shows there are significant losses associated with imbalance on the LV network compared to other factors. This has led us to focusing our attention to novel and conventional methods of LV phase re-balancing including the use of selectable three-phase services.
— Individual harmonics are much lower the G5/4 Stage 1 connection limits. This would mean the losses associated with harmonics are likely not high enough to warrant the installation of harmonic filters.

The initial findings are consistent with the findings of SSEPD New Thames Vision Project, especially to power factors close to unity and relatively high levels of phase imbalance.

We have instigated our Enhanced Losses Forecasting project with Newcastle University that will perform further analysis on the LV monitoring data.

End 2019

What we are planning to do

We will continue with our roll-out, as part of our smart grid enablers investment programme, and undertake associated analysis. This will help us to further refine our cost-benefit analysis assumptions of taking losses reduction actions. For example looking whether power factor correction equipment is economic to reduce the losses associated with reactive flows we are experiencing. We'll also be using this data as part of the Enhanced losses forecasting model.

End 2022

Objective

How we are considering the network in a holistic manner and making efforts to understand how losses on their network affect others

Details of action	When

Losses on the customer side of the meter

What we said in Tranche 1

"The load reductions experienced in the ENW CLASS project could be a combination of distribution losses changes, customer losses changes and customer load changes. We will investigate electrical losses on the customers' side of the meter through analysis of existing customer datasets (this could include ENW CLASS, UK Power Networks (UKPN) Low Carbon London, Northern Powergrid Customer-Led Network Revolution and WPD LV Templates)."

What we've done so far

We commissioned the consultancy WSP to undertake a study[6] investigating the Impact of Voltage and Harmonic variations on domestic customer losses. This included how the DNO's actions have an effect on the losses on the customers' internal wiring and their appliances. This study built on the learning from CLNR, ENW's CLASS and WPD's Network Equilibrium projects. The main conclusions are:

— With a large uptake of LCTs the range of individual customer's supply voltages is expected to increase, with a potential impact on the efficiency of customers' appliances and the efficiency of domestic networks.
— Harmonic currents in domestic networks are expected to increase with a small negative impact on the operation of customers' appliances and the efficiency of domestic networks.
— The efficiency of domestic systems is dominated by appliance efficiencies because losses in domestic wiring networks are small by comparison.
— Losses in domestic wiring networks were found to be largely insensitive to voltage variations.
— The efficiencies of modern domestic appliances employing electronics are generally insensitive to voltage variations.
— Customer actions will dominate the efficiency of their domestic system rather than operation of the distribution network.

As part of the ENA losses working group we've been looking into the effect on losses of smart reinforcement to increase capacity for LCT growth (see Holistic and co-ordinated approach to losses).

Complete

What we are planning to do

We will continue with our HV conservation voltage reduction programme as the effect on customer losses within their premises is minimal. However, we recognise that a periodic review may need to be undertaken to look at the future composition of customers' loads in order to review the losses implications on and the effectiveness of conservation voltage reduction. So far we've concentrated our efforts on domestic customers; however we now propose to focus our attention on non-domestic customers. We plan to investigate the reactive power consumption by non-domestic customers through half-hourly reactive power settlement data and offer advice about how the customer can reduce this in order to reduce losses on both their network and our own. This shifts expectation around what a DNO can do outside of their network. It allows DNOs to use their technical expertise to directly help customers to reduce their losses and in turn their electricity bills.

Q4 2019

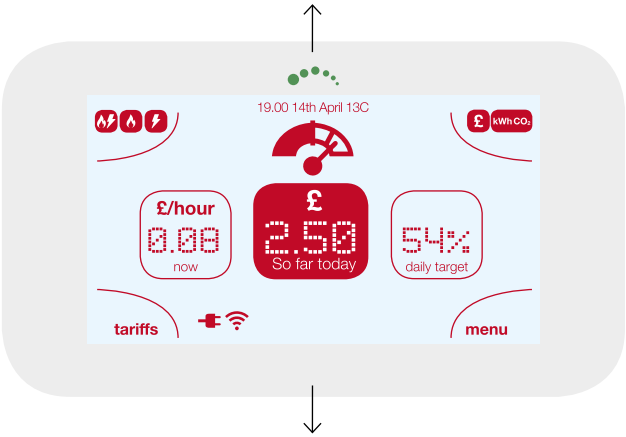
[4] www.networkrevolution.co.uk/
[5] http://www.northernpowergrid.com/innovation/projects/distributed-storage-solar-study-nia-npg-011
[6] WSP Report Link https://www.northernpowergrid.com/downloads/4121

Focus on smart meter tasks

Smart meter data comparison with low voltage monitoring data (see Analyse low voltage board monitoring data)
Status: In Progress

Tamper alerts management processes (see Management of Non-technical losses)
Status: In progress

Smart meter derived load loss factors (see Analyse project data)
Status: Complete



University of Sheffield Smart Data project (see Errors in power flow measurement)
Status: Complete

Smarter Network Design Methodologies (see Processes to manage losses)
Status: In progress

Newcastle University Losses forecasting model (see Enhanced losses forecasting model)
Status: In progress

Adapting network operation to load and losses characteristics

End 2018

What we said in Tranche 1
"Consider how networks might be operated to different parameters dependent on a particular network's and customer's load and losses characteristics."

What we've done so far
Since 2012 there has been a rolling conservation voltage reduction programme in both Northern Powergrid's licence areas to reduce the operating voltages at the 11kV and 20kV voltage levels. Broadly these have been reduced by 1.8% from 11.3kV to 11.1kV and 1.0% from 20.3kV to 20.1kV. As of January 2018 this has been undertaken on 265 primary sites (approx. 48% of the HV and LV networks), with no observable detriment in the performance of customer's equipment as the voltages supplied are still within acceptable limits.

The measures employed appear to have prevented an increasing trend of customers reporting high volts as more distributed generation is connected to the network. Alongside ENWL's CLASS project and WPD's voltage reduction in South Wales programme we've been investigating how reducing the voltage at HV (and in turn at LV) has an effect on the both the customers and the network characteristics.

Northern Powergrid's preliminary analysis[7] has shown that sites where voltage has been reduced have a 2.8% reduction in demand compared to sites where the voltage has not been reduced. This is thought to be a combination of reduced customer consumption, an increased penetration of distributed generation feeding local demand and a reduction in network losses on the HV, LV and customers networks. As this programme is rolled out across the network we estimate an annual saving of £50m on customers' bills via reduced energy consumption and reduced network losses.

Since 2015, over 1000 HV feeders have been assessed to optimise open points to balance load and customer numbers. In turn this should reduce losses. In an extreme example when an open point is moved from an interconnected primary substation to the mid-point losses are reduced. For a typical feeder pair to be optimised we estimate around 26MWh/year would be saved or (£1,300/ year). (See appendices for more information.)

Q4 2019

What we are planning to do
We are rolling out smart AVCs at our major substations across Northern Powergrid. This element of our smart grid enabling programme will allow our major substations to use advanced voltage control features such as remote changing of set-points, load drop compensation (LDC), tap stagger and remote tap change indication and control.

In parallel with the smart AVC rollout we've already started to apply LDC at primary substations. The initial trial at Seghill Primary substation[8] has shown the ability of LDC to release more voltage headroom for generation and some further conservation voltage reduction losses benefit.

We are going to investigate using the same AVC technology to dynamically change voltage set points at supply points to optimise losses on the outgoing EHV circuits. Applying LDC to increase the voltage on the 66kV and 33kV network at time of high load will allow for I^2R losses to be reduced but without changing the voltage experienced by most customers' equipment, as their voltage is to still be controlled at HV by the primary substation transformer tap changer.

[7]HV Conservation Voltage Reduction Impacts study
https://www.northernpowergrid.com/downloads/4117
[8]IMP 001 915 002 – An Application Guide for using Load Drop Compensation on HV Systems
http://www.northernpowergrid.com/asset/1/document/3997.pdf

Exceptions to loss reduction actions

What we said in Tranche 1

"Explore whether there are any unforeseen consequences of loss reduction actions on distribution networks, other industry actors (e.g. National Grid Electricity Transmission (NGET)) or certain classes of customer, or specific cases that run against the general case. For example it is already clear that there may be interaction between losses on DNO systems and voltages on the transmission system, and while voltage reduction may potentially reduce customer losses in areas dominated by switch mode power supplies, that same action may increase losses in industrial areas rich in induction machines due to the higher currents they then draw."

