WPD Losses Stakeholder Event
IET Birmingham
09th December 2019

Paul Jewell / Peter White
DSO Development Section

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

House Keeping

Agenda

- Introduction and Development of our Losses Strategy.
- Changes to our Losses Strategy.
- Innovation Projects.
- Collaborative Working.
- Future Projects.
- Open Forum.
- SSE TASS Feedback

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Introduction and Development of WPD's Losses Strategy

Paul Jewell

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Introduction

2014

- The Energy Efficiency (Encouragement, Assessment and Information) Regulations 2014 required Ofgem to “assess the energy efficiency potentials of networks” and to provide “a list identifying concrete measures”.

- Standard Licence Condition 49 applicable from April 2015 required licensees ‘to ensure that Distribution Losses from its Distribution System are as low as reasonably practicable, and to maintain and act in accordance with its Distribution Losses Strategy’.

- Ofgem had not yet announced their valuation of the societal cost of losses.

Development of our Losses Strategy

2014

- WPD published the first Losses Strategy as a part of the RIIO-ED1 business plan submission.
- At that time the strategy was quite high level and lacked detailed costings and benefit analysis.
- We held our first stakeholder engagement session to discuss the detail of our revised document.
- The joint WPD/UKPN project “Management of Electricity Distribution Losses” had not yet completed or reported.

Development of our Losses Strategy

2015

- The SOHN report on “Management of Electricity Distribution Losses” was issued and gave us 26 recommendations for focus.
- Ofgem had set the societal cost of losses, so interventions could be ranked against this level of benefit.
- We held our second stakeholder event, our Strategy was reviewed on the basis of comments made and was issued.
- We added sections dealing with imbalance, service cables, harmonics, network meshing and storage as a result of stakeholder comments

Development of our Losses Strategy

2016

- WPD's 2016 Strategy was reviewed on the basis of comments made and was issued.
- WPD did not hold a stakeholder event in 2016, the view was that a biennial event was sufficient. The WPD 2017 strategy was issued.
- The ENA's Technical Losses Task Group was formed.

2017

- In 2017 WPD held our third stakeholder engagement session to discuss the detail of our revised document.

Development of our Losses Strategy

2018

- The 2018 version of the WPD Losses Strategy document was published.

- During 2018 WPD purchased circa 100 single phase 25kVA amorphous cored Pole Mounted transformers and these are being installed on the network in the South West and South Wales, the purchase of the amorphous transformers provided a better total cost of ownership and CBA than the current existing 25kVA CRGO single phase PMT transformer.

- As part of the SOHN Report WPD carried out a feasibility study of using the waste heat from a primary transformer to heat the substation buildings, this was successful and WPD are currently working with a manufacturer to bring this to BAU.

Development of our Losses Strategy

2019

- We are now up to date.
- It is our 2019 stakeholder engagement session.
- The ENA Technical Losses Task Group now have a report into the treatment of losses in RIIO-ED2. This is a requirement for DNOs under the Ofgem Losses Discretionary Reward.

Changes in the WPD Losses Strategy

Peter White

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Changes in the WPD Losses Strategy

- The format of the WPD Losses Strategy document has changed it now details: -
  - Aims, Objectives and Outputs
    - The intention of this document is to provide an outline of the actions that are being taken by Western Power Distribution in order to reduce losses.
  - Standard Conditions of the Electricity Dist. Licence
    - WPD's Losses Strategy has been reviewed and modified to ensure that it provides economically beneficial interventions that will help keep distribution losses as low as reasonably practicable.
  - Stakeholder Input, Review and Governance
    - Stakeholder engagement is a key priority for WPD and, as loss reduction is a relatively new subject for many of stakeholders, it is important stakeholders are encouraged to engage with WPD on the topic. WPD's aim is to improve stakeholder's awareness of losses so that they can take steps to reduce losses themselves.
  - Innovations and Projects
    - Innovation projects are the main way in which new methods can be developed to reduce losses, which is why they are a cornerstone of the losses strategy.

