Scottish and Southern Energy
Power Distribution

Scottish and Southern Energy Power Distribution Losses Discretionary Reward

Tranche 1 Submission January 2016

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1 Overview

As a responsible network owner we care about the impact of losses on both customers' bills and the environment, and we wish to be recognised for leading the way in proactively targeting and reducing losses.

In this document we set out our vision on how we intend to take action to drive down network losses by:

- Improving our understanding of the causes of network losses by utilising information from new sources of data;
- Engaging with a range of stakeholders including establishing a new DNO Losses Forum supported with an internal SSEPD Losses Steering Board;
- Implementing dedicated teams to identify and where practicable rectify sources of losses on our network; and
- Identifying new techniques and approaches to reduce losses, including establishing an industry leading Losses Competition complete with prize fund to stimulate innovation.

These measures and the others outlined in this submission will see SSEPD make a step change in our approach to managing losses on the network.

We first set out our approach to managing losses in our revised Losses Strategy published in April 2015. This strategy identifies the actions we will put in place to ensure that distribution losses are kept as low as reasonably practicable. This submission builds on that Strategy and identifies how we will move to a level beyond that set out previously. Distribution losses are an unavoidable consequence of transferring energy across the electricity network and have a significant financial and environmental impact. The cost of distribution network losses to GB customers is approximately £1 billion per annum. Changes in the way we use and generate electrical energy are expected to increase losses on the network making management even more important.

At the heart of a business operating in the energy sector, SSEPD believes that there has to be a strong and embedded commitment to sustainability. Correspondingly, in 2013 we adopted a new definition for our **Sustainability** value: **'Our decisions and actions are ethical, responsible and balanced, helping to achieve environmental, social and economic well-being for current and future generations'**. Reducing losses will help to support this commitment to operating a sustainable distribution network.

In order to achieve this we need to make sure that losses remain a key consideration in all of the activities we undertake to operate our network. This will ensure that the impact of losses continues to be included in our decision making processes for equipment specification, procurement, network planning and investment as well as operation and maintenance.

We are determined to drive down the cost to customers from losses; only by taking a holistic approach, considering losses in all of our activities and working with a broad range of stakeholders will we be able to achieve this. I believe that the measures outlined in this document, in combination with our ED1 Losses Strategy, will result in the most significant change to losses management in the history of the industry.

The annual cost of distribution network losses to customers is approximately £1 billion.

Colin Nicol - Managing Director Networks

2 Our plan – our Vision – our Priorities

In this submission we set out how we will achieve a step change in the management of losses with the implementation of measures to target and reduce losses effectively.

The work we have already undertaken has given us the firm belief that losses can be significantly reduced by smart, targeted and pro-active solutions.

To achieve this we believe that the responsibility for reducing losses and improving network efficiency within our network needs to be clearly and unambiguously assigned within our organisation.

Our vision therefore, is to establish dedicated "Losses Teams" responsible for systematically applying the right solution, in the right place, at the right time to bring about a sustained reduction in losses. By intervening in such a systematic manner we anticipate being able to provide other benefits to the network and customers.

The measures outlined in our RIIO ED1 Losses Strategy are already being implemented and this should see us make good progress. However, going forward the drive on losses is expected to be upwards as a result of the electrification of heat and transport combined with the growth in distributed generation leading to an increased utilisation of the electrical network. Additionally, this growth in Low Carbon Technologies and potentially dynamic tariffs could give rise to peakier network demand profiles which will result in even higher network losses.

Our focussed approach will tackle this upward drive directly applying and making best use of the new tools, data and equipment which will become available. In this submission we will describe the steps we plan to transform our approach to reducing the losses on our network – this is embodied in the creation of our Losses Teams. Broadly modelled on the leakage teams of the water industry, for the first time in the Distribution industry this will see the creation of a dedicated resource specifically focussed on loss reduction. To drive this forward we will focus on:

1- Understanding *where* to intervene

- Building on our existing strategy by directly funding new pieces of analysis to better develop our understanding of losses and focus our actions;
- Improve preparation for the Smart Meter rollout by leveraging the learning from our existing LCNF projects including SAVE and NTVV; and
- Initiating engagement with adjoining DNOs and upstream TO/SO to ensure that networks operations are optimised across boundaries.

2 - Understanding *how* to Intervene

- Engaging with wide range of key stakeholder including supply chain, other utilities and other energy market participants to raise awareness of losses and ensure a holistic approach to the management of losses;
- Sponsoring the creation of a new award category at the Energy Innovation Centre Awards for the best new approach to the management and understanding of network losses; and
- Developing a range of solutions (detailed later) from innovation programmes throughout the world.

3 - Intervening *effectively*

- Creation of dedicated 'Losses Teams' to focus on the implementation of appropriate loss reduction actions on the network;
- Establishment of an SSEPD Losses Steering Group to chaired by our Director of engineering and Investment to focus and support for our programme of work; and
- Leading the creation of a DNO Losses Forum to share best practise and develop a coordinated approach to the understanding and management of network losses.

Initiatives over and above existing losses strategy planned in EDI

Figure 1 – losses related activites in ED1 over and above our revised Losses Strategy

The first stage of this work is already underway, SSEPD have funded a new project – 'Losses Teams' to build on the knowledge and learning gained from the NTVV project. The aim is to develop a better methodology which will allow us to characterise and identify network segments which are the most likely to be experiencing high losses.

This will allow a range of potential network interventions to be systematically assessed and crucially will give SSEPD valuable additional understanding of network losses. This project is described in more detail in Appendix 1. This project will also consider the wider benefits which could be achieved by targeting interventions to reduce losses, this could include:

- Improved network phase balancing – this could 'unlock' additional network capacity and avoid the need for network reinforcement;
- Power Factor Improvement – again this has the potential to increase network capacity;
- Reliability – our improved understanding may allow for an earlier indication of potential faults or equipment failures; and
- Asset Health – better management of phase balancing, harmonics and power factor should improve asset health and potentially extend asset life.

The following sections will set out how we plan to implement our strategy for understanding and ultimately reducing losses on our network This will reduce costs for customers with associated environmental and carbon benefits.

3 Losses Strategy – a firm foundation

Our Losses Strategy will build on the progress made during the previous price control period (see Figure 2 below).

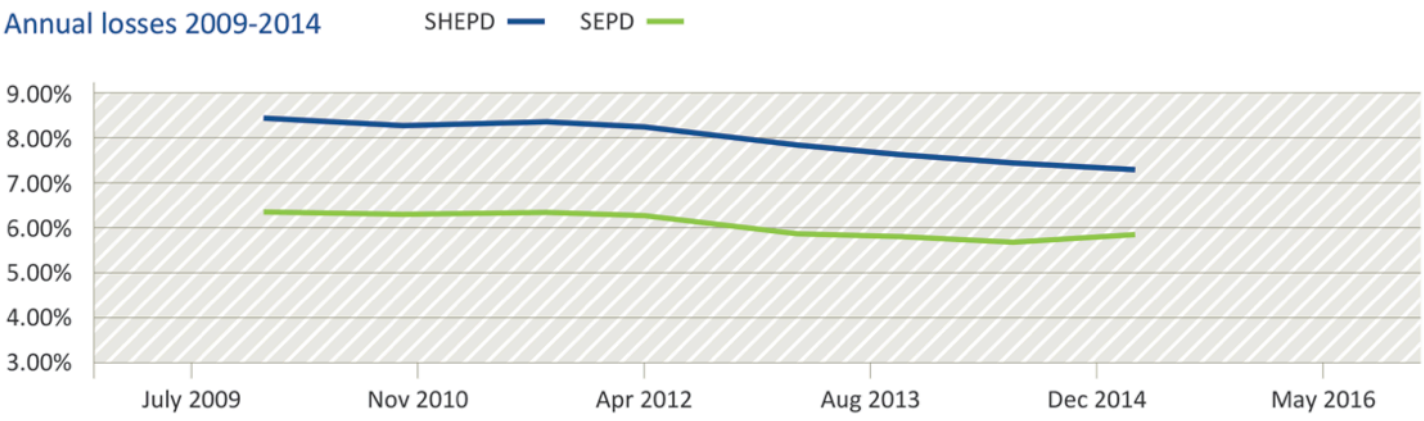


Figure 2 – SSEPD percentage losses reported during DPCR5

The measures we plan to undertake to achieve this were published in our updated Losses Strategy in April 2015. Since then we have begun the process of implementing the appropriate changes within the business to deliver the anticipated reduction in network losses.

- Installing Primary & Grid transformers that out perform the EU Eco Directive;
- Increasing the minimum size of new Distribution transformers to:
  - 500kVA for ground mounted units
  - 50kVA for pole mounted units
- Early replacement of pre 1960 secondary transformers;
- Increasing the minimum cable size to the next size up:
  - 185sqmm conductor at low voltage
  - 150sqmm conductor at 11kV

To make certain the measures defined at strategy level are fulfilled as stated, we have made the necessary changes to our Strategy, Policy, Work Procedures and Technical Guides.

In order to ensure that the information is successfully communicated we have undertaken a comprehensive programme of engagement both internally and externally. These strategy changes have also been shared with our Procurement and Connections teams to ensure they understood the implications and critically can predict the future volumes of particular items of plant.

Further internal briefing sessions have been undertaken with key departments including:

- Network Planning
- System Planning
- Operational depots

Following the internal dissemination and agreement, the operational alterations were shared with external stakeholders. This process consisted of:

- Updated Losses Strategy published on SSEPD website
- Formal consultation with Independent Connection Providers
- Policy published on the SSEPD website
- Approved plant and equipment procedures updated to reflect strategy

The formal consultation allowed ICPs to understand the reasons behind the design alterations and to have their concerns listened to. In addition to the formal consultation with ICPs we have committed to face to face discussions with all interested stakeholders within SSEPD's programme of Regional Stakeholder Engagement events planned for 2016.

We plan further engagement activities to raise awareness and understanding of network losses, these are described in more detail in Section 5. The outputs from these sessions will allow us to refine and develop our approach going forward.

The Losses strategy is the foundation for the work we plan to do and it provides a robust framework for us to implement the further changes we propose.

3.1 Ensuring our strategy is relevant

An important part of the Strategy implementation is to ensure the document is updated at regular intervals throughout the ED1 period. The intention is to complete a review of the Cost Benefit Analysis (CBA) for each of the measures employed annually to ensure costs are reflective of current prices and to capture any significant changes or relevant industry learnings. In addition we have also committed to a full scale review at the mid point of ED1 to consider a wide range of potential new measures that may have a positive business case, based on changes over the past four years. Particular focus at this point will be on the outputs and learnings from both SSEPD's LCNF Tier 2 portfolio and other GB DNO's Innovation projects. We will also include further inputs from the supply chain and other stakeholders as part of this review.

The SSEPD network covers a vast geographic area from extremely isolated areas in the highlands of Scotland to the densely populated Thames Valley. The networks that supply these differing communities have very different characteristics; the work we are undertaking will help us to identify the most appropriate interventions and measures which are best suited to the networks that we manage.

4 Understanding of losses – best use of new data

Having a clearer understanding of the losses on the network and the underlying causes is an essential element of our approach to managing losses. Existing LCNF projects have already begun to develop a better understanding of losses on the network; the figure below shows the estimated breakdown of where losses occur on our network.