What we've done so far

By reducing the HV and LV voltage levels, losses have been reduced through net demand reduction. As part of the HV conservation voltage reduction programme we studied the HV feeders from the primary substation to be reduced. These studies modelled the voltage regulation under maximum demand scenario. A small proportion of the HV feeders (mostly rural) had voltage drops approaching statutory limits under outage conditions. This meant the primary substations where these feeders were connected to could not have the reduced voltages applied. These particular feeders may have to be reinforced using conventional or smart solutions in order for the voltages to be reduced and the losses benefits to be realised. These feeders will be re-assessed during the ED1 period to evaluate what the cost benefit for their losses reduction via this route is justified.

A secondary concern identified with reducing the voltage at primary substation was the reduction in tap range on certain primary transformers with an offset tap range and 22kV transformers running close to 20kV. For these transformers at the revised voltage set point and under light loading conditions leads to the tap changer running out of tap range. Whilst under normal operating conditions this poses little operational concern it can be a concern under abnormal TSO driven conditions, for example when demand reduction is required. The first stages of the grid code requirement for demand control[9] is for DNOs to reduce demand through voltage reduction. This requirement is risked as under some conditions as the transformer may not be able to reduce the HV voltage any further due to its tap range limitations.

Within our IMP/001/911 Code of Practice for the Economic Development of the LV System[10] we've introduced a maximum economic loading guide for new transformer installations. This guides designers to oversize transformers for the load they are connecting to incorporate losses. However, for dedicated wind and solar transformers we've found that oversizing the transformer for losses is not economic. This is due to the less onerous load profile of the wind and solar, meaning increased investment in reducing copper losses is not justified compared with typical customer load profiles. This is a clear exception to a loss reduction action.

As part of the ENA technical losses working group we commissioned a study to investigate the Impact of Low Carbon Transition on Technical Losses. This work looked at the losses impact of LCT growth and of the losses impact of smart vs traditional reinforcement. The use of smart solutions as an alternative to conventional reinforcement is expected to increase losses, however Northern Powergrid will only implement smart solutions where they are economic from a whole system perspective. (See Holistic and co-ordinated approach to losses.)

As part of our update of asset ratings policies the impedance of cables[11] and overhead lines[12] has been updated to include standard values of resistance, reactance and susceptance for the positive, negative and zero sequence components. As some of this data was not readily available the values traditionally had to be estimated. We've added a sample of these updated parameters to our electrical models for enhanced modelling purposes and then undertook some impact studies to understand how losses would be affected. We found the main impact of this update will be the inclusion of susceptance values which can be used to model reactive power and losses calculations under light loading conditions, which has specific impacts on both Northern Powergrid and the TSO.

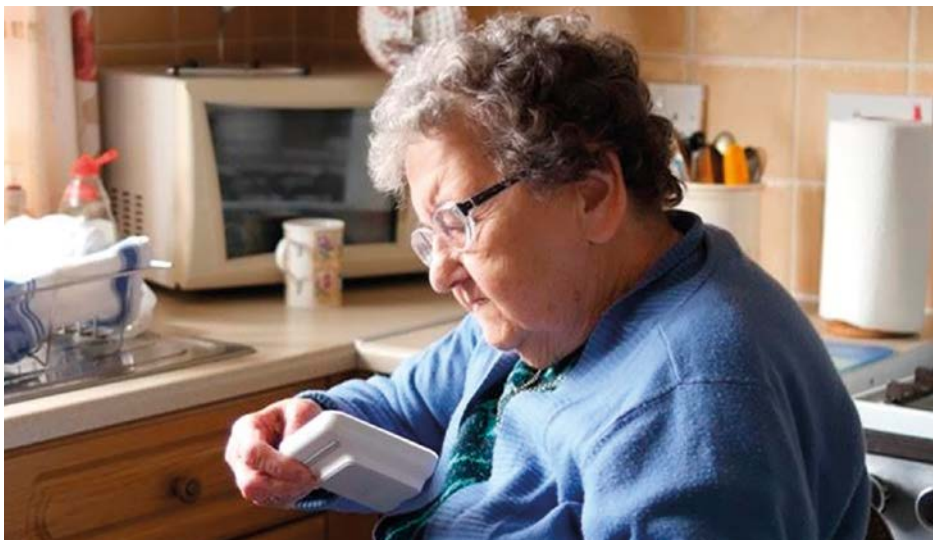
Complete

What we are planning to do

In 2018 we will update the full electrical parameters in our network models to include these more comprehensive values.

The transformer tap changer range limitation is to be studied as part of the EHV LDC investigation (see Adapting network operation to load and losses characteristics).

Q4 2018



[9]Grid Code: Operating Control No. 6 – Demand Control. https://www.nationalgrid.com/sites/default/files/documents/36903-OC6%20Demand%20Control.pdf

[10]www.northernpowergrid.com/asset/0/document/109.pdf

[11]www.northernpowergrid.com/asset/0/document/3299.pdf

[12]www.northernpowergrid.com/asset/1/document/1995.pdf

1.2
Effective engagement and sharing of best practice with stakeholders on losses

So far we have
- Consulted on our losses plans
- Engaged with a wide range of stakeholders
- Created a losses education animation and webpage
- Collaborated with other DNOs on losses understanding projects

The objective of our stakeholder engagement is to facilitate clear, open and honest communication and engagement that is compliant with the stakeholder standard AA1000 principles of inclusivity, materiality and responsiveness.

Our approach has been to:
- Communicate losses in a way that ensures it is accessible to stakeholder and customers;
- Actively use stakeholder engagement to identify the issues that matter and develop solutions that work;
- Translate stakeholder feedback into improved services for our customers;
- Regularly review and develop our engagement practices and share proven practice;
- Research, benchmark and adopt best practices to support continual improvement;
- Review our performance and planning in light of customer feedback; and
- Ensure that the impacts of our engagement are quantifiable.

Key losses stakeholders
- End users of the system – particularly customer representative organisations (such as Citizens Advice and Which?);
- Local authorities;
- Equipment suppliers – engagement with the British Electrotechnical and Allied Manufacturers' Association (BEAMA) and the small and medium enterprise (SME) sector through the Energy Innovation Centre (EIC);
- Environmental groups and organisations – such as the Energy Saving Trust;
- Energy suppliers;
- Other GB network operators – including National Grid Electricity Transmission (NGET) and independent distribution network operators (IDNOs);
- Academic and consultancy organisations;
- International operators – particularly our Berkshire Hathaway Energy affiliates; and
- The Institution of Engineering and Technology (IET).

Ongoing dialogue with our stakeholders ensures that we align our developments with our stakeholders' priorities by ensuring that we clearly link stakeholder comments to our plans and provide feedback on our response to suggestions – it is important to us that our stakeholders know that we are listening and responding to their opinions. The input from these groups will assist us to comply with our requirement to manage losses as well as enhancing our understanding of the importance they place on active losses management.

How we are using stakeholder engagement

We have built on and extended our existing stakeholder engagement approach to bring losses to life for our stakeholders. Losses is now considered in the same way as the innovation, the Distribution System Operators transition, customer service and the social agendas. We've therefore undertaken an extensive programme of stakeholder engagement around losses. This has included a wide variety of stakeholders including customer focus groups, including our expert stakeholder panel, industry experts and also technical experts. We have also developed an introductory animation to better communicate our losses programme, and to facilitate more comprehensive feedback from our stakeholders about this complex topic.

We will continue our extensive programme of stakeholder engagement to inform our losses management actions, educate customers on electrical losses and allow stakeholders to understand how those actions feed through to their bills.
As with the rest of Northern Powergrid's stakeholder engagement activities, we ensure that dialogue is two-way, and with a commitment to close the loop on engagement with all feedback responded to in a timely manner.