Changes in the WPD Losses Strategy

- Background and Theory
  - The energy lost in distribution creates a financial cost which is paid for by the customer. The energy lost, which includes theft, accounts for unnecessary carbon emissions, which impacts climate change. Reducing losses effectively increases the network capacity.

- Improving Understanding
  - In order for WPD to reduce losses effectively, there is a need to have a far better understanding of them. WPD needs to quantify the losses that are present on the network; identify where they occur; understand why they occur and have methods for predicting what effect certain actions taken to reduce losses will have on the losses.

- Policies and Actions
  - This section contains all the various areas that WPD are currently focusing on with a view to reduce losses going forward. These actions can be split into three areas: - actions completed before 2018, actions completed during 2018 and plans for 2019 and beyond.

Changes in the WPD Losses Strategy

- Actions Completed During 2018 and ongoing actions
  - This sections list all the actions that have been completed during the previous 12 month period and what projects are on-going.
- Plans for 2019 and beyond
  - This sections list all the actions that are projected to be completed during the next 12 month period and what projects will be on-going.
- Future Considerations
  - There are a number of potential ways to reduce losses which rely on technology that are not yet suitably developed. As such none of these methods are likely to be implemented during RIIO-ED1, but it is important that WPD monitors them for RIIO-ED2 and beyond.
- Summary & Conclusions
  - This section contains a précised breakdown of the work completed.

Innovation Projects

Peter White

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Projects to Meet the Road to Zero

- The government's Carbon Plan 2050 reduces carbon emissions by decarbonising heat and transport.
- As a consequence of this WPD expect to see flexible LCT loads that include battery storage, small scale generation, heat pumps and 32A/7kW electric vehicle chargers to escalate.
- The new LCT demand is likely to increase beyond the current single phase 60A/15kVA standard, worst case could see a circa 40% increase.
- DNO's need to be ready to accept this additional demand as it develops.
- Studies of losses in future systems have shown that they are affected by the: -
  Increase in the connection of Low Carbon Technologies and the Application of innovative technologies.

Provision of Capacity

- WPD have a sized approach to EV charge capacity with different solutions for domestic, street side, car park or large depot scenarios.

- Domestic Smart Homes EVs and Storage — WPD will utilise the findings of the Electric Nation project to refine the design models. WPD are also investigating how three phase cables can provide additional capacity and show how a domestic installation can make use of locally generated power and storage to provide the energy required to charge an electric vehicle.

- On Street Charging Solutions— This project will look at solutions for charging vehicles in residential locations on the street or at communal parking areas. WPD intend to work with Local Authorities and other Regional bodies to design and demonstrate dedicated infrastructure for electric vehicle charging.

Provision of Capacity

- Hub Charging Solutions— Local Authorities are likely to establish charging hubs in car parks and other off street locations. These offer the advantage of being able to provide a large single point load connection to the WPD network using a bespoke transformer.

- Depot Solutions—Where depots of commercial vehicles require charge WPD will either use the bespoke transformer option used for charge hubs or offer a high voltage connection to allow customers a higher connection capacity.

Network Losses and LCT's

- As the network supplies customers, a small percentage of the energy is used to "power" the network and is described as losses. This losses energy is the running costs of the network.

- Losses are related to the circuit load flowing in Amps, and become more apparent at high load situations due to a squared function. Increasing the load will increase the losses, as Losses = $I^2.R.\sqrt{}$harmonics; hence DNO's trying to reduce losses, thereby reducing power to run the network.

- From a Losses point of view houses built in the 1950's, 1960's and 1970's are likely to have a Cu. 0.0225in^2 ≡ 15mm^2 single phase PILC service cable, this gives in ideal conditions a maximum of 100A laid direct.

Network Losses and LCT's

- Early phenolic resin cut-outs although designed for a higher rating were nominally rated at 60A, for various reasons.
- The latest grey cut-outs are DMC (doe moulding clay) and these have a 100A rating.
- In the past this 60A supply has been sufficient, as the majority of homes remain gas heated; and even those homes that utilised economy seven electric heating fell within the single phase 15kVA at 0.95 lagging power factor capacity.