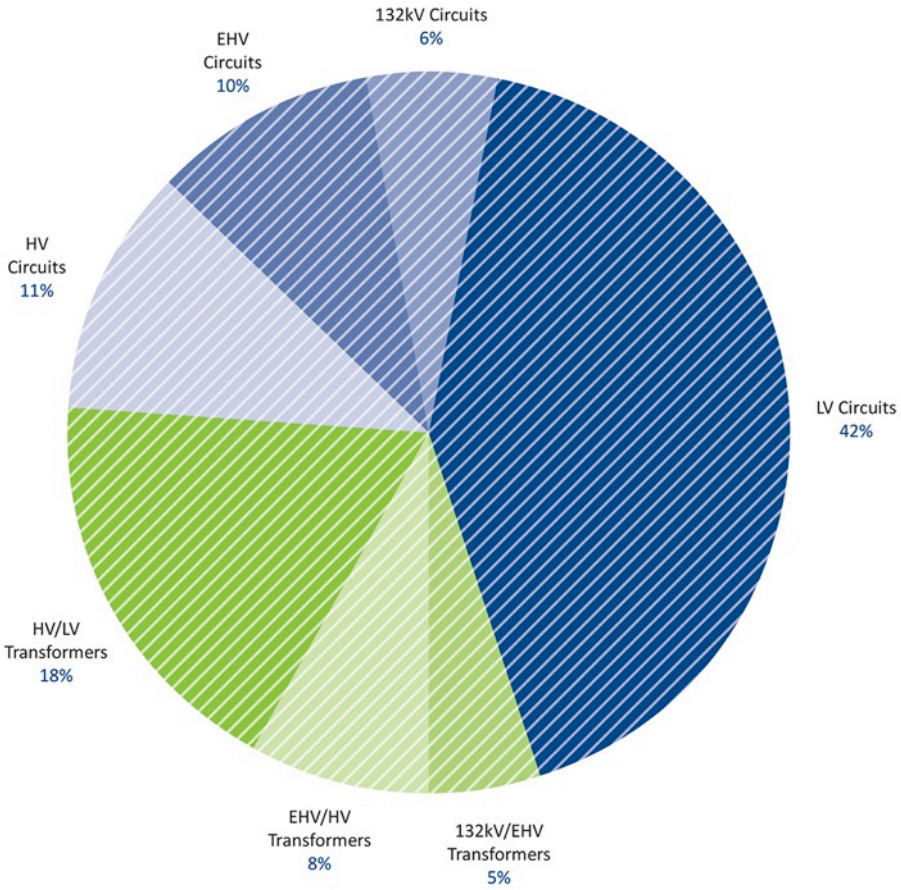


Figure 3 – estimated breakdown of where losses occur on our network

Identifying network losses accurately has always been challenging with no established methodology and limited availability of the relevant data. However, there are a number of new sources of data particularly the forthcoming Smart Meter rollout which give an opportunity to improve understanding of losses. Similarly, there have been improvements in the cost, quality and reliability of monitoring equipment for secondary substations.

With this in mind we have already embarked on a new piece of work – Losses Teams – which will give us a much deeper understanding of the source of losses on our network and should allow us to move to a level beyond that detailed in our Losses Strategy. Using the data gathered from the NTVV project, this will see a detailed study into the losses characteristics of a section of the SSEPD network. This will allow the characterisation of the 'types' of network and help to identify sections with the highest levels of losses. Figure 4b gives an indicative view on the potential outputs for a section of our network, which characterises our network using a simple traffic light system. This will then be used to target further investigation and potential interventions to improve network performance.

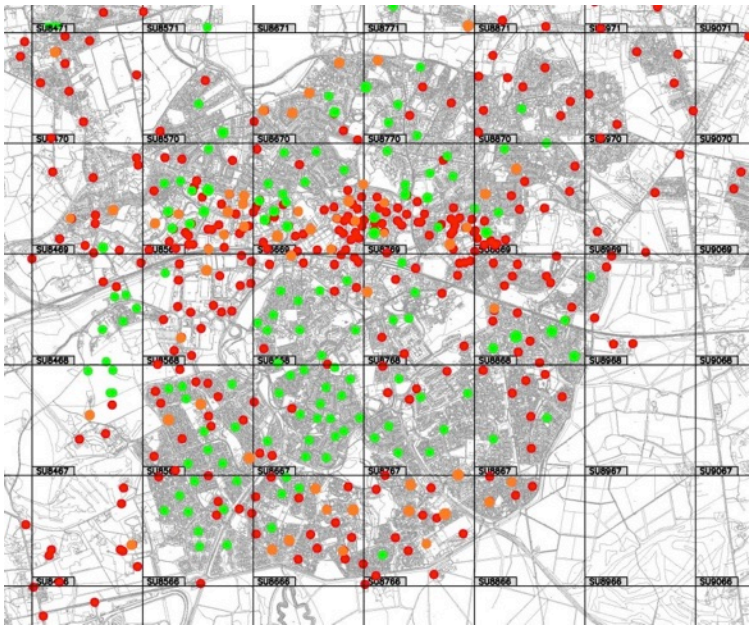


Figure 4a – network segmentation and characterisation

Figure 4b – detailed investigation to target sources of network losses

This will be based on secondary substation and low voltage feeder data collated from over 300 secondary substations and approximately 300 pseudo Smart Meter installations that were deployed as part of the NTVV project. This will allow for appropriate interventions to be targeted to the relevant network segments. We are also proposing the creation of dedicated teams to implement these measures and specifically target network losses. This project is described in detail in the following sections of the report.

Where appropriate we will also continue to make network visibility and loss reduction key elements of our innovation portfolio going forward. The knowledge and learning gathered from these projects will continue to allow us to develop our understanding of losses which will allow further refinement of our policies and procedures to target losses cost effectively. This will be shared with the other DNOs at a new forum as described in Section 4.1.

We also propose the creation of an internal Losses Steering Group chaired by the Director of Engineering and Investment to raise the profile of losses within the business and to ensure that losses are appropriately considered in all of our operations. This steering group will include representation from all of the key areas of our business including network planning, asset management, operations and procurement. This will help ensure that the learning from the Losses Teams project are implemented into business as usual detailed further in appendix 3.

4.1 Inter network engagement work

Historically DNO licence areas have been operated as separate entities without significant inter connection between other licence areas. There are existing shared sites where DNOs have feeds direct from adjacent network operators and we also operate sites where the 11kV or 33kV switchboard may be shared. These sites are normally at or near to historic geographical boundaries.

To operate an efficient GB network, DNOs must cooperate to ensure that investment, planning and operational decisions are as well informed as possible to mitigate any unintended adverse impacts on other parts of the network. To supplement the work on our losses strategy SSEPD have initiated engagement directly with the DNOs and TOs in areas where our networks have interconnection.

The potential exists within this arrangement to impact the efficiency of the combined networks, even though it is very likely that this inefficiency would be currently unknown to the individual network operators. This could be from longer than necessary circuits installed to ensure security of supply (P2/6 compliance), contradictory or non optimal voltage settings and open points geographically constrained at the network boundary. Therefore a more holistic approach could have a number of potential customer benefits including:

- Reduced connection cost;
- Increased efficiency of the combined network; and
- Reduction in cost to achieve network security of supply.

In order to better understand the impact that actions within our distribution networks have with interconnected networks such as other DNOs or TOs we have started a process of direct engagement. This engagement firstly involved discussing the current practice with each of our boundary neighbours.

In SEPD and SHEPD this includes:

- Western Power Distribution;
- UK Power Networks;
- Scottish Power Energy Networks;
- National Grid; and
- SHE Transmission.

An initial meeting was held with each of our boundary neighbours beginning this process in our southern network in October 2015 with UK Power Networks and followed by WPD in November 2015. The discussions provided an understanding of the exiting process and we were able to gauge the willingness of all parties to make alterations or improvements. From the work to identify best practice it has been agreed that there could be potential benefits from having a more structured, joined up approach. The work has since shifted from understanding the potential issues of the current practice to developing an initial layout of a process to define the principles required to improve DNO interconnection.

The sessions on our SEPD network area were followed up in a similar manner for our SHEPD licence with Scottish Power Energy Networks. There was agreement to work together to help to better understand the combined network impact. The main areas of interest focused on the interconnection points between our networks at 33kV. A decision was made to jointly work together to analyse the losses impact of these interconnection points. This first piece of work will form a baseline to understand the level of existing losses and will influence future areas work.

The potential exists within this arrangement to impact the efficiency of the combined networks, even though it is very likely that this inefficiency would be currently unknown to the individual network operators.

The potential areas of consideration relate to how we will:

- Determine the most efficient Point of Connection (PoC) for future customers even if this crosses geographical network boundaries;
- Consider the benefits of transfer capacity between DNO areas to meet P2/6 compliance under N-1 conditions;
- Consider most appropriate PoC for future connection applications close to network boundaries, to ensure most efficient connection;
- Assess the most suitable location for network open points without the traditional geographical boundary constraints; and
- Review voltage settings at shared locations to ensure combined network operation is operating efficiently.

The intention is to work together with the other DNOs to refine the process over the coming months and we expect to complete the work in 2016. The completed process will highlight the options available to DNOs when managing new connections, building new substations or making alterations to the network at or near to geographical boundaries. The process will detail how to obtain key information required to perform network analysis outside of the DNO patch with appropriate contacts of network planners aligned to support inter DNO analysis. It is anticipated that the new process will not be constrained by geographical boundaries e.g. a new connection within a particular DNO's patch may be closer and more cost effective to connect to an adjacent DNO's network with an associated reduction in network losses. The aim of the process is to ensure losses are considered at a whole network, as opposed to DNO licence area level, and ultimately reduce costs to the customer without being constrained by existing boundaries.

Concurrent with this we will also engage with the upstream TOs and the SO. These discussions will follow a similar pattern to that proposed for engaging with neighbouring DNOs. This is an area which could be particularly beneficial in locations which have high penetrations of embedded generation which require careful management of reactive power. Again, this will focus on reviewing existing arrangements and then identifying areas for potential improvement. In a similar way SSEPD will also engage with gas network owners, to establish if there are opportunities to identify and manage losses across both networks. The increasing electrification of heat and the additional information available from the Smart Meter roll out may give further opportunities for collaboration.

To help facilitate this SSEPD would propose to lead the creation of a DNO Losses Forum, to allow for the sharing of best practice and provide a focus for the DNOs and other licensees. This will allow knowledge and best practice to be shared and facilitate the transition to business as usual across the industry. SSEPD were among the first DNOs to deploy energy storage technology on the network and led the establishment of the Energy Storage Operators Forum to ensure that knowledge and learning were quickly shared throughout the industry; this included the publication of a Good Practice Guide. We believe that the management of losses would benefit from a similar approach. Therefore, we would propose to lead the creation of a DNO Losses Forum. Further details are included in Appendix 3.

SSEPD will look to lead the creation of DNO Losses Forum to share best practice and give focus to the industry.

5 Effective engagement and sharing of best practice

Losses are an issue which cannot be tackled by DNOs in isolation and need a holistic approach involving all of the participants in the energy supply chain. Without engagement with a variety of stakeholders we cannot make the desired progress to deliver the anticipated losses benefits.

As outlined above, we have already set in motion a process to engage with other DNOs and the TOs, however, to realise all of the potential benefits we need to engage with a much wider variety of stakeholders who have an interest in ensuring that the network is operated as efficiently as possible. We have ongoing relationships with many of these stakeholders and where appropriate we will continue to build on these relationships to:

- Raise awareness amongst stakeholders on the causes of electrical losses, their cost and associated societal and environmental environmental impact;
- Develop an understanding with stakeholders on their impact on losses;
- Seek to develop working partnerships with stakeholders to develop projects which have the potential to lead to a reduction in losses; and
- Engage with industry partners to ensure that a holistic approach to loss reduction is put in place.