Engaging with stakeholders to share good practice and develop enduring partnerships

Partnership working has been crucial to the development of an effective and innovative losses programme and its delivery of positive outcomes.

Collaboration with other DNOs has featured highly in our losses work plan such as sharing our understanding and learning on losses with the ENA Technical losses working group. This has been a key group to facilitate industry knowledge sharing and has fostered candid discussions between the respective losses experts from the different DNOs.

Processes to share best practice

The outcomes from our projects have been published on our losses and innovation websites and communicated via stakeholder bulletins and focused bespoke engagement with key parties in order to ensure that maximum GB-scale value is extracted from the learning that is developed. This approach has allowed for communications to be targeted at an appropriate level for the audience and for it to be delivered cost effectively.

Relevance of other stakeholder engagement processes and incentives

Ofgem has understandably sought reassurance that if the proposals contained in this work programme are rewarded through the Losses Discretionary Reward that we are not being funded through other routes in our price control.
In particular, there is a stakeholder engagement incentive that is particularly focused on our services for customers that are more vulnerable.

The activities proposed in this programme of enhanced understanding of electricity losses have not featured and will not feature in our separate applications for the stakeholder engagement reward. Rather, the proposals make use of existing, effective stakeholder engagement 'infrastructure' such as the Stakeholder Panel, Online Customer Community and regular customer focus groups delivered across our nine zones and Stakeholder Bulletin that the wider business uses across its functions. The following table describes the engagement actions to facilitate the enhanced understanding of losses over the life of the work plan.

Objective

How we are planning to utilise stakeholder engagement to inform our losses management actions

Details of action		When
Stakeholder-led consultation **What we said in Tranche 1** "Canvas opinion from key industry stakeholders and our online community on the types of actions that they would like to see over and above those already included in our losses strategy document." "Provide updates at Northern Powergrid's Stakeholder Panel. This has already started and will take the form both of presentations at meetings and email updates to interested panel members between meetings." "Host an initiation workshop to review our proposed actions, take feedback and adapt as necessary. This forum will also be used to determine the most appropriate timing and type of future engagements throughout the life of the work plan."	**What we've done so far** We've run a consultation on our losses plans 'Delivering Enhanced Management of Electricity Losses'. This consultation ran from 28th November 2017 to 29th December 2017. We consulted on the following areas: — General comments on our strategy for losses; — General comments on our 2016 losses discretionary reward submission; and — Ideas for market-based services to reduce losses. We had a limited response to our consultation which has led us to run more targeted campaigns in the future with our stakeholder panel and online communities platform. We've also provided updates on our losses plans at our stakeholder panel events as part of our wider carbon footprint reduction sessions.	**2016 and ongoing**
What we are planning to do We will continue to provide regular updates to our Stakeholder Panel to continue get their views.	Within the online communities platform we will run a more targeted consultation with our interested stakeholders.	**Ongoing**

"..it would be useful to understand the impact of the market moving to near zero marginal prices, losses won't cost anything?"

Stakeholder view
London DSO Event November 2017

Objective
How we are engaging with stakeholders to develop relevant partnerships which may help to manage losses

Details of action	When
Dialogue with our broad range of stakeholders **What we said in Tranche 1** "Facilitate regular update briefings to share information and gain feedback." "Information included in the monthly stakeholder bulletins (reaching 4,000+ people) and website updates." "Topics published on our online communities' platform." **What we've done so far** — Added the topic of losses to our regional customer focus groups delivered during 2017. — Created a losses webpage[13] to highlight the losses actions we are undertaking to the interested parties with a useful summary of our losses plans. — On our community engagement website we've added a dedicated network losses[14] area. This allows our customers to engage on topic areas related to losses management. — Created a losses animation[15]. Despite the losses engagement with stakeholders being well received from a conceptual level we still struggle to engage with stakeholders on our loss reductions initiatives. We've spent a considerable amount of the stakeholders' time educating them on losses, rather than developing a dialogue with them about our plans. We've therefore created a short animation to help stakeholders get up to speed more quickly, so that their remaining time can be used more constructively. The animation will also be useful for internal and external losses dissemination as well as within our losses webpage.	2016 and ongoing
What we are planning to do We will continue with our plans to engage with our stakeholders at our customer focus groups and stakeholder panel meetings.	Ongoing

Objective
How we are planning to utilise stakeholder engagement to inform our losses management actions

Details of action	When
In-depth dialogue with expert stakeholders **What we said in Tranche 1** "Invite parties to form an expert steering group to sanity check the work and provide direction on potential next steps." "Consider inviting third parties to work collaboratively as the project develops, where clear benefits may be gained." "Explore the opportunities for data exchanges with IDNOs regarding losses on their networks." **What we've done so far** — Presented at our Stakeholder Expert Panel to gather feedback from stakeholders on our Losses strategy and consultation exercise but also to gather feedback on the most effective way to communicate losses to broader, less expert groups such as consumers. — As part of our consultation[16] we asked if the recipients would be interested in joining our online losses forum. — We've had dialogue with a transformer manufacturer about very low loss transformers and how we can work together to get a new product into the DNO market (see Sharing UK best practice and understanding). — We've presented[17] our losses plans at our DSO events to industry experts in London and York to foster discussion around how network losses fits into the transformation of the overall energy system. These events were presented to over 130 stakeholders. The second event was also webcast to broaden its accessibility for time-poor stakeholders. — We've also presented at our local IET community in West Yorkshire to over 70 engineering and technology experts with the aim of gaining insight into energy efficiency programmes from other industries. — Engaged in discussions with ICPs in relation to the use of oversized standard equipment such as LV cable.	2016 and ongoing
What we are planning to do — We are going to build on one particular stakeholder's comment on how the cost of losses should take into account the variable electricity price during the day rather than an average price over the year. This will involve undertaking a study to investigate what effect the electricity spot price has on our losses' cost-benefit analysis used for investment decisions. — There is a perverse financial incentive for DNO designed connections to appear more expensive than IDNO designed connections. This is because the DNOs have a licence obligation to reduce losses whereas IDNOs do not. This leads to the cheaper, higher loss IDNO connection being more likely to be accepted by the developer. We believe this encourages developers to opt for higher loss connections. Therefore we will raise the issue for the playing field to be levelled and IDNOs to have the same losses licence condition as DNOs.	Q4 2019

[13] https://www.northernpowergrid.com/losses
[14] https://northern-powergrid.explainonline.co.uk/
[15] https://www.youtube.com/watch?v=M9v_2HDnMLI
[16] www.northernpowergrid.com/asset/0/document/3870.pdf
[17] www.youtube.com/watch?v=tZ7Ml3hOkkU

Objective

Demonstration that we have processes in place to share our own best practice with relevant stakeholders

Details of action	When

Holistic and co-ordinated approach to losses
 	
What we said in Tranche 1
"Participation in the Energy Networks Association (ENA) technical losses group whose purpose is to ensure best practice is shared between ENA members (including DNOs, transmission operators and system operator)."
 	
"Actively participate in industry working groups working groups with NGET such as the Transmission Distribution interface (TDI) group and the Power Responsive Steering Group."
 	