The way forward

- In order to future proof homes WPD are pioneering a “superfast electricity” approach to the LV service cables, where customers with higher demands could use a three phase larger capacity service to help balance their demands and reduce overall losses in the service cable.

- WPD will be partnering POBL and Sero Homes in a new build project in Tonyrefail and a retrofit project in Blaen-y-maes where this idea will be put into practice.

The way forward

- An added societal benefit is that the losses in the service cable would reduce as the high single phase current would now be spread across the three phases thereby reducing the LV losses.

- WPD believe now is the time to mandate that all new service cables to new build housing change to a three phase design, giving customers 3 times the conventional capacity.

- With the change in the Building Performance Regulations all new buildings by April 2020 will need an EV charge point installed, it would be sensible to mandate all new builds should have all the LCT's added to meet the Road to Zero Strategy 2018 and The Carbon Plan 2011. Otherwise the UK will not meet the CO^2 targets which will impact all of us!!

Low Carbon Technology Parc Erin

To reduce fuel poverty, POBL and Sero Homes will install Low Carbon Technology in 238 homes.

Each property will have a combination of EV charger, HP, Solar Panels and Battery storage devices. White good will be smart everything connected to a PLC.

Each property will have the ability to export 3.68kW of to WPD's Low Voltage network.

Parc Erin Estate

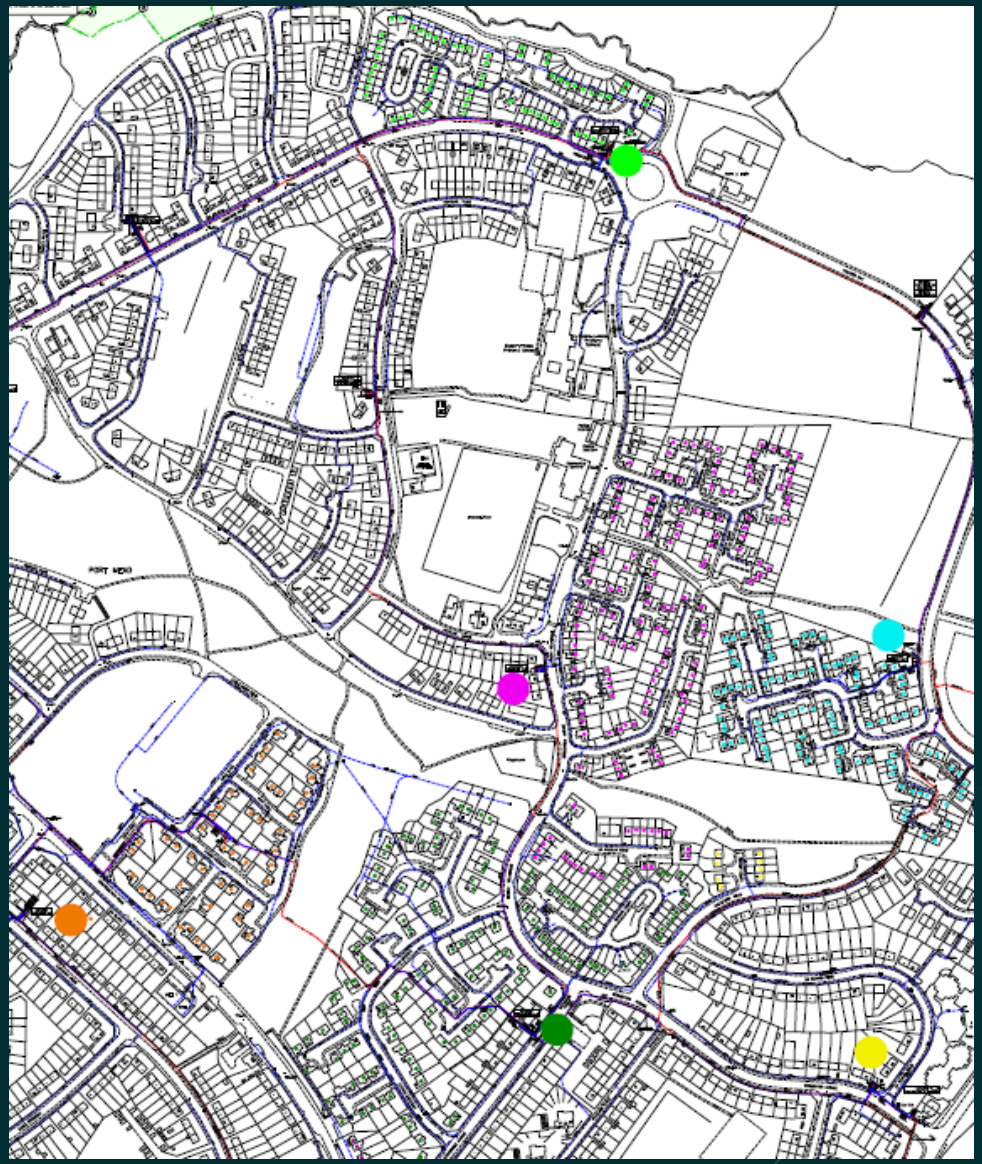
Low Carbon Technology Blaen Y Maes

To reduce fuel poverty, POBL and Sero Homes will install Low Carbon Technology in 645 homes.

Each property will have a combination of HP, Solar Panels and Battery storage devices.

Each property will have the ability to export 3.5kW of to WPD's Low Voltage network.

The Existing Network



- Tapered mains.
- Looped services.
- Insufficient capacity on existing transformers to accommodate volt rise.

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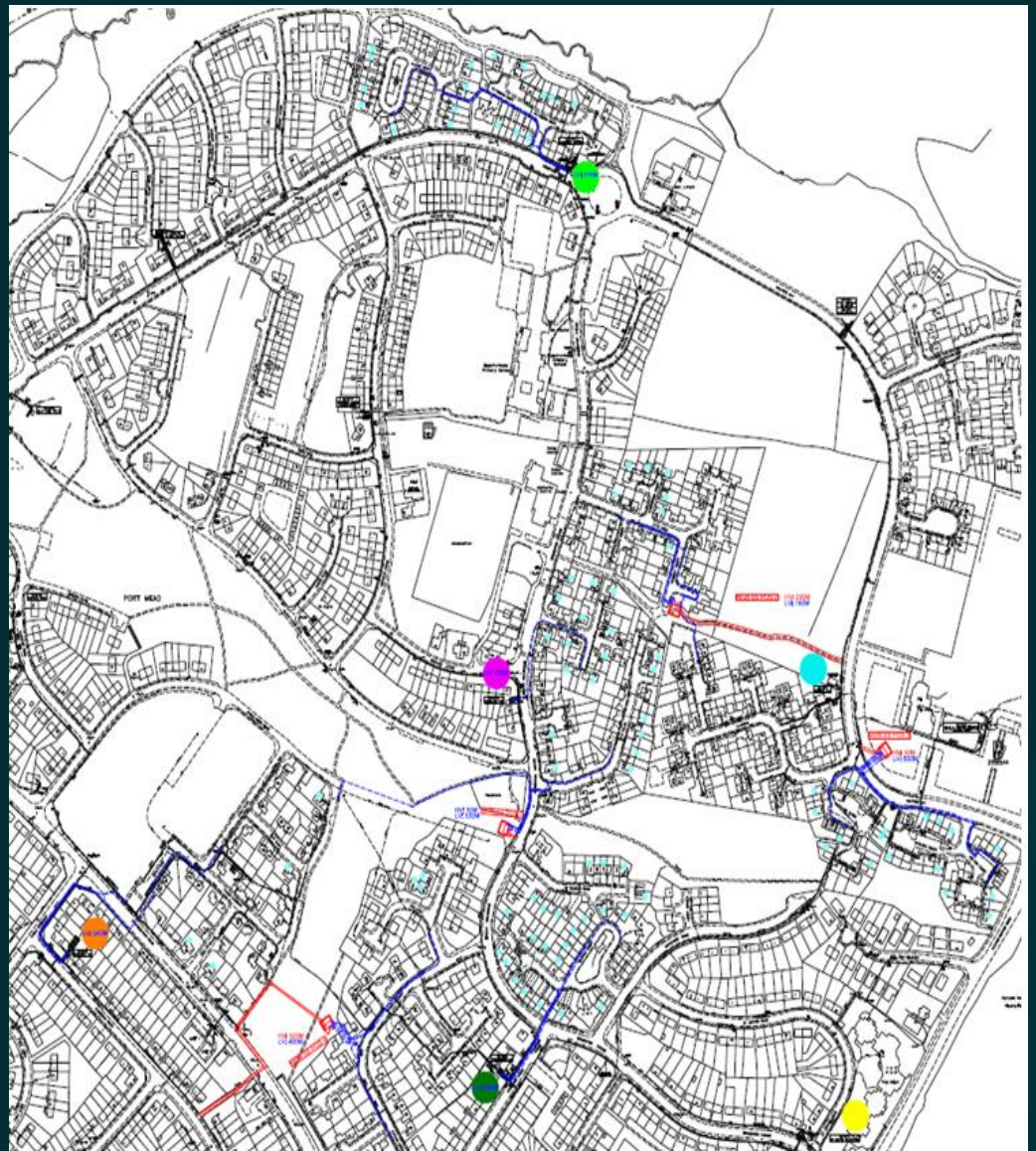
The Enhanced Network