5.1 Identifying our stakeholders

High Influence / Low Interest

Strategic
- MPs and MSPs
- Scottish Government
- UK Government
- DECC
- SEPA
- Environmental Agency

Organisational
- Smart Grid Community
- DNOs

Operational
- GB Consumers
- Gas Network Operators
- Police and Fire Service

High Influence / High Interest

Strategic
- Ofgem

Organisational
- Transmission Owners
- System Operator
- Suppliers
- Meter Operators
- ICPs / IDNOs

Operational
- Local Authorities
- Housing Associations
- Landlords
- Supply Chain – equipment manufacturers
- Innovation Community

Low Influence / Low Interest

Operational
- Communities
- Telecoms and Water Companies
- Media

Low Influence / High Interest

Operational
- Academia
- Community Energy Groups
- Fuel Poverty Groups
- Renewable Generation Developers
- Home Builders/NHBF

5.2 A holistic approach

We plan **additional** engagement activities to increase the knowledge and understanding of losses:

- **Neighbouring DNOs** – liaison with neighbouring DNOs offers the potential for network operations to be optimised across boundaries. There are a number of areas where SSEPD and adjacent DNOs have interfaces where closer cooperation has the potential to reduce losses. Discussions have already taken place with all our DNO interfaces UKPN, SPEN and WPD – further details in Section 4.
- **Transmission Operators** – SSEPD will review interfaces with TOs to ensure that losses are the respective networks are operating 'optimally' from a losses perspective. For example managing voltage control and reactive power in areas where there has been a significant increase in distributed generation. This will follow the structure of the meetings with the neighbouring DNOs.
- **Suppliers/Meter Operators** – SSEPD will continue to work with both suppliers and meter operators to focus and reduce non-technical losses such as Conveyancing and Settlement inaccuracies. SSEPD have already established a dedicated Revenue Protection Team. This team has made significant progress in reducing the number of incorrectly allocated MPANs, inaccurate metering information etc. In order to further progress this work we plan to develop further systems to make better use of data to allow us to better target meters with inaccurate de-energisation details to allow SSEPD and the suppliers to target appropriate actions.
- **Connections Customers** – we will continue to build on our relationship with all connection customers including IDNOs and ICPs to raise their awareness of electrical losses and the policy changes outlined in our Losses Strategy in particular. Going forward we will include electrical losses within our engagement plans with connection customers – this will allow them to ensure that their networks are designed and that they understand the benefits from the policy changes described in our Losses Strategy. Initially, this will include Connections Customer Steering Panel meetings planned for Oxford and Stirling during February 2016.
- **Community Energy Groups** – encouraging the local production and consumption of energy can support a reduction in overall network losses. We will continue to engage with Community Energy Groups, development agencies and both Scottish and UK governments to help facilitate local energy schemes. Through this engagement we will ensure that the efficiency of the distribution network is appropriately considered as these projects are developed. Further information in Appendix 6.
- **Unmetered Customer User Group** – SSEPD has existing relationships with unmetered customers (primarily Local Authority Lighting departments) to develop best practice on connection issues. During these sessions we will highlight losses to raise their awareness and that we continue to develop inventory and connection information to ensure accurate billing and recording. Losses and the efficiency of the network will continue to form part of the agenda at these sessions.
- **Supply Chain and Equipment Suppliers** – we have well established relationships with suppliers these include all of the major electrical OEMs. Through this process we will continue to raise awareness of changes to our strategy and to help identify innovative equipment solutions targeted at increasing efficiency**.**
- **Gas and water companies** – engage with other network operators to share best practice in managing losses. This will include gas and water network operators who share the same footprint area as SSEPD.

5.3 Losses competition

To ensure that we have identified best practice and are aware of new innovations and developments within the market place, SSEPD plan to initiate a Losses Competition. The competition aims to identify new approaches to measurement, modelling and analysis of network data to improve our understanding of losses. In addition it seeks to identify new technology and other interventions which could lead to a reduction in network losses. This will be open to a wide range of potential participants including academics, SMEs and the wider innovation community with a prize fund for the best ideas. This will be included as a new category at the Energy Innovation Centres Annual Awards. Further details in Appendix 4.

6 Process to manage losses

6.1 Identifying best practice

In developing the Losses Strategy we took the learning from a wide range of sources in order to establish best practice across the industry both nationally and internationally.

To ensure that we manage network losses effectively, we will continue to review and assess developments in best practice both nationally and internationally. We are well placed to continue with this as we have already completed a review of best practice completed as part of an earlier IFI project and as part of the first SDRC for the LEAN project. These projects helped inform the development of our Losses Strategy and are described in more detail in the following sections.

We will use a range of techniques to identify best practice, including:

- Feedback from stakeholder engagement activities described in Section 5;
- Ongoing monitoring relevant learning from existing and future LCNF/NIA and NIC projects;
- Learning from the proposed DNO Losses Forum; and
- Outcomes from proposed Losses Competition.

However, we recognise that this is an area where we will need to continue to monitor closely and be able to take advantage of developments for the measurement, management and reduction of losses. This will include developments in technology, improved analysis techniques and availability of better information from the smart meter roll out. Our Losses Teams project will conduct a further review of best practise and these will be modelled to assess their suitability. This is described in further detail in Work Pack 3 in Appendix 1.

These outputs will be used in our Losses Teams project and any beneficial measures identified will be considered for implementation. In order to give focus, the Losses Team project will see the creation of dedicated teams who will be specifically tasked with implementing loss reduction measures across our network.

The strategy utilises the expertise of our engineering staff to propose and calculate CBAs to consider the potential interventions. This is supported by the sources detailed below:

- Historical SSEPD losses focused R&D work;
- Losses related R&D projects completed by GB DNOs; and
- Existing and previous versions of each DNO's losses strategy.

Of particular benefit to the strategy analysis was the work completed and published as part of an SSEPD IFI project 'Losses Reduction Study' (http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7373696). This project considered a range of innovative approaches to loss reduction as opposed to simplistic conductor or transformer upgrades. The approaches were the result of a detailed review of best practice from across the world.

The project estimated the benefits from potential interventions. The complete 33kV/11kV network on the Isle of Wight was modelled in detail to provide an estimated annual energy saving for each of the interventions. This energy saving was then used as an input into a CBA using the parameters specified within the Ofgem Societal Benefits spreadsheet. This process identified two interventions which had the potentially positive CBAs. These measures were taken forward for further development in the 2015 LCNF Tier 2 funded project Low Energy Automated Networks (LEAN). The LEAN project considered the switching out of underutilised plant and optimising the location of network open points to minimise losses – further details in Appendix 7.

The first SDRC on the LEAN project completed a literature review to study best practice with the industry in GB and internationally (https://www.ssepd.co.uk/LEAN/Learning/). This report highlighted a number of international projects with positive results on power factor correction from a losses perspective. Additionally the literature review provided a benchmark for the GB network against other EU countries and, although not always a direct comparison did show there was potential for GB to improve. We have disseminated the findings of this report on the LEAN website and have also responded to specific requests/questions from other DNOs with regard to the content of the report.

Both of the projects above identified a number of other measures which were not commercially viable at that time and were therefore not included in our strategy. However, these will be kept under review and their implementation re-evaluated to take account of improvements in technology, developing commercial arrangements and potential cost reductions as the various technologies mature. It is our intention to carry out a full review of our Losses Strategy at the mid point of the ED1 period.

The work completed by other DNOs was also studied in developing our strategy. Of particular interest was the IFI funded report prepared by SOHN Associates and Imperial College (http://www.westernpower.co.uk/docs/Innovation-and-Low-Carbon/Losses-strategy/SOHN-Losses-Report.aspx), which proposed a wide range of potential loss reduction mechanisms and interventions. These recommendations were reviewed using a similar methodology to that outlined above. Again, only a small number of the measures identified were currently viable at present. For example, losses from transformer cores in units installed circa pre 1958 transformers were identified as being higher than more recent models primarily due to improvements in the quality of the steel used to create the transformer cores. This fed into our analysis and provided a case for prioritising older but otherwise healthy Distribution transformers for replacement.

The analysis carried out has allowed SSEPD to identify a range of interventions which are currently commercially viable and these have been identified in our published Losses Strategy. However, a range of other options were also identified which although not currently financially attractive for GB customers may warrant further analysis and assessment. The availability of better quality information from Smart Meters, improvements in technology efficiency / reliability and reducing costs will see many of these become beneficial in future. This will be a key element of the Losses Teams project.

We have disseminated the findings of the LEAN project literature review and have responded to specific requests from other DNOs

6.2 Preparation for Smart Meter rollout

A key part of our strategy is to ensure we are in a position to exploit the maximum benefits from Smart Meter data. To help achieve this we have committed to the assessment of dedicated Losses Teams in our business with the sole focus of improving network efficiency.

We have already committed internal funding to complete an in-depth investigation of the potential benefits of having teams of staff working with the single aim of improving network efficiency. This initial analysis phase will utilise data collected from monitors installed in over 300 secondary substations in conjunction with 300 pseudo Smart Meters. This will be used to characterise various network types and identify the network segments which are likely to be the worst performing from a losses perspective. Having characterised the worst performing segments we will be able to identify the most appropriate interventions to resolve the issues.

A key part of this investigation focuses on how to best utilise Smart Metering data to identify losses on the network. Again this will use data gathered from 300 pseudo Smart Meters which were installed in the TVV project. The analysis will focus on how to link Smart Meter data with substation monitors. At a high level this will allow the energy delivered from our secondary substations to be compared with the energy taken off the network by consumers. The difference between the two is the network losses as shown in Figure 5 below. This information will help us to validate our models and develop a better understanding of losses on our network. In future this information will help to inform our modelling work and identify potential issues. These could then be highlighted to our Losses Team staff for further investigation and implementation of any appropriate remedial action. The potential interventions will be selected using a CBA based approach in order to ensure best value.