What we've done so far
— The ENA Technical Losses Working Group has
  — Commissioned a study to investigate the Impact of Low Carbon Transition on Technical Losses. This work looked at the losses impact of LCT growth and of the losses impact of smart vs traditional reinforcement. This focused on two sample networks, one in ENW and one in Northern Powergrid. This was presented at the 2017 LCNI Conference.
  — Produced learning material on Electrical Network losses and taken Ofgem through it. The aim of this exercise was to allow for meaningful future discussions between the DNOs and Ofgem with regards to the challenges of future losses incentive mechanisms. (See appendices for more information.)
  — Shared our best practices and learning from each other's project, strategies and discretionary reward submissions.
— We disseminated the University of Sheffield Smart Data project at CIRED in Glasgow in June 2017 and to BEIS in December 2016.
— We co-authored ETR 140 'Statutory Voltage Limits at customers' terminals in the UK and options for future application of wider limits at low voltage reduction'. As part of this process we shared our experience of our voltage reduction programme and its effect on consumption.
— We have been a contributing partner in the ENA Open Networks Project. This project is a collaboration that aims to transform the way that both DNOs and TSOs will operate and work for customers. Within this project, the workstream considering system coordination is tasked with minimising losses alongside other constraints.
	2016 and ongoing

What we are planning to do The ENA Technical Losses Working Group is producing options for how we could develop an output-based losses incentive mechanism for ED2 with a focus on smart meter data, as well as continuing to share our respective learning on losses understanding. 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 sharing and facilitate future collaboration while improving the experience for our stakeholders. Additionally, to aid development of future losses projects and transfer to business as usual, 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.	**Q4 2019**

1.3
Processes to manage losses

So far we have
— Shared our best practice with our sister companies
— Set up a Smart Grid Implementation Unit within Northern Powergrid

The national roll-out of smart meters opens up new possibilities for the management of losses and we are in the early stages of understanding of how we may use this new source of information to design and operate a more efficient and high performing electricity network.

We are delivering actions that will enable us to significantly develop our understanding. One source of learning is the international experience that we and others have in both the roll-out of advanced metering systems or more generally in the development of networks. Northern Powergrid is ideally placed to access some of the learning necessary from its internal contacts within the fellow affiliates of Berkshire Hathaway Energy. Our sister companies, operating in 11 North American states and often vertically integrated in distribution, transmission and retail, provide a valuable knowledge resource for us to access for the benefits of our customers in the UK.

National and International best practice

As part of the Berkshire Hathaway Energy group of companies we have been working with our counterparts in the US on the sharing of best practice in the areas of network reliability, connection of distributed energy resources and smart grids. Our parent organisation is a lead supporter of the low carbon transition in the United States, being a signatory to the Climate Change Action Plan that was tabled at the Conference of the Parties Paris summit (COP21). The management of losses is an important practical step we can take to support our group policy of delivering balanced outcomes for customers including decarbonisation of the grid.

We have valuable US experience of connecting distributed low-carbon generation, developing significant numbers of windfarm and solar farm projects and delivering smart meter benefits. Therefore, through these relationships, we have been exposed to initiatives conducted in the US whose findings and therefore learning may be applicable in the UK. This has included US experience in VAr support and also conservation voltage reduction.

We intend to continue this knowledge sharing and losses management opportunities features in discussions on the evaluation of future innovative technology.

How are we preparing to use smart meter data

We have been actively involved with the technical specification of the smart meters and the overall system since its inception. Indeed one of our smart grid development engineers has been a leader for the DNO community on the meter specification, meter and system configuration and data privacy. We are well placed to understand what smart metering will provide for us and we have supplemented that with the expertise of experienced smart grid development engineers to develop our future network design policy and processes.

This team is developing the functional requirements for future design tools using smart metering update as part of our Smarter Network Design Methodologies NIA funded project. This project builds on our Customer-Led Network Revolution project, the Smart Data project, our new asset management systems and our Siemens Energy IP gateway. The ultimate aim of the project is get the best value from smart meter data by modelling our LV network more accurately to allow for more cost-effective future LCT growth. The following table describes the actions to facilitate incorporating processes to manage losses.

Objective

The best practice we have considered when contemplating processes and methods to manage losses on our networks

Details of action	When
Sharing international best practice and understanding **What we said in Tranche 1** "Explore international best practice specifically focusing on the work undertaken by Berkshire Hathaway Energy sister companies: — HV losses evaluation – Pacificorp in Oregon — LV losses evaluation – MidAmerican Energy Company in Iowa." **What we've done so far** Northern Powergrid is part of the Berkshire Hathaway Energy group and as such is in regular communication with our colleagues in our sister companies in North America. These companies range from transmission and thermal generation to renewables and distribution, including electricity metering and retail, and collaboration with them benefits UK customers. Our sister companies have faced similar challenges on electrical losses and efficiency to those posed in the UK, and have undertaken innovation projects to attempt to control or reduce losses. Two in particular have relevance to Northern Powergrid. Pacificorp considered use of conservation voltage reduction to reduce losses on their network. The project had partial success on a technical basis, but was not successful over-all. Even on handpicked circuits thought likely to provide a losses reduction, the losses reduction was marginal; in practice only around 10% of the modelled prediction of the reduction. Given this loss reduction it was not cost effective to make the investment necessary to gain the reduction. In Northern Powergrid the same proposition might yield a different answer. The voltage in Pacificorp was running relatively low compared to the required supply voltage, while Northern Powergrid's voltage runs relatively high. The capital investment necessary in Pacificorp to allow any further voltage reduction was therefore relatively higher than it would be for Northern Powergrid. The cost per MWh saved was at $112.49 uneconomic in the Pacificorp area, but might be regarded as economic in a UK setting. These findings have helped provide confidence to Northern Powergrid in our pursuit of the conservation voltage reduction at primary HV busbars that we are undertaking. MidAmerican Energy have trialled distributed VAr support to optimise voltage. Again this shows promise functionally, but given the capital intense nature of the method (238 VAr support devices were required for 3 HV feeders) it is not likely to be adopted in the UK until other methods have been exhausted. Northern Powergrid have however moved to more flexible arrangements for the connection of generation and storage, allowing VAr control at these connections which has the potential to provide similar functionality at a far lower cost. (See appendices for more information.)	**2016 and ongoing**
What we are planning to do As we go forward, Northern Powergrid will continue to discuss issues like losses with our sister companies. The Berkshire Hathaway Energy group runs a number of collaboration processes sponsored overall by the group CEO, with the individual company CEOs leading on specific topics. The Grid Innovation Collaborative which covers novel techniques for improving our base service, addressing losses and reducing costs is led by Northern Powergrid. We will make full use of this group and make use of our ownership structure to benefit UK customers.	**Ongoing**

"Losses define our overall system efficiency and we should actively consider them in all of our network investment decisions."

Phil Jagger
Smart Grid Development Engineer

Sharing UK best practice and understanding

What we said in Tranche 1
"Continually monitor the learning from other DNO projects where there is particular relevance to losses (for example the WPD and UPKN report into 'The management of electricity distribution network losses')."

What we've done so far
— Implemented a process which reviews the other DNOs losses projects, their losses strategies and also learning from other parties within the UK. For example, as part of this process we reviewed WPD's policy of pro-active replacement of pre BEBs T1:1958 ground-mounted distribution transformers. We undertook a cost-benefit and came to the same conclusion as WPD. Therefore we are pro-actively replacing these transformer units as part of synergies with other investment drivers.
— We participate in the ENA Technical Losses Working Group which is primarily used as a forum for knowledge sharing.
— Taken on board the recommendations from Sohn Associates report within our losses strategy. Out of the 14 recommendations from the report ten lined up with our existing strategy and the remaining four we are going to investigate further. An example of this is their recommendation 7[18], which has led us to start writing a guidance document for assessing losses, with a strong emphasis on comparing losses between smart vs traditional solutions within designs.
— We are building on WPD LV templates and ENW's CLASS for our Smarter Network Design Methodologies project.

2016 and ongoing

What we are planning to do
From our Eco-design directive (Tier 2) discussions with other DNOs on the ENA transformer panel there seems to be considerable reluctance to adopt very low loss amorphous core transformers on certain technical grounds. During 2018 we plan to work collaboratively with a transformer manufacturer to install several Amorphous core transformers on to the Northern Powergrid network using standard working procedures. This should help to allay technical concerns around brittleness, size, weight, harmonics and noise in preparation for Eco-design Tier 2 maximum loss levels for transformers which comes into force in 2021. We will feedback our experience to the ENA transformer panel. This learning has the potential to shift expectations by helping to remove potential technical barriers for very low loss transformers and using the Northern Powergrid project as a positive case study for other DNOs, commercial and industrial users. We estimate that if we moved from Eco-design Tier 1 transformers to Amorphous Core designs we'd save 680MWhrs incrementally every year on the ground mounted transformers we install. (See appendices for more information.)