- Installation of 3 Phase Services
- Additional 300WCN Mains Used split up existing feeders
- Installation of 4 New 1MVA Transformers

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The benefits

- Increased capacity for domestic Low carbon technology, including fast 21kW three phase home charging for future EV's.
- Increased capacity for domestic storage systems, linked with larger PV arrays and heat pumps gives greater flexibility.
- Potential social landlord opportunities to provide vulnerable customers with cheaper energy by managing energy flows to fuel poor developments whilst giving fixed energy bills included in the rent.
- Installation of air source heat pumps typically of the order 9kW will help reduce CO^2 emissions.

The benefits

- Innovative uses for three phase generation and battery storage to compliment /support local electricity networks.
- A reduction in Losses on the LV network, by spreading the current over three phases and by using the electricity generated in the PV and stored in the ES in the home.
- The use of three phase services to homes will reduce out of balance losses on the local WPD LV network and 11/0.4kV transformers.
- An added benefit to UK plc

WESTERN POWER DISTRIBUTION INNOVATION TEAM

Losses Investigation

9th December 2019

CHRIS HARRAP
INNOVATION AND LOW CARBON NETWORKS ENGINEER

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Project Overview

Background

- Losses are a important issue on electricity networks
- Licence obligation to operate efficient and economic networks

Aims

- Further our understanding of technical losses; and
- Provide information to help cost effectively manage losses

Outline project approach

- Install monitoring on sample HV and LV feeders, gather data
- Use data to design HV and LV feeder loss estimation methods
- Use data to validate preferred estimation methods
- Produce HV & LV feeder loss estimates

Project Partners

Loughborough University

manxutilities
bun shirveishyn vannin

GRIDKEY

Project Metrics

- NIA project
- April 2015 – May 2019
- £1.9m spend

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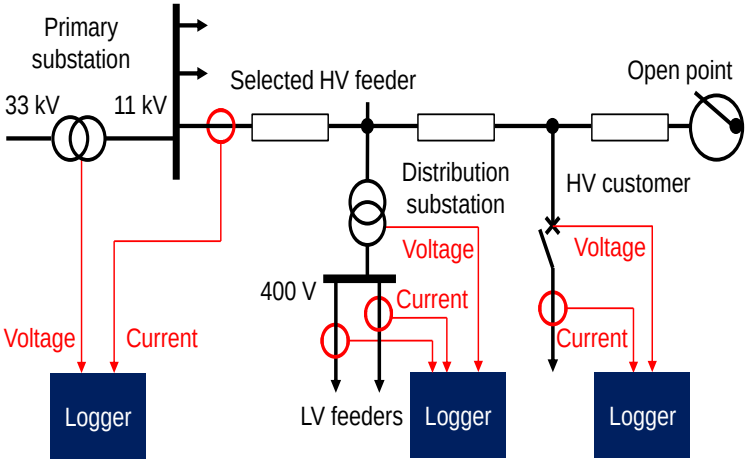
Feeder Monitoring