How Smart Meters will identify network losses

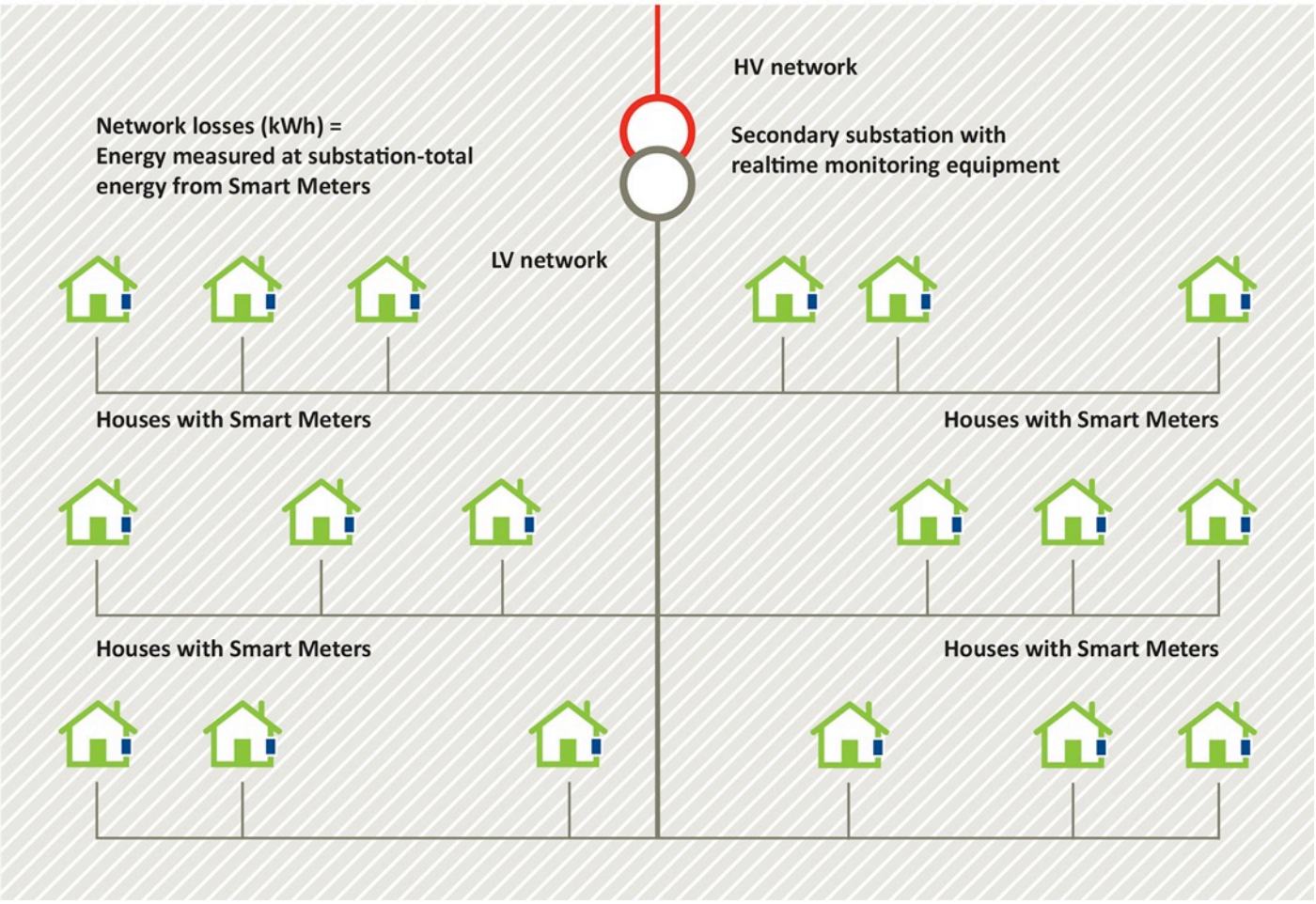


Figure 5 – Smart Meters and substation monitors

We have already committed internal funding to complete an in depth investigation into the data collated from 300 Smart Meters installed in the NTVV project.

The Losses Teams project aims to inform the development of the necessary processes to understand the extent that Smart Meter data can be utilised to pinpoint high loss feeder circuits and clarify the percentage levels of Smart Meter penetration required. This means that we can implement these processes before the Smart Metering rollout is complete.

Having identified the potential interventions, the Losses Team will be responsible for the implementation of the proposed solution or any other corrective actions. This will also include fitting additional monitoring to gather the necessary data to validate and update the CBAs to ensure that the outcomes are as predicted. It is envisaged that this approach will also provide other associated benefits including:

- Improved network reliability;
- Improved asset health; and
- Improved network visibility through better monitoring.

The cumulative impact of these benefits may move otherwise unjustified loss reduction interventions past the 'tipping point' into viability.

6.3 Managing non-technical losses

Non-Technical Losses are crucial areas which form an important part of our approach. SSEPD have established a dedicated Revenue Protection Team to give a focus on managing non-technical losses. We intend to build and develop on the work undertaken in this area.

We have a process to proactively investigate potential theft cases resulting in losses on the network from a series of reports. These include de-energised MPANs, untraded MPANs and new connection quotes which have been requested but never paid for or completed. During the investigation process we use a variety of data sources such as industry flows to identify potential issues for further investigation.

We have a dedicated telephone number and email address where intelligence and allegations of theft can be brought to our attention for investigation. We also receive intelligence from the UKRPA website and local authorities. Investigations will include but are not limited to desktop investigation as well as site visits.

In order to further improve on the progress already made it is our aim to enhance the array of reports and tools available to us to expand our investigations and make better use of the data we have in order to identify and more readily resolve cases to further reduce losses on the network. Again these will only be implemented if it is cost effective and efficient to do so.

Over the calendar year 2015 our Revenue Protection team have made considerable progress reducing non-technical losses across our network in comparison to previous years; recovering DUOS estimated at over **£2 million**. This is money that would have previously been considered as network losses and hence passed onto customers' bills. The work completed by SSEPD Revenue Protection team is internally funded and will continue to reduce costs to customers in the SSEPD licence areas over the ED1 period.

7 Innovation and implementation to business as usual

Innovation is key to SSEPD and we have a rich portfolio of innovation projects, which are selected to meet the priorities of the business, primarily to reduce costs, improve reliability of the network and to facilitate connection to the network. Projects are developed and trialled to give the business confidence that they can be successfully deployed and will deliver the anticipated benefits.

These trials are funded from SSEPD internal resource or via one of the Innovation Stimulus mechanisms (NIA/NIC), the funding source being selected based on the level of risk and the scale of the project. In either case the trial is used to develop the project and reduce the risk to an acceptable level prior to implementation, with deployment being funded exclusively by SSEPD.

SSEPD have always recognised the importance of loss reduction and how innovation can play an important part in ongoing management. Therefore, we have a number of losses focussed projects within our portfolio of innovation projects, and the most notable include:

- Low Energy Automated Networks (LEAN) – LCNF Tier 2
- Losses Reduction Study – IFI
- ACCESS - NIA project

Further details of these projects can be found in Appendix 6, 7 and 8. We will continue to maintain this approach going forward and will ensure that losses play a significant part in our future Innovation projects and most importantly that the project outcomes are reviewed and if appropriate are implemented

7.1 Innovation into business as usual

1 - Losses Teams

The Losses Teams project will provide a focus for our actions to reduce losses. If the outcomes from the initial project are successful then it will see the implementation of a dedicated resource for network efficiency. This will be a key mechanism for moving any appropriate innovations into business as usual. This concept has taken learning from the Water Industry where there are dedicated leakage teams that have the sole objective of reducing water leakage on the network.

We have evaluated this approach and believe that it could be successfully applied to electrical networks. The Losses Teams project is **not funded through any innovation mechanism** or other RIIO-ED1 financial activities; the money is funded directly from SSEPD. The project has Investment Board approval to allow us to progress with the feasibility assessment project.

The initial activity is the detailed analysis of data collected during the NTVV project to give a more robust understanding of network losses. SSEPD with support from TNEI Services have already commenced on this work; the scope is set out below and in Appendix 1 with a high level programme in Appendix 2.

Work Pack 1. Initial analysis

The initial requirement concerns a **high level analysis** of the substation monitoring data. The analysis will identify and rank the secondary substations and feeders with the highest specific parameters:

- Items that would be an indicator of losses;
- Loading imbalance between phases (both at individual feeder and site level);
- Transformer losses based on loading/age etc.;
- Feeder loading and connection;
- Low power factor;
- High harmonic content; and
- Non-technical losses.

Work Pack 2. Detailed technical analysis

The second work pack considers the results from WP1 to perform detailed analysis on a smaller number of sites, up to 20% of the 300 substation sample size and associated number of suspicious feeders.

The scope of Work Pack 2 is focused on a smaller number of sites and aims to investigate, in a rigorous manner, the prioritised sites and to conclude the specific reasons why these sites may experience higher losses than others.

Work Pack 3. Electrical modelling of interventions to mitigate losses

The third and fourth work packs will model the potential solutions to reduce losses such as re-jointing customers onto different phases, changing equipment specification or installing additional equipment such as balancing devices.

Work Pack 4. Financial modelling

This work will take the outputs from Work Pack 3 and model within the Ofgem specified CBA to determine whether or not a proposed solution is viable.

Work Pack 5. Smart Meter data utilisation

A key part to how the teams will operate in future scenarios will be the way Smart Metering data can be utilised. This is a stand alone piece of work in order to understand the data that will be available to network businesses specifically for the purposes of losses identification. The work will make recommendations on what additional equipment would be required to exploit the benefits of the data and to what extent the Smart Meter data can support losses identification either technical or non-technical. This will help ensure SSEPD are set up and ready to implement a process to utilise Smart Meter data in advance of the GB wide rollout.

Work Pack 6. Recommendations for teams rollout and Replication

The project will conclude with a recommendation on how to begin the process of rolling out teams of staff with the primary objective of reducing losses on our network. The recommendation will be taken to our internal Investment Management Board for final approval later in 2016.

In summary we believe that this work is a key innovation aspect of our ongoing approach to managing losses on the network; it has taken best practice from other utilities and applied them to the area of electrical distribution. We feel that this sets us apart from other DNOs by taking a proactive approach to identify and reduce losses on our network and we believe this has the potential to become a standard part of the GB Distribution business in the latter half of ED1.

7.2 Innovation into business as usual

2 - Constraint Managed Zones

SSEPD have a strong track record in successfully bringing the outcomes and learning from innovation projects into business as usual.

These included ongoing deployment of Active Network Management (ANM) connections following the success of the initial Orkney ANM project and the subsequent NINES project on Shetland. Following the success of these initial trials SSEPD are in a position of offering a number of more flexible options for the connection of new generation, further information is available on our website. (http://www.ssepd.co.uk/AlternativeGenerationConnections.aspx)

More recently SSEPD were the first GB DNO to test the marketplace for Constraint Management Services as an alternative to conventional network reinforcement. This will see SSEPD procuring a service to reduce demand at a primary substation during defined service windows – thus avoiding the need to upgrade and reinforce existing network assets. By employing the Constraint Managed Zone service (CMZ) , peak demand on the network is reduced which in turn has a corresponding reduction in network losses.

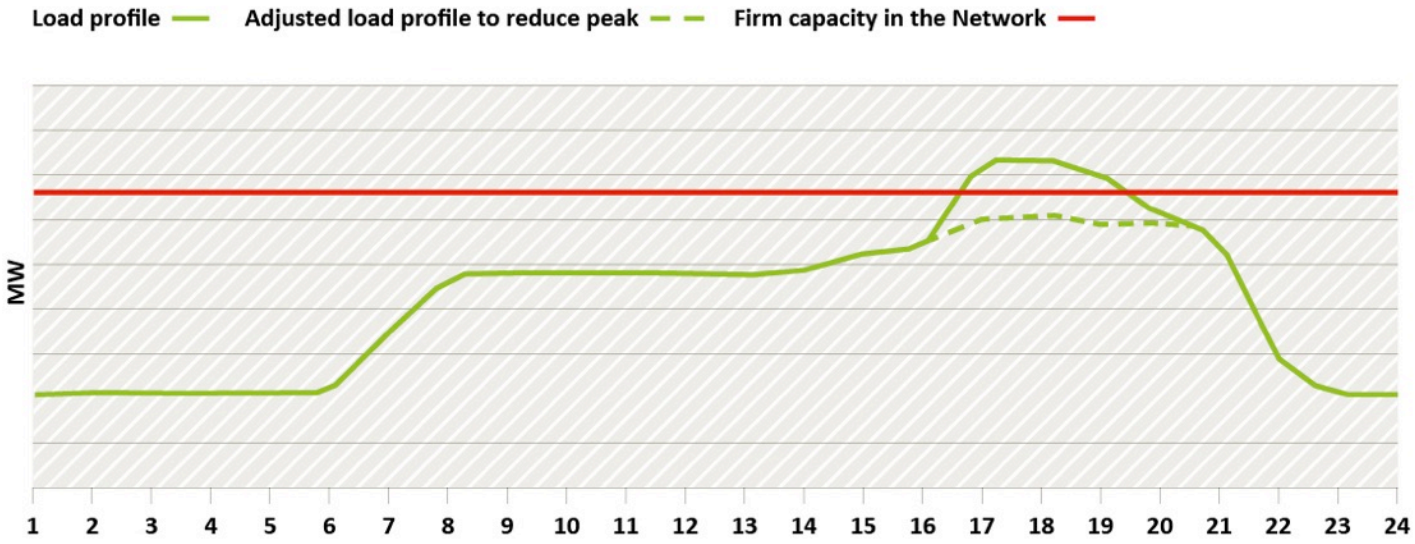


Figure 6 – network capacity managed with CMZ service

SSEPD are currently completing the tender process for the initial site. This process will be concluded early in 2016 with implementation shortly afterwards. In the longer term there are a number of other sites already identified where a CMZ type solution could be beneficial. If these schemes are implemented then they have the potential to reduce losses in addition to the evident financial benefits of reduced network reinforcement. This approach could be as easily applied to losses reduction as well as managing other network issues.