Q4 2019

Management of non-technical losses

What we said in Tranche 1
"Improved management of unregistered connections (known as 'untraded' meter points). We have historically addressed untraded meter points with energy suppliers, their agents and customers to get them registered so that the units are traded and settled correctly. We have pro-actively raised a formal industry change to introduce more rigour and provide clearer guidance on how to manage customers who are not registered with a supplier – we need to see this work through to its conclusion and build the outcome into our routine operations."

What we've done so far
This change was approved by Ofgem on the 30 August 2016 and implemented on 1 October 2016. In addition, we have invested in technology and resource to tackle this issue; field operative staff physically act on information received and carry out premise inspections working in conjunction with key back office support staff such as our Call Centres and a dedicated team operating within our Registration Services function.

2016 and ongoing

What we are planning to do
As part of our smart metering programme we will explore how tamper alerts from smart meters will be managed in conjunction with suppliers.

Q4 2019

Objective
How we are preparing to effectively use smart meter data to develop specific actions to manage losses

Details of action	When

New progressive investment team

What we said in Tranche 1
"Progressive Investment Team formed (covering losses, smart meters and smart grids) – initially two experienced design engineers that will consider the use of smart metering data, process improvements and policy guidance."

What we've done so far
Since 2017 this team has been expanded and is now called the Smart Grid Implementation Unit and sits within our Asset Management directorate. This team is tasked with the delivery of our ED1 smart grid development commitments and is working with the rest of Northern Powergrid to facilitate changes in how we design and operate the network. The improved understanding of losses and how we can effectively manage losses in future needs to be considered within this wider context rather than being a standalone function within the business.

Complete

[18]When considering active network management solutions and technologies to facilitate low-carbon connections, the impact on losses should be given full consideration.

1.4

Innovative approaches to losses management and actions taken to incorporate these approaches into business as usual activities

So far we have
— Mobilised a project investigating micro-resilence
— Provided losses guidance and training to all our HV and EHV designers

Improved understanding and ultimately reduction in losses is one area of our innovation strategy that we expect to receive more prominence in the coming years. We already have a few areas where we can see work usefully taking place and we further expect this list of opportunities to grow as we engage more on this subject with other DNOs and the wider range of stakeholders.

Another important consideration in innovation is the transfer of innovative learning into business as usual practices. This is as imperative in the area of losses as it is with other categories of innovation. In the case of losses, we have delivered actions to encourage this transition – most particularly, changes to our investment appraisal processes to ensure losses are valued at the societal cost. This will go a long way to promote the appropriate internal decisions made as part of policy or individual investment decisions.

How we are using innovative approaches to manage losses

We have installed on our network a suite of different sized energy storage devices located at different points on our network. These were installed during our Customer-Led Network Revolution project and we intend to maximise the benefits of these devices by using them for improving network resilience and assessing their impact on losses. We will seek to understand how those storage devices impact network losses when they are used in an optimal manner for system operator balancing services. We also expect this work to benefit our evaluation of whole energy system losses – particularly when cycling efficiency losses are taken into account.

How our findings are being incorporated into business as usual activities

The key route we have implemented so that losses management is incorporated into business as usual activities was to include an assessment of the social cost of losses in the options assessments in our investment appraisal documentation. This ensures that proposals made by engineers are transparent in their effect on losses at the time management come to make decisions on those proposals. It has ensured that the proposals and decisions, and their effect on losses, have been appropriately documented.

To facilitate this, tools and associated training for losses assessment have been rolled out to design engineers. We recognise that it is not only process or system changes that are required within our company and across the industry to 'price' the societal cost of carbon in the making of investment decisions. There is an issue of a cultural change required and we have recognised this in the training we have delivered to our engineers.

Funding of the enhanced understanding of losses programme

Innovation is funded through a number of different routes. First, it may be funded through our standard price control revenues as is typical for business improvements with short payback periods and more certain outcomes. Innovation funding mechanisms are used for specific projects that qualify for funding and where outcomes are either more long term or less certain – these can be from within the regulatory price control (e.g. the network innovation allowance) or externally (such as academic research funding or Innovate UK).

The Losses Discretionary Reward opens up a new avenue for network operators to fund the kind of activity described in this programme. Unless otherwise noted the specific projects identified in this proposal are not funded under any of the innovation funding mechanisms or specifically linked to any other RIIO-ED1 period financial initiatives.

Objective
How we are planning to use innovative approaches to manage losses

Details of action		When
 **Innovative approaches to be explored** **What we said in Tranche 1** "Explore opportunities to use energy storage as a method of reducing system losses (e.g. power factor correction and flattening the load curve) – understand the impact that electrical energy storage can have on our system losses." "Evaluate whether heat generated by electrical losses may be recycled either to offset electricity purchases that are used to maintain substation environments, or by thermo-electrical methods used for harvesting low grade heat."	**What we've done so far** We've engaged with Smarter Grid Solutions for the micro-resilience project which is now called DE-ROSA and is funded as a Network Innovation Allowance project. This project aims to create a high level blueprint for network resilience and how this can be achieved using open protocol standards and automation technology. We've also carried out a literature study for the re-use of heat project. There is considerable learning from UKPN's Bankside Project which heated the Tate Modern Gallery in London. This learning can be transferred to be used on a lower cost and more widespread use on Northern Powergrid's network.	**End 2018**
What we are planning to do We are building on UKPN's Bankside Project with the same consultancy (Arup) to look into the roll-out of this technology into business as usual. This project aims to look into the different heat recovery solutions available, the economic and technical feasibility of these	solutions and the opportunities on Northern Powergrid's network. We are also planning to use the data from our ex-CLNR Rise Carr battery which is now used for balancing services to put a financial value on the battery losses.	**Q4 2018 for re-use of heat** **Q4 2019 for Rise Carr**

Objective
How we will incorporate these approaches into 'business as usual' activities

Details of action		When
 **Adoption through changes to processes, systems and culture** **What we said in Tranche 1** "Use of losses cost-benefit analysis (CBA) within the investment appraisal process to ensure a level playing field for traditional and innovative approaches." **What we've done so far** In July 2016 we updated IMP/001/103 Code of Practice for the Methodology of Assessing Losses[19]. This Code of Practice details how to use Northern Powergrid's CBA tools which are built around Ofgem's tool used for the RIIO-ED1 submission. The Code of Practice sets out how to value losses when investigating investment	options for policy decisions on assets at LV and HV, bespoke design decisions at EHV and also capitalised loss values for transformer procurement. An example of how designers have used the tools is a new generator connection where the designer assessed a higher initial cost 132kV point of connection against a lower initial cost baseline 33kV point of connection. The Code of Practice also gives guidance into load loss factors (LLF), load growth factors and network configuration. The code of practice is referenced in the respective LV, HV, EHV and 132kV economic development codes of practice. The Smart Grid implementation unit also attends internal design team meetings to present progress updates on our losses commitments.	**Complete**
What we are planning to do To support our designer engineers in assessing losses on smart solutions we will produce an application guide aimed at the more complex design schemes so that losses are appropriately valued.	We will also add the subject of losses to our internal environmental newsletter in order to help to further incorporate losses into Northern Powergrid's culture.	**Q4 2018**

[19]IMP 001 103 – Code of Practice for the Methodology of Assessing Losses
http://www.northernpowergrid.com/asset/0/document/4034.pdf

Consideration of UK best practice and understanding **What we said in Tranche 1** "Consider the outcomes from other DNOs' proposals to enhance understanding of losses including their innovative approaches."	**What we've done so far** We've now implemented a process to review other DNOs, losses strategies and innovation projects. Since version 2 of our Strategy for Losses this is highlighted in the appendices and notes any relevant learning for Northern Powergrid and roposed actions arising from this.	**Complete**
What we are planning to do We will continue to do this as part of the periodic	updates of our strategy for losses and continue to participate in the ENA Technical Losses Working Group.	**Ongoing**
In-house training **What we said in Tranche 1** "Briefing of innovative approaches to design staff and management by the progressive investment team as the approaches become ready for deployment." **What we've done so far** As part of a wider change management exercise driven by Northern Powergrid's Smart Grid Implementation	Unit, all HV and EHV design engineers (staff and contract) have received formal training in how to incorporate losses into their designs. This was undertaken over three days in April 2017 at an offsite location. The training involved an explanation of the IMP/001/103[20] cost-benefit analysis tool, what load loss factors (LLF) are and why they are used, analogies between petrol and diesel choices for car buying and a new connections example using Northern Powergrid's load flow software (sample slides shown in appendix).	**Ongoing**
What we are planning to do As well as reinforcing losses management training to designers, we will also train our graduate engineers	in losses formally as part of their graduate training scheme.	**By Q4 2019 (but ongoing)**

[20]IMP 001 103 – Code of Practice for the Methodology of Assessing Losses http://www.northernpowergrid.com/asset/0/document/4034.pdf

Section 2
Next steps

We will continue to deliver our new and existing actions during the next two years. As with the previous tranche this will involve building on feedback from our stakeholders, other DNOs and industry experts. Where necessary we will adjust our actions to reflect the work done by others and keep a watching brief of technology and external changes to make sure our action plan continues to be relevant.