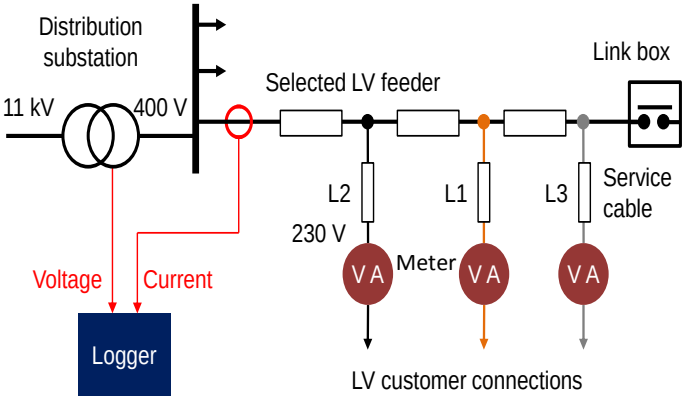
HV Monitored Feeders

- 11 feeders – urban / rural; cables / overhead
- Monitoring at 183 entry and exit points
- Primary Subs / Dist. Subs / HV Connections



LV Monitored Feeders

- 11 feeders – domestic / industrial and commercial; cables / overhead
- Monitoring at 360 entry and exit points
- Gridkey at substations / NOPs
- Advanced meters at customer connections



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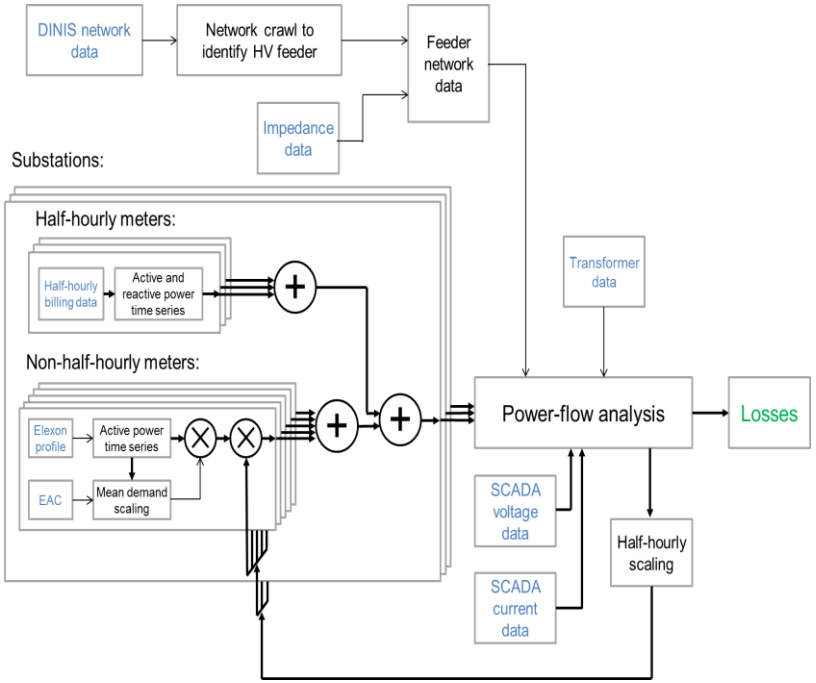
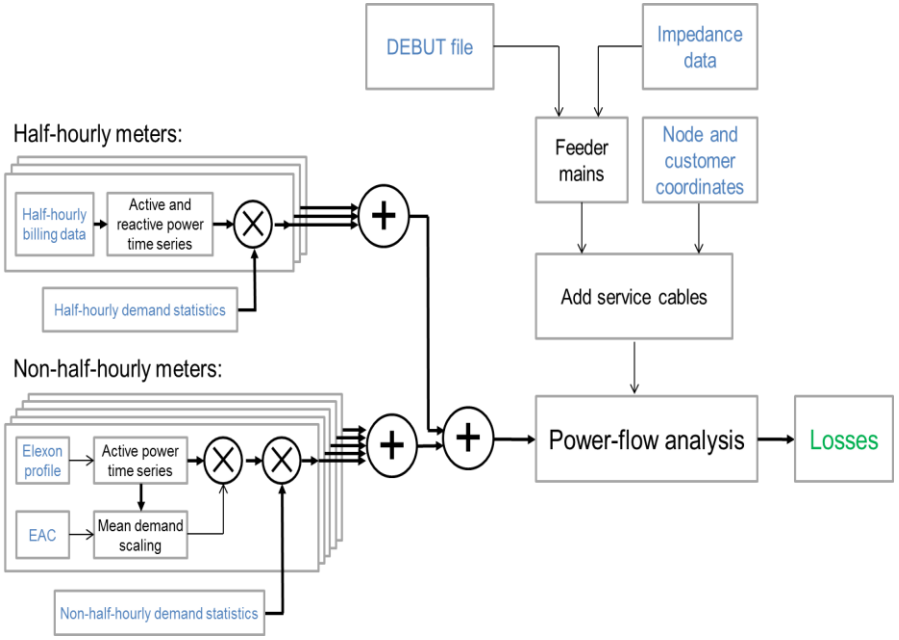
Loss Assessment – HV and LV Methods