The combination of results from the Losses Teams project and the support from the Losses Steering Board will ensure that any new innovation which is found to be a commercially viable mechanism for reducing losses is successfully implemented within our business.

8 Conclusion

In this submission we believe that we have shown that we are committed to proactively targeting and reducing losses on our network. Our Losses Strategy gives us a firm foundation and the additional work identified within this document allows us to make a significant step forward in our understanding and proactive management of losses.

To deliver this we will:

- **Gain a greater understanding of losses** by using knowledge from out innovation project to develop a new methodology for characterising our network;
- **Engage with our stakeholders** by leading engagement with DNOs and establishing the DNO Losses Forum;
- **Develop New Processes** – our Losses Teams project to make best use of Smart Meter data and will see the implementation of dedicated teams to manage losses on the network. This is a pragmatic action focused approach to managing loses on our network; and
- **Use Innovative approaches** by ensuring that we have identified best practice; this will include a new award for Best Losses Initiative.

We believe that the approach we have outlined will allow us to move beyond that required for our general licence obligation and deliver additional benefits for our customers.

Scottish and Southern Energy
Power Distribution

Scottish and Southern Energy Power Distribution Losses Discretionary Reward

Tranche 1 Submission
January 2016

Appendices

Table of Contents

Appendix 1 – Losses Teams project

Our approach – Losses Teams

Our ambition is to be recognised as a credible network owner with a proactive approach to managing losses. To support this we have initiated a project which will leverage the learning and data gathered from our portfolio of projects and in particular the LCNF funded NTVV project. We propose to establish dedicated Losses Teams to drive loss reduction across the network, as identified below.

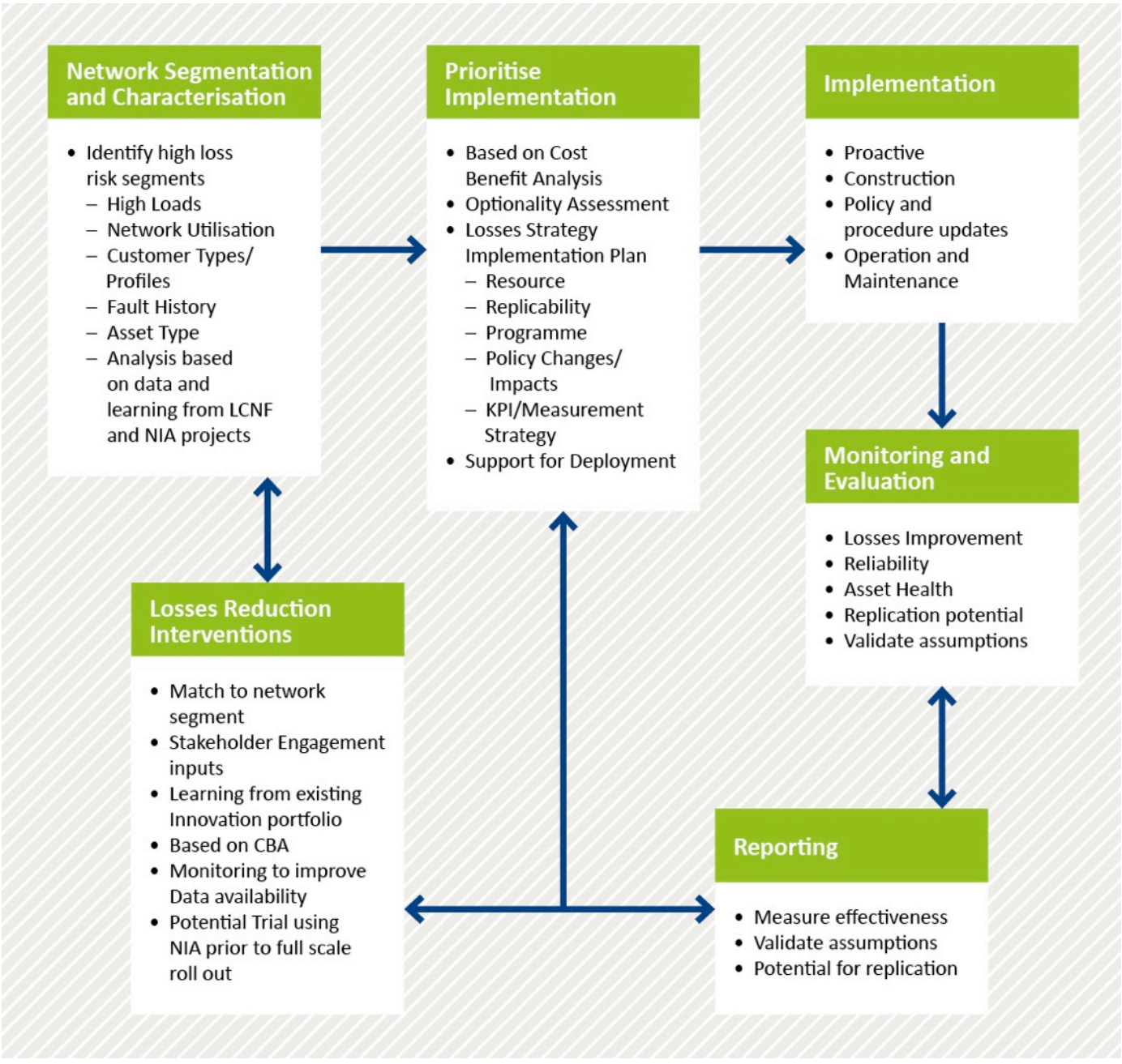


Figure 1 – Losses Team Process

To help us gain a greater understanding of losses we plan to leverage the data gathered from 300 substations as part of the LCNF funded NTVV project. This will be supported by data from approximately 300 pseudo Smart Meter installations deployed at locations with substation monitors. Specialist support from TNEI and Element Energy has been engaged to carry out detailed analysis of the data. A full description of the six work packages is shown below.

Methodology and approach

Work Package 1: Initial analysis

Substation monitoring data is to be analysed in order to identify substations and feeders which experience high losses. We expect that this will include a year round appraisal of MWh losses and also correlate this to a number of other metrics which could signify losses including:

- Loading imbalance between phases;
- Transformer losses based on loading/age;
- Feeder loading and connection;
- Low power factor;
- High harmonic content; and
- Non-technical losses.

Work Package 1 will also include an analysis of the correlation between losses and recorded data on the HV side of secondary substations (e.g. phase imbalance, harmonics) and between feeders that experience high occurrence of faults.

The approach to Work Package 1 is shown below:

Figure 2 – Losses Teams Work Package 1

The LV network data will be examined in more detail to quantify, for secondary substations and feeders as appropriate, a number of other parameters which could be associated with losses.

For example, based on the snapshot of LV network data from the NTVV project, it would be possible to consider some, or all, of the following parameters:

- **Phase imbalance:** power, reactive power and current in each phase is recorded – these could be used to quantify the phase imbalance of each feeder. Phase imbalance could be an indicator of high losses e.g. having a high number of customers in one phase increasing current and consequentially losses in the conductor and high probability of faults. Phase imbalance could be calculated at the level of individual feeders but also for each secondary substation;
- **Transformer losses:** losses in each secondary substation will have been determined in the previous task. High transformer losses could be an indicator of high losses on the LV network by, for example, lowering voltages on the LV side of the secondary substation. With a high penetration of fixed power load, this would increase current flowing in the feeder and therefore increase losses. With the information of the asset we could also determine some indications to find losses (e.g. a new transformer is expected to have lower losses);
- **Feeder loading:** the loading of each feeder (in terms of its rated capability) could be determined in each half hour. High feeder loading could be an indicator of high losses; similar to phase imbalance, an increase in the current along a feeder and reaching thermal limits increases losses, decreases voltage and increases the probability of faults in the feeder;
- **Power Factor:** active and reactive power flow are given for each phase of each feeder, and therefore the power factor of each feeder in each half hour could be calculated. Power factor will be analysed to find a relationship to losses;

- **High Harmonic Content:** harmonic distortion is provided in the HV measured data for each secondary substation. Harmonic distortion could be an indicator of high losses because the odd harmonic injection in the network increases the reactance of the conductors and overheats the feeders leading to losses. In essence the higher the distortion the higher the losses; and
- **Voltage:** voltage at each secondary substation is given within the LV data. Altering the voltage setpoints could reduce losses depending on the nature of loads connected to the network.

Work Package 2: Detailed technical analysis

In Work Package 2, a sample of sites (20% suggested by SEPD) will be analysed in more detail. This sample is anticipated to be made up of those feeders which have higher than expected levels of losses. The main goal of this work package will be to determine the reasons that these feeders experience higher levels of losses, and then to define a methodology through which Losses Teams could identify, monitor and manage losses. This would be undertaken at both the project scale (~300 sites) and at a wider SSEPD network scale.

Our approach to Work Package 2 is shown in the figure below.

Figure 3 – Work Package 2

Of the sites selected for more detailed analysis, it is proposed that sites should be prioritised based on losses they experience in conjunction with their customer profile, demand profile and fault profile.

A mechanism for estimating high loss locations will be developed and the following characteristics will be considered:

- Assets being operated close to their ratings;
- Assets with high variable or fixed losses;
- Assets in poor condition reaching the end of their lifetime;
- High penetration of non-linear load (increased harmonic distortion);
- Phase imbalance; and
- Large power flows and low voltages, etc.

The outcome of this analysis will be used to develop a methodology that could be applied to the wider network.
The development of a methodology will consider:

- Steps to be followed in order to identify losses (see above) – a number of options will be presented e.g. measurement, modelling;
- Tools required (e.g. bespoke software or spreadsheet tools);
- Data requirements and data specifications (e.g. resolution of monitoring data, hardware required for monitoring);
- Cost implications (e.g. staff, equipment and software costs);
- Time implications (e.g. would monitoring be required for an entire year in order to confirm losses, or do correlations exist between annual losses and peak losses); and
- Operational considerations.

Work Package 3: Electrical modelling of interventions

A range of interventions which could mitigate or manage losses are to be identified and analysed. This will include a horizon scanning exercise to review national and international best practice in the management and mitigation of network losses, both technical and non-technical. Interventions may include:

- Switching customers between phases on a feeder;
- Harmonic filters;
- Power factor correction;
- Voltage regulation;
- Upgrading transformers (including the relation to their remaining asset life);
- Upgrading conductors;
- Phase balancing equipment;
- Network reconfiguration;
- Changing fuses for circuit breakers; and
- Localised distributed generation recommendations.

For each intervention, modelling will be completed to show how it changes losses over a 12 month period, based on historical data.

Our approach to Work Package 3 is shown in the figure below.

Figure 4 – Work Package 3

Each of the interventions will then be modelled against a range of network scenarios as identified in the previous work packages.