In parallel with this the progress on our tranche one actions and how this has evolved to create our tranche two actions will now be assessed by Ofgem as part of its Losses Discretionary Reward process. We expect this assessment to operate in the period up to Summer 2018. Ofgem will itself invite comments on our document to inform its judgement through a formal consultation in early 2018.

We will update the losses section of our website with the outcome of the Ofgem judgement and any adjustments we make to our action plan over the course of the next two years.

In the meantime, if you have any comments on the contents of this document please provide them in the first instance to **losses@northernpowergrid.com**

Supporting evidence appendix

This appendix includes supporting evidence of the progress on our actions since tranche one.

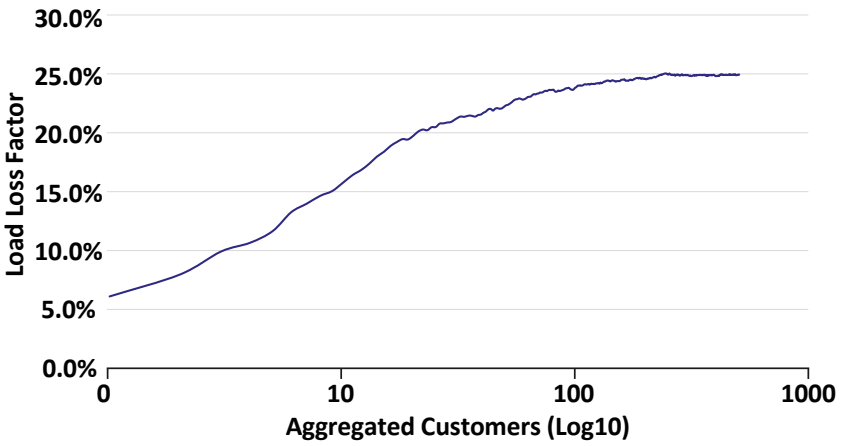
Enhanced losses forecasting model

Gannt chart below shows the Newcastle University project plan.

Activity	Task	Months																						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
WP1 – Literature Review	1.1 Review of academic and industrial literature	O1.1																							
	1.2 Review of salient NIA / NIC / LCN projects beyond and including those already identified by Northern Powergrid with focus on methods		O1.2																						
WP2 – Network Data Analysis and compiling of Technical Reports	2.1 Analysis of data from existing external NIA / NIC / LCN projects							O2.1																	
	2.2 Analysis of Northern Powergrid data focussing on LV distribution board data and additional network monitoring data										O2.2														
	2.3 Power Flow Measurement Sensitivity Analysis												O2.3												
WP3 - Enhanced Losses Model	3.1 Development of a spreadsheet based model																		O3.1						
	3.2 Validation of model outputs																				O3.2				
WP4 - Future Network Scenarios and Solutions	4.1 Incorporation of potential future network solutions and assessment of impact on technical network losses																								O4.1

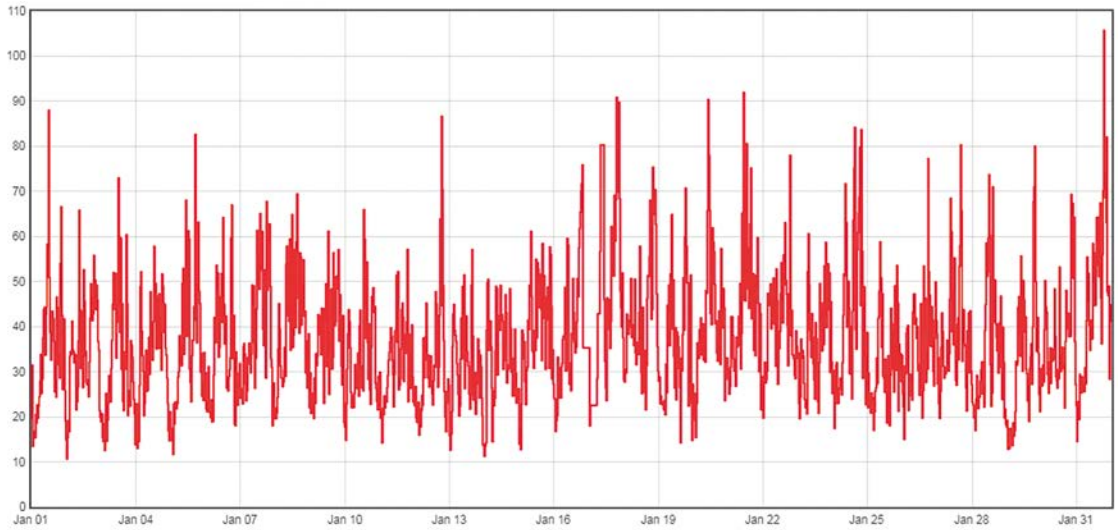
Analyse project data

The graph below is an extract from the Code of Practice for the Methodology of Assessing Losses, IMP/001/103. This shows how the load loss factor increases with customer numbers and is the reasoning behind valuing copper losses higher for ground-mounted transformers than for pole-mounted transformers.



Analyse low voltage board monitoring data

An extract from our DS3 project which shows the neutral current on a distribution transformer. This shows the high level of imbalance of some of our low voltage network.



Talking about loss management

"To me if we're losing electric that's a big concern."

Customer view
Grimsby workshop
September 2017

"Upscaling cables – how economical is this strategy?"

Stakeholder view
Leeds IET Event November 2017

Northern Powergrid's IET Smart Grid Event in Leeds University in November 2017 – Showing upsizing 11kV cable 300mm2 vs 185mm^2

"You might spend £500,000 on it (losses innovation) but you might save a million."

Customer view
Grimsby workshop
September 2017

"...it would be useful to understand the impact of the market moving to near zero marginal prices, losses won't cost anything?"

Stakeholder view
London DSO Event November 2017

Northern Powergrid's DSO Transition event in London in November 2017 – Results of poll following presentation on Losses management

"The losses project appears to be providing value but could do way greater focus on new technologies as an enabler."