Work Package 4: Financial modelling

The costs and benefits of successful losses interventions will be assessed qualitatively through a series of cost benefit analysis (CBA). This is expected to take a similar form to the Ofgem CBA template used by DNOs in their RIIO-ED1 business plan submissions. The Net Present Value (NPV) of each intervention will be calculated in order to determine which are cost effective.

Figure 5 – Work Package 4

Work Package 5: Utilisation of Smart Meter data

The objective of this work package is to assess the range of options available for using Smart Meter data to identify and manage losses and to provide a set of recommendations on the best way in which these datasets can be used along with any limitations associated with the various approaches available.

The rollout of Smart Meters offers important new opportunities to gather high resolution network data at lower voltage levels than has been possible in the past. As the rollout of Smart Meters continues across the UK, it is important to understand how Smart Meter data can be used to add value, improve service and reduce costs to UK consumers such as through losses identification and management. In these early stages of smart meter deployment, particularly where only partial technology penetration has been achieved, it is essential to understand the limitations around using Smart Meter data and how these limitations can best be mitigated and alleviated through the use of complementary datasets and application strategies. For the use of Smart Meter data in losses identification and management, this is particularly important and a range of potential solutions are available which we will assess in the context of suitability for use on the SSEPD network.

One of the key challenges around using Smart Meter data to identify and manage technical and non-technical losses on the SSEPD network is around data completeness. With penetration of Smart Meters not currently exceeding 40% over an entire feeder at monitored SSEPD substations, a robust methodology for filling these data gaps is required. This approach will need to be scalable as additional Smart Meters are deployed on the network – thereby reducing the extent of data gap analysis and interpolation required. Therefore, for Smart Meter data to be used most effectively to help identify losses, phase loading and potential imbalances as well as non-technical losses (such as theft), it is necessary to fill the gaps in the Smart Meter dataset (i.e. for customers that do not yet have a Smart Meter) to build up a complete picture of customer load for use in conjunction with the other network monitoring datasets.

Our approach to Work Package 5 is shown in the figure below.

Figure 6 – Work Package 5

Work Package 6 – Recommendations for rollout and replication

In Work Package 6, a methodology for mitigating and managing losses on the SSEPD network is to be developed. SSEPD's concept is that there will be teams of staff with the primary objective of identifying parts of the network that produce high technical or non-technical losses. Measurements of losses will be taken and interventions implemented in order to reduce losses. We expect that this will be based on the methodology for identifying losses proposed in Work Package 2, on the interventions modelled in Work Packages 3 and 4, and on the role of Smart Meter data determined in Work Package 5. This work package will consider the potential for replication of any of the solutions and the optimum method of delivery.

From this it will be possible to identify the resources and organisational structure required to deliver the initiatives.

Following completion of this initial analysis phase a recommendation will be made to SSEPD Investment Board on the deployment of the Losses Teams. This will include appropriate time for development of any additional procedures etc. required in advance of mobilisation of the Losses Teams. A high level programme is included as Appendix 2.

Appendix 2 – Losses Teams project indicative programme

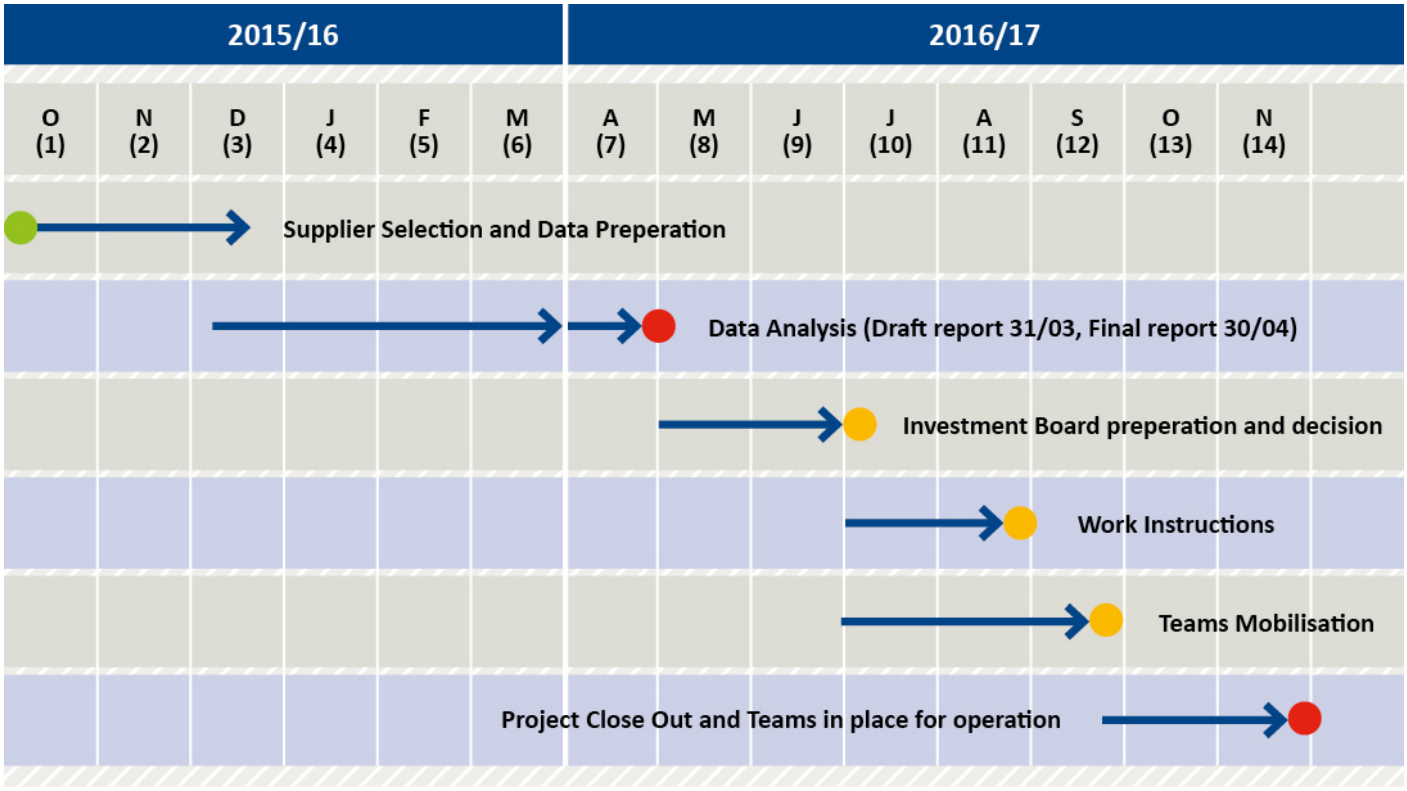


Figure 1 – indicative Losses Teams project programme

Appendix 3 – DNO Losses forum & internal steering board

DNO Losses Forum – Terms of Reference

1. Introduction

Electricity losses are an inevitable consequence of transferring energy across electricity networks. Electricity losses have a significant financial and environmental impact upon consumers. Effective losses management can therefore protect consumers from unnecessary increases to the distribution costs that they pay. Whilst DNOs do not pay for the cost of losses, they have a crucial role in ensuring that losses are managed to the lowest possible level to minimise impact on customers' bills.

SSEPD have led on a piece of work to engage directly with DNOs/TOs where our networks have interconnection. We have already begun a process of direct engagement with each of our boundary neighbours, and it has been agreed that there could be benefits to the establishment of a DNO Losses Forum.

The DNO Losses Forum will provide an opportunity for DNOs to share learning and best practice, and will provide a focus for engaging with other industry stakeholders such as energy suppliers and meter operators.

2. Aims and objectives

The Forum will be established as the forum for UK electrical licensees to meet and to share knowledge and learning in relation to their understanding of network losses and implementation of loss reduction interventions on GB power distribution and/or transmission networks. Specific objectives include:

- Review of members' activities in relation to improving their understanding of losses including best practice and lessons learned;
- Presentation and discussion of specific member case study material, in relation to the development loss reduction technology;
- Exchange of knowledge and experience in relation to the operation and in-service performance of loss reduction technology, on members' networks;
- Receipt of invited presentations from key third party stakeholders (e.g. academics, overseas owners/operators, other utilities, supply chain etc.);
- Identification of specific issues to be addressed, particularly regarding the impact on losses of the growth in Low Carbon Technologies and utilisation of new data from the proposed Smart Metering roll out; and
- Provision of collective licensee 'platform', with which to address/progress issues of common interest.

3. Membership

Membership will be open to all UK DNOs and the GB TOs and the SO.

Internal Steering Board – Terms of Reference

1. Introduction

In order to support the numerous areas of additional losses related activities planned within ED1 and to ensure the Losses Strategy is updated annually an internal steering board has been agreed at Senior Management level. The steering board will have attendees from across the Distribution business and will be chaired by the Director of Engineering and Investment.

2. Aims and objectives

The key aims and objectives of the internal review board are to provide an oversight to the losses related work and to ensure a consistent message is delivered across multiple business units over ED1. The board also aims to:

- Ensure the Losses Strategy is revised annually in line with the regulatory guidelines;
- Ensure the additional losses activities are managed to the proposed timescales and within the agreed budget;
- Make key decisions on whether or not proposed alterations should be adopted by the business for wider rollout; and
- Remove any blockers to implementing the revised processes across the business at a high level.

Appendix 4 – Losses Competition

Introduction

To ensure that we have identified best practice and are aware of new innovations and developments within the market place, SSEPD plan to initiate a Losses Competition. The competition aims to identify new approaches to measurement, modelling and analysis of network data to improve our understanding of losses. In addition it seeks to identify new technology and other interventions which could lead to a reduction in network losses.

The competition will run as follows:

- **Stage 1:** Submission of concept designs, from which a shortlist will be selected and invited to proceed to stage two.
- **Stage 2:** Stage two will involve further exploration and refinement of the stage one concept ideas. This stage will commence with one-to-one briefing sessions with shortlisted designers and technical advisers from SSEPD. Feedback from stage one judging will also be available during this session.

The competition is a call for ideas only with no commitment beyond the competition to develop any of the schemes. However, in the event that the winning scheme or schemes are built then the authors will be fully involved in the design development process and credited accordingly. Entrants invited to stage two will be expected to further explore the viability of their proposals; therefore this should be borne in mind from the outset.

A monetary prize fund will be awarded to the winner and the shortlisted finalists to encourage participation in the competition.

Competition objectives

Electricity losses are an inevitable consequence of transferring energy across electricity networks. Electricity losses have a significant financial and environmental impact upon consumers. Effective losses management can therefore protect consumers from unnecessary increases to the distribution costs that they pay. Whilst DNOs do not pay for the cost of losses, they have a crucial role in ensuring that losses are managed to the lowest possible level to minimise impact on customers' bills. Network losses have been estimated as much as 7% and they contribute to approximately 1.5% of Great Britain's greenhouse gas emissions.

Accurate assessment of network losses is notoriously difficult to achieve, due to the large number of variables involved and the historically limited volume of data available. SSEPD are seeking highly innovative and imaginative solutions that will, help us to:

- Improve their understanding of network losses, this could include new modelling and analytical techniques to help develop new assessment tools;
- Identify new processes and technology to reduce network losses;
- Better measure and monitor network losses; and
- Reduce the costs associated with network losses.

The competition aims to identify new approaches to measurement, modelling and analysis of network data to improve our understanding of losses. In addition it seeks to identify new technology and other interventions which could lead to a reduction in network losses.

We are therefore seeking highly innovative and imaginative solutions that nevertheless respond to the exacting technical requirements and offer the potential for development into deliverable projects.

Proposals should be both grounded in reality and be capable of being delivered within the RIIO ED1 price control period.

Assessment criteria

Stage 1

- Response to and understanding of Brief (30%)
- Philosophy and Approach (20%)
- Innovation (20%)
- Economic (30%)

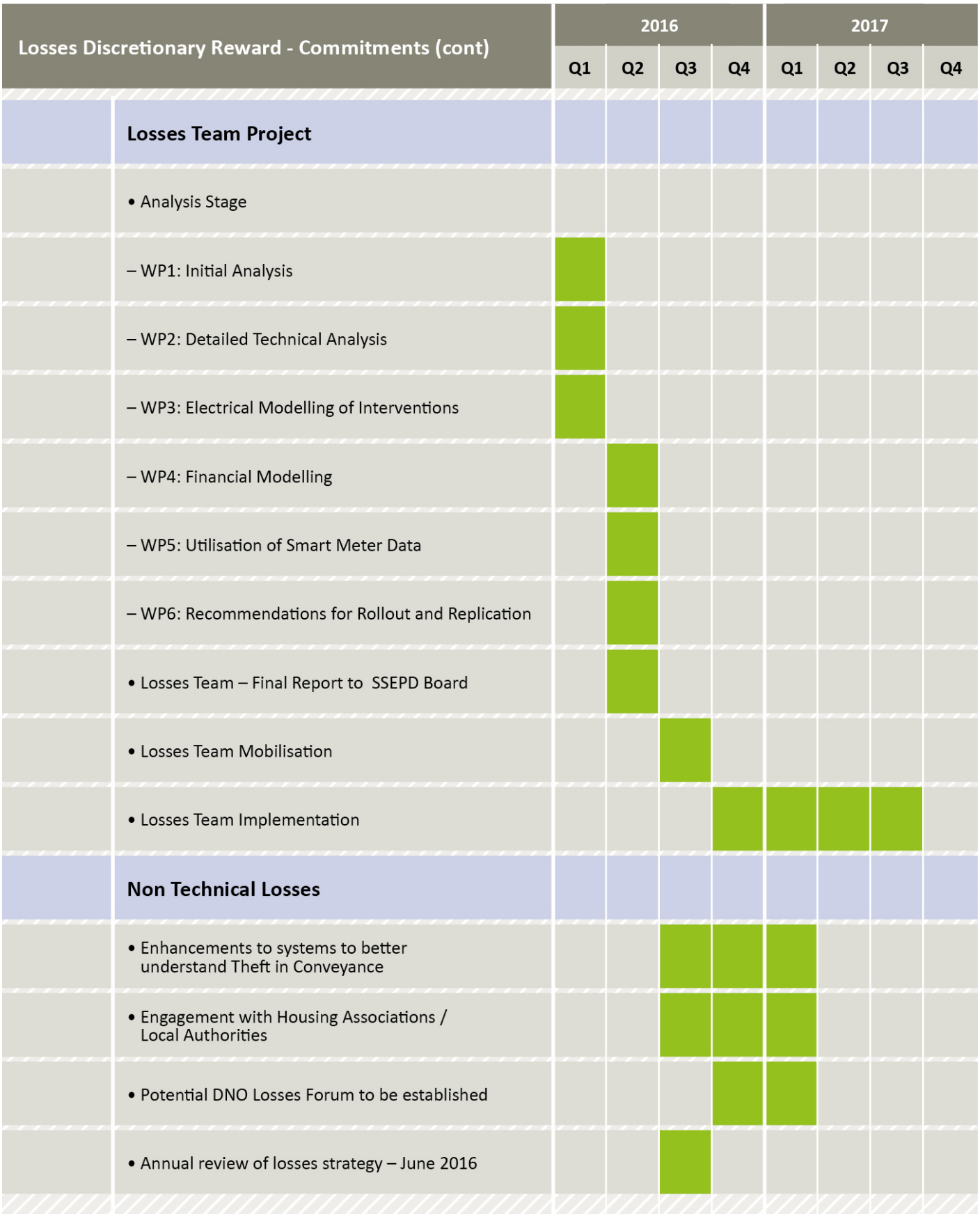
Stage 2

- Quality of proposal in response to feedback from SSEPD (30%)
- Construction, viability, functionality, practicality (in response to feedback) (30%)
- Cost Benefit (40%)

Appendix 5 – Route to implementation

Losses Discretionary Reward - Commitments	2016				2017			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Internal Engagement								
• Establish SSEPD Losses Steering Group								
• Internal Engagement Sessions to raise awareness								
External Engagement – Network Users								
• Continue Inter DNO engagement with adjacent DNOs								
• Scottish Power Transmission and National Grid Electricity Transmission - TOs								
• National Grid Electricity Transmission – System Operator								
• Gas and Water utilities with same footprint areas								
• Renewable Developers								
• Independent Connection Providers / Independent Distribution Network Operators								
• Unmetered User Groups								
• Electricity Suppliers / Meter Operators								
• Community Energy Groups								
External Engagement – Supply Chain								
• Large Scale OEMs -								
• SMEs / Innovators								
• "Losses Prize " – Loss Reduction Competition for Academics / SMEs								

Appendix 5 – Route to implementation (continued)



Appendix 6 – Engagement in Action – Community energy

Local Energy Challenge Fund

The local consumption and production of energy avoids the need to transport energy over longer distances, thus avoiding or reducing losses. The north of Scotland is ideally suited for these projects with abundant renewable resources and a large number of remote communities. The Scottish Government aims to reach a target of 500 megawatts of community and locally owned renewable energy by 2020.

SSEPD have been actively engaged with the Local Energy Scotland to support the development of projects in Scotland via the Local Energy Challenge Fund and the CARES Infrastructure and Innovation Fund. The Challenge Fund was launched by the Scottish Government in August 2014 to demonstrate the value and benefit of local low carbon energy economies. The Challenge Fund aims to support large-scale local low carbon demonstrator projects which show a local energy economy approach linking local energy generation to local energy use. The CARES fund was launched in 2011 and grant funding is available for communities to investigate and develop projects that link local energy generation with local energy use, or projects that wish to develop innovative distribution and storage solutions.

SSEPD have played an active role in the Selection Panel for both schemes and have provided direct support and advice to the projects planned for the SHEPD area. These include:

- **ACCESS** – based on the island of Mull this project looks to allow renewable generators to connect to new electrical controllable electrical demand via a 'Virtual Private Wire'.
- **Surf and Turf** – based on Orkney will look to use 'constrained' renewable energy to produce fuel for the islands ferries.
- **Fintry Development Trust** – this project aims to deliver a low-cost, local renewable energy tariff to alleviate fuel poverty among residents of Fintry in Stirlingshire through the 'virtual' linkage of their electricity consumption with supply from a nearby Anaerobic Digestion (AD) plant.

SSEPD have contributed directly to the development of these projects and will continue to monitor the outputs from the projects to assess their impacts on losses.

About ACCESS – Assisting Communities to Connect to Electric Sustainable Sources
Project lead: Community Energy Scotland
Project partners: Mull and Iona Community Trust, SSE Energy Supply Ltd, Element Energy, VCharge, SSE Home Services
Local Energy Challenge Fund Grant awarded: £1,769,000

Project summary

The ambition of this project is to lay the foundations for something which does not yet exist in Scotland – a cost-effective platform for enabling the real time matching of local electricity generation and local electricity demand at a distribution network level.

It will drive the development of financially viable grid connections for small scale generators in transmission constrained areas of the Scottish networks, and enable the supply of electricity from renewable sources directly to the heating needs of local consumers.

The field trial aspect of the project will be based on the Isle of Mull on the west cost of Scotland. The project will run for two years (April 15 to April 17), with installations of new heating systems scheduled to commence in September 2015.

Overall ACCESS Project aims

1. To demonstrate real time balancing of renewable generation (a 400kW community owned hydro generator) and distributed demand from local homes and businesses.
2. To develop an affordable protection and communications system for enabling 'non-firm' grid access to transmission constrained generators.
3. To engage with and provide benefit to local homes and businesses.
4. To create the commercial arrangements required for future deployment and rollout ('local heat tariffs').
5. The ambition of ACCESS is to lay the foundations for a cost-effective platform for enabling the real time matching of local electricity generation and local electricity demand at a distribution network level.

SSEPD Role in ACCESS

The method involves creating the technical and commercial framework to allow generators to manage generation and demand within a pre-determined network area. Specifically this is intended to link local controllable demand (i.e. heating systems) with intermittent local generation. In general both UK and Scottish governments have put in place some policy drivers to facilitate locally owned community generators to be used to supply local customers in an attempt to address fuel poverty in rural areas.

This project seeks to test the effectiveness of these drivers, as well as explore additional regulatory barriers and proposing changes when appropriate. The large scale ACCESS project includes a range of partners which represent many of the main actors in the value chain including renewable generators, community groups, energy suppliers, aggregators etc. The intention is to trial the new arrangements by linking the output from a community owned hydro scheme with new local flexible demand. The generator will be responsible for matching local demand with generation and SHEPD will only intervene if network integrity is compromised.

The DNO has a crucial role to play in facilitating this project. In addition to the provision of connections for both the new generation and controllable demand, SHEPD intend to install network monitoring equipment which will monitor network parameters at potential constraint points and will send appropriate signals to disconnect either the generator and/or demand to protect and maintain network integrity. These signals will only be used should the network come close to breaching safe operating parameters. At all other times the generator and their chosen demand aggregator will be responsible for balancing supply and demand within the specified network.

An NIA project NIA_SSEPD_0011 was registered in July 2015 to define SSEPDs involvement in the ACCESS project.
This project will give valuable learning and will allow an evaluation of the reduction in losses by maximising the use of locally produced energy.

Appendix 7 – LEAN case study

The LEAN (Low Energy Automated Networks) project is a circa £3m project which is primarily funded from Tier 2 of Ofgem's Low Carbon Networks Fund (LCNF) and aims to establish whether it is technically feasible and economically viable to implement the proposed energy efficiency methods at our primary substations.

SEPD will trial two methods to reduce losses. The Transformer Auto Stop Start (TASS) method will switch off one in a pair of transformers in selected substations to reduce fixed losses. To further reduce losses and maintain network supply integrity the Alternative Network Topology (ANT) method will be deployed alongside TASS where appropriate. The project is split into three distinct phases:

Phase One

The first phase of the project consists of the following activities:

(i) **Development of loss-reduction model:** This activity involves in-depth study and analysis to investigate actual load profiles across the network.

(ii) **Engagement with a specialist:** In-depth investigation and consultation with a transformer specialist.

(iii) **Supplier engagement:** SEPD will engage with manufacturers and suppliers of its existing asset portfolio to make further validation of assumptions made.

(iv) **Off-network trials:** Pre-deployment testing will be carried out on a transformer that is not currently connected to the distribution network.

(v) **Requirements specification:** A functional requirement for necessary equipment will be developed and made available to the supply chain. This is to ensure that (i) the cost assumptions for the project are correct and (ii) there is a robust and secure supply chain available to support a potential rollout.

At the end of Phase 1 the project's benefit case will be re-evaluated. The project will only proceed if the trials can demonstrate clear benefits for customers without causing financial detriment to DNOs.