Stakeholder view
London DSO Event November 2017

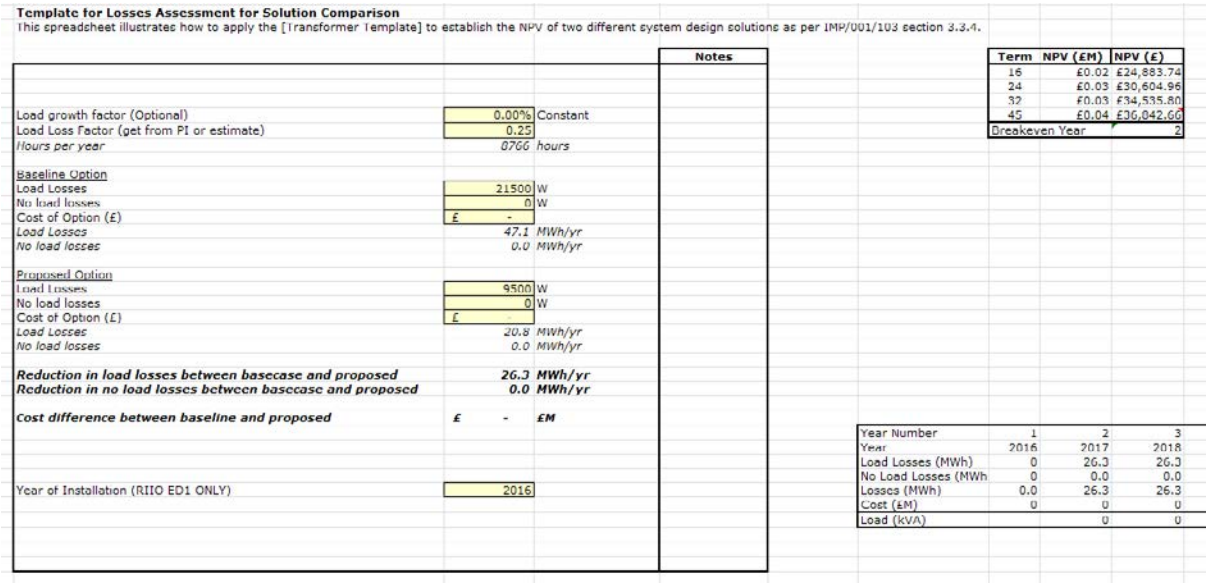
"...if you're innovating your technology, your cables and things then that's going to generate less heat and less energy."

Customer view
Grimsby workshop September 2017

Adapting network operations to load and losses characteristics

Example of losses benefit of moving an open point from the primary substation circuit breaker towards to the middle of two feeders.

	Blackburn Meadows – Meadowhall Cinema 11kV	Newhall Road – Brightside Lane Off 11kV	Total
Existing Scenario – CB Open at Newhall Road Primary			
Load	180A	0A	180A
Peak Losses	21.5kW	0kW	21.5kW
Annual Losses (0.25 LLF)	47.1MWh	0MWh	47.1MWh/year
Proposed Scenario – Open point to split load into two			
Load	87A	91A	178A
Peak Losses	3.3kW	6.2kW	9.5kW
Annual Losses (0.25 LLF)	7.2MWh	13.5MWh	20.8MWh/year
Annual Losses Saving			**26.3MWh/year**
Annual Losses Cost Saving			**£1,372/year**
NPV over 45 years			**£36,842**



Template for Losses Assessment for Solution Comparison

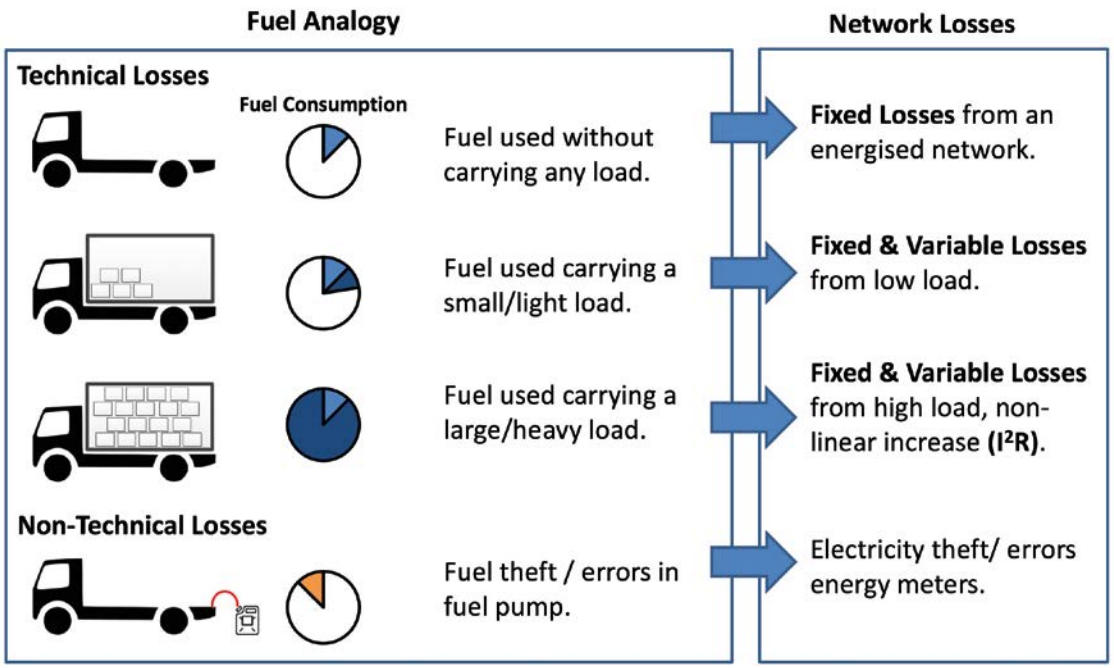
This spreadsheet illustrates how to apply the [Transformer Template] to establish the NPV of two different system design solutions as per IMP/001/103 section 3.3.4.

			Notes
Load growth factor (Optional)	0.00%	Constant	
Load Loss Factor (get from PI or estimate)	0.25		
Hours per year	8766	hours	
Baseline Option			
Load Losses	21500	W	
No load losses	0	W	
Cost of Option (£)	£ -		
Load Losses	47.1	MWh/yr	
No load losses	0.0	MWh/yr	
Proposed Option			
Load Losses	9500	W	
No load losses	0	W	
Cost of Option (£)	£ -		
Load Losses	20.8	MWh/yr	
No load losses	0.0	MWh/yr	
Reduction in load losses between basecase and proposed	**26.3**	**MWh/yr**	
Reduction in no load losses between basecase and proposed	**0.0**	**MWh/yr**	
cost difference between baseline and proposed	**£ -**	**£M**	
Year of Installation (RIIO ED1 ONLY)	2016		

Term	NPV (£M)	NPV (£)
16	£0.02	£24,883.74
24	£0.03	£30,604.96
32	£0.03	£34,535.80
45	£0.04	£36,042.66
Breakeven Year		2

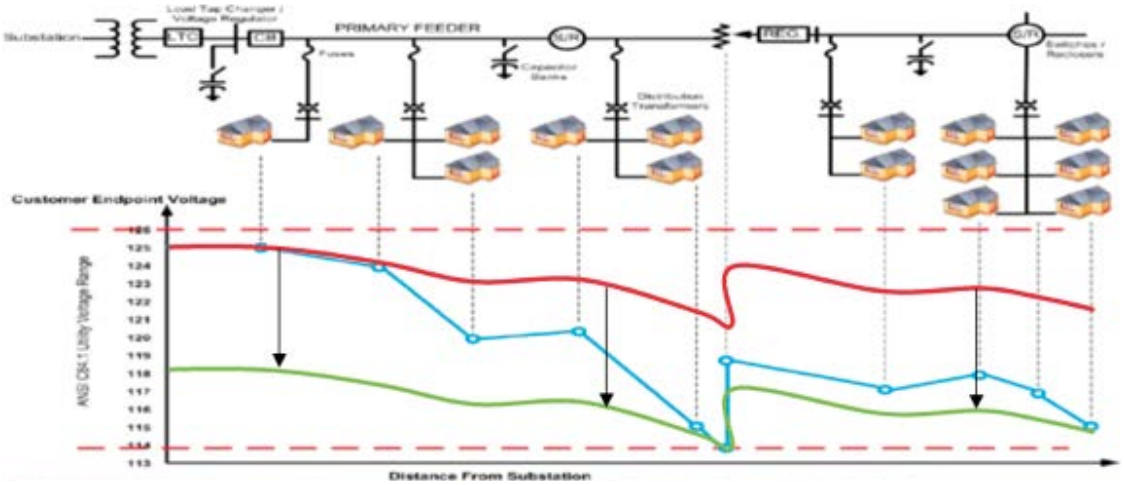
Year Number	1	2	3
Year	2016	2017	2018
Load Losses (MWh)	0	26.3	26.3
No Load Losses (MWh	0	0.0	0.0
Losses (MWh)	0.0	26.3	26.3
Cost (£M)	0	0	0
Load (kVA)		0	0