Phase Two

The second phase of LEAN is concerned with validation of the model i.e. actual deployment and operation, and comprises the following activities:

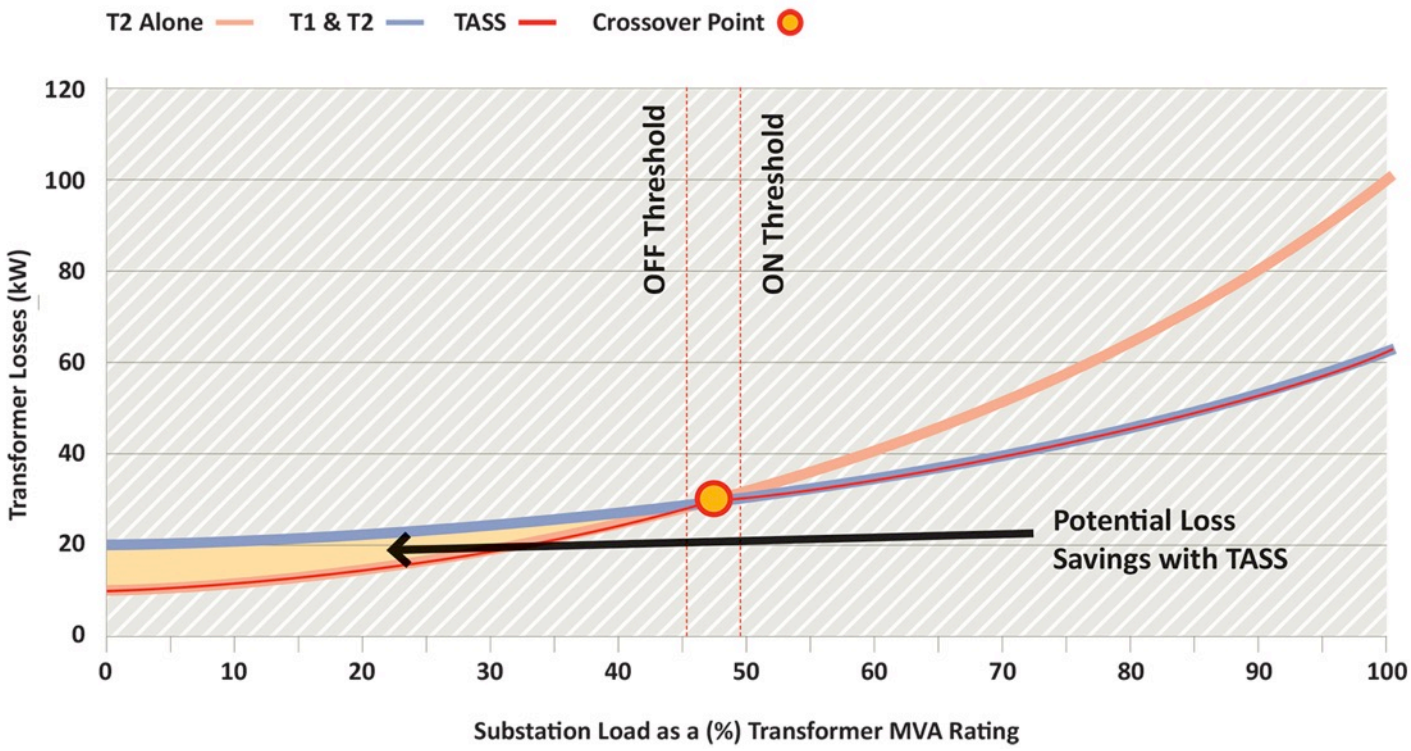
(i) **Final site selection:** A number of primary substations will be selected for LEAN deployment (TASS options 1, 2 and 3, and where appropriate, ANT). The substations will be representative of SEPD's and GB's distribution network scenarios, but will also be selected to ensure that there is minimal risk of supply interruptions.

(ii) **Deployment and demonstration:** The LEAN methods will be applied over a two-year period.

Phase Three

(i) **Operation and monitoring:** The selected transformers will be monitored throughout two years of operation, to capture learning related to the operation of LEAN in real life scenarios. The types of monitoring will depend on the type of equipment used and on which blend of TASS and ANT has been deployed.

The graph below illustrates the basic concept of saving energy through switching out primary transformers at times of low site demand. The blue line shows the losses from two transformers and the red line is the losses from a single transformer, and where the lines intersect is the crossover point. Hence when demand is less than this point the site can run on a single transformer.



Source: Lean Report, S&C Electric Europe Ltd, prepared for Scottish and Southern Energy Power Distribution Ltd.

Figure 1 – theoretical graph of transformer losses and energy savings

Appendix 8 – Phase balancing work

Three phase LV networks are likely to have some degree of imbalance, e.g. the loading on each phase will not be perfectly equal at all times. The imbalance on a three-phase network creates additional resistive heating losses from increased peak loading on the phase conductor and also increased current flowing through the neutral conductor. Implementing a device to balance the network would reduce these losses significantly and hence save operating costs. In addition balancing phases would provide additional capacity and reduce the likelihood of voltage breaching limits.

As part of an energy storage Tier 1 project SSEPD trialled dynamic phase balancing on a low voltage feeder using substation monitor and batteries connected to each phase. This work was completed to understand the impact on network losses.

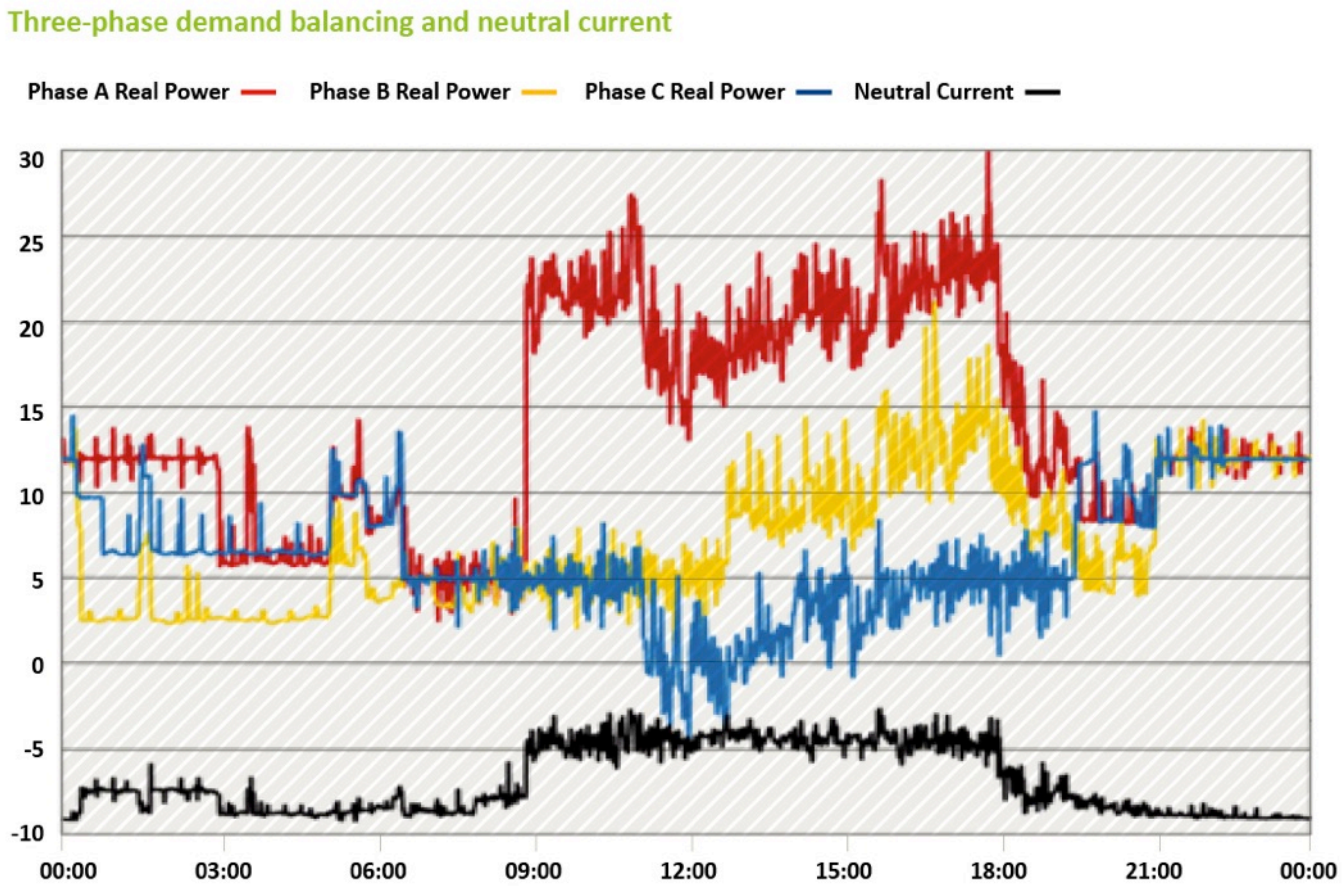


Figure 1 – three-phase demand and neutral current plotted to show the affect of phase balancing for short periods

The graph in Figure 1 displays the system beginning to balance at 6:30am and continues to remain balanced until the Community Energy Storage unit on phase A runs out of capacity at approximately 9:00am. At this point the effect on the neutral current can be seen clearly – increasing from approx. 10 amps up to 50 amps. The peak loading on phase A is also reduced from 23kW to 5kW. This simplistic demonstration allows the principle of balancing to be understood and the reduction in network losses to be calculated.

The learning from the initial trial has fed into the Thames Valley Vision project where we have installed 25 similar storage units. However these devices allow the balancing of phases without the need to utilise the battery e.g. power from phase A can be fed onto phase B using electronics only. This work is currently ongoing and will be used to inform our CBA work on the topic of phase balancing as part of the Losses Teams.

The work completed has focused on using energy storage or power electronics however the analysis outcomes are relevant to any form of phase balancing from dynamic manipulation to manually moving customers from one phase to another.

Figure 2 – fully commissioned energy storage device with three-phase phase balancing capability – NTVV project

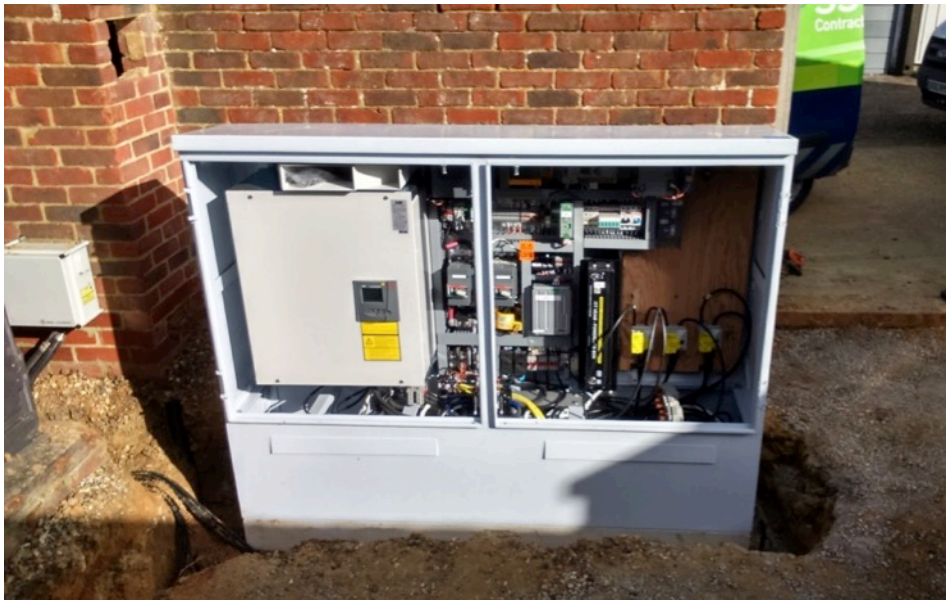


Figure 3 – open view of power electronics used to balance phases – NTVV project