Holistic and co-ordinated approach to losses



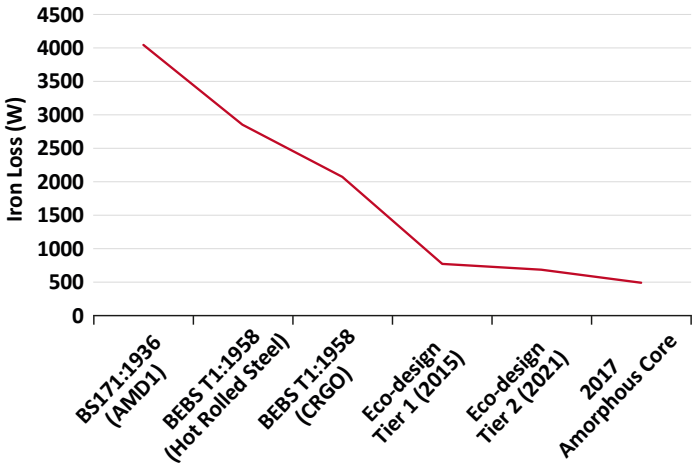
Example slide from Electrical Network Losses Ofgem Teach-in

Sharing international best practice and understanding



Example slide from NV Energy VVO/ VVO/CVR Pilot Project

Iron Loss Trend



Sharing UK best practice and understanding

A graph showing the Iron Loss trend of a 1000kVA transformer from 1936 to 2017. We are targeting early replacement of pre-1958 transformers and investigating the use of Amorphous Core transformers.

In-house training

Example slides from internal losses training to Northern Powergrid's design engineers.

- Calculate annual losses assuming no load growth and LLF of 0.2 (note hours per year 8766)

  Option 1 = *217kW*8766*0.2 = 380MWhrs*

  Option 2 = *125kW*8766*0.2 = 219MWhrs*

- Broadly 1MWh/year over 30 years is worth £1200 in today's money. How much do the losses cost?

  Option 1 = *380MWhrs*£1200 = £456k*

  Option 2 = *219MWhrs*£1200 = £263k*

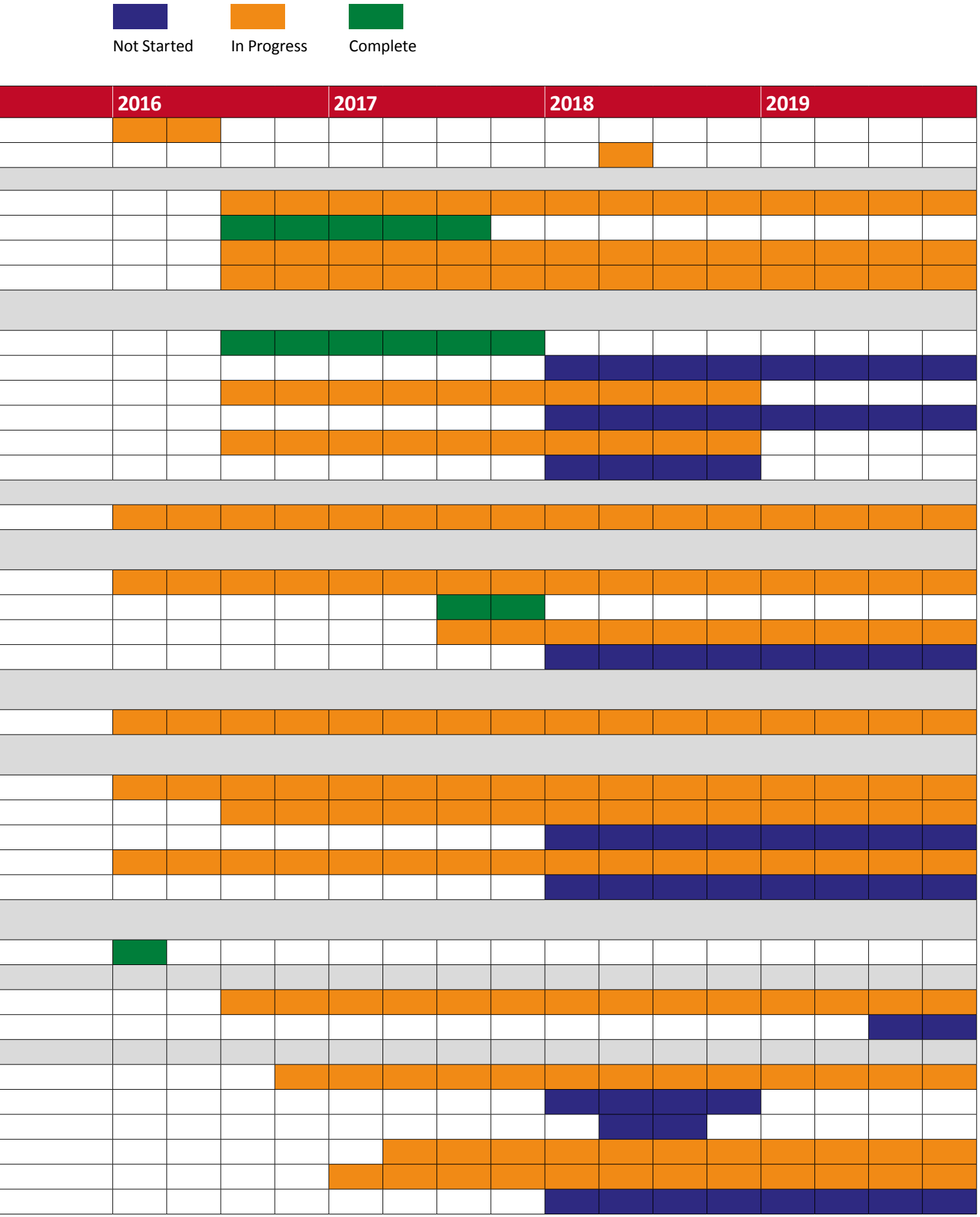
- Which option is the cheapest overall?

  Option 1 = £500k + £456k = £956k

  Option 2 = £675k + £263k = **£938k**

Proposed work plan

Section	Objective
	Ofgem Assessment – Tranche 1
	Ofgem Assessment – Tranche 2
Understanding of losses	**Improving our understanding of the current level and sources of losses on our networks**
	Enhanced losses forecasting model
	Errors in power flow measurement
	Analyse project data
	Analyse low voltage board monitoring data
	How we are considering the network in a holistic manner and making efforts to understand how losses on their network affect others
	Losses on the customer side of the meter
	Customer VAr advice
	Adapting network operation to load and losses characteristics
	EHV LDC investigation
	Exceptions to loss reduction actions
	Enhanced electrical parameter in models
Effective engagement and sharing of best practice	**How we are planning to utilise stakeholder engagement to inform our losses management actions**
	Stakeholder-led consultation
	How we are engaging with stakeholders to develop relevant partnerships which may help to manage losses
	Dialogue with our broad range of stakeholders
	Losses education animation
	In-depth dialogue with expert stakeholders
	Variable cost of electricity on losses
	Demonstration that we have processes in place to share our own best practice with relevant stakeholders
	Holistic and co-ordinated approach to losses
Processes to manage losses	**The best practice we have considered when contemplating processes and methods to manage losses on our networks**
	Sharing international best practice and understanding
	Sharing UK best practice and understanding
	Amorphous Core transformer installations
	Management of non-technical losses
	Smart meter tamper alerts process
	How we are preparing to effectively use smart meter data to develop specific actions to manage losses
	New Progressive Investment Team
Innovative approaches and implementation into BAU	**How we are planning to use innovative approaches to manage losses**
	Innovative approaches to be explored
	Rise Carr battery losses investigation
	How we will incorporate these approaches into 'business as usual' activities
	Adoption through changes to processes, systems and culture
	Application Guide for losses in design schemes
	Internal environmental newsletter
	Consideration of UK best practice and understanding
	In-house training
	Graduate training


Not Started
In Progress
Complete
2016
2017
2018
2019

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