HV Feeder Loss Assessment process



LV Feeder Loss Assessment process

Losses for individual feeders can be assessed using business-as-usual data, these assessments doesn't need any additional monitoring to be installed

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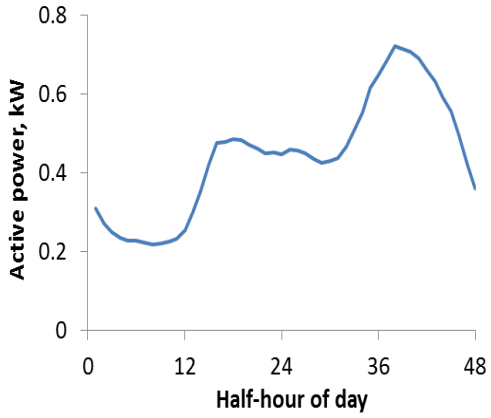
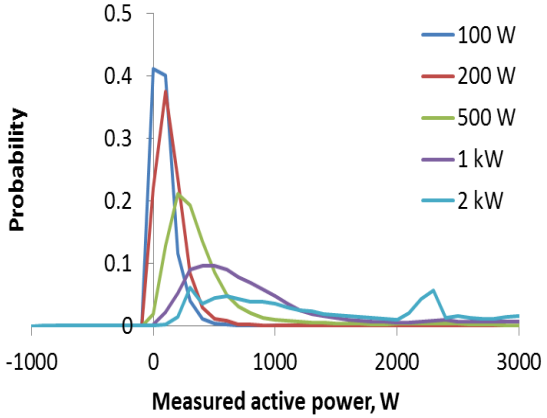
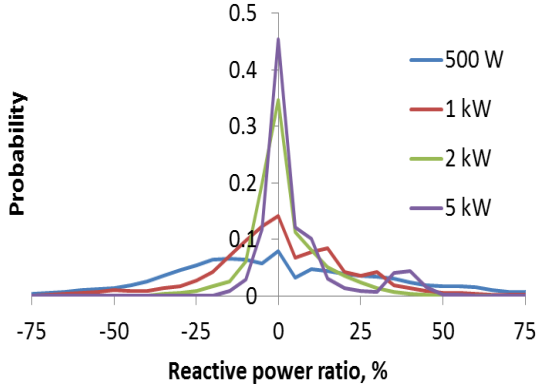
Loss Assessment – Modelling LV Demand







Half-hourly profile → **Add time variation and unbalance** → **Add reactive power**

- From demand data and Elexon Profiles
- Variation of 1-minute demand per phase for a given half-hourly demand
- Variation of reactive power for a given active power

Detailed analysis of the results from the Isle of Man monitoring provided the underlying statistical models that have been used for LV feeder assessments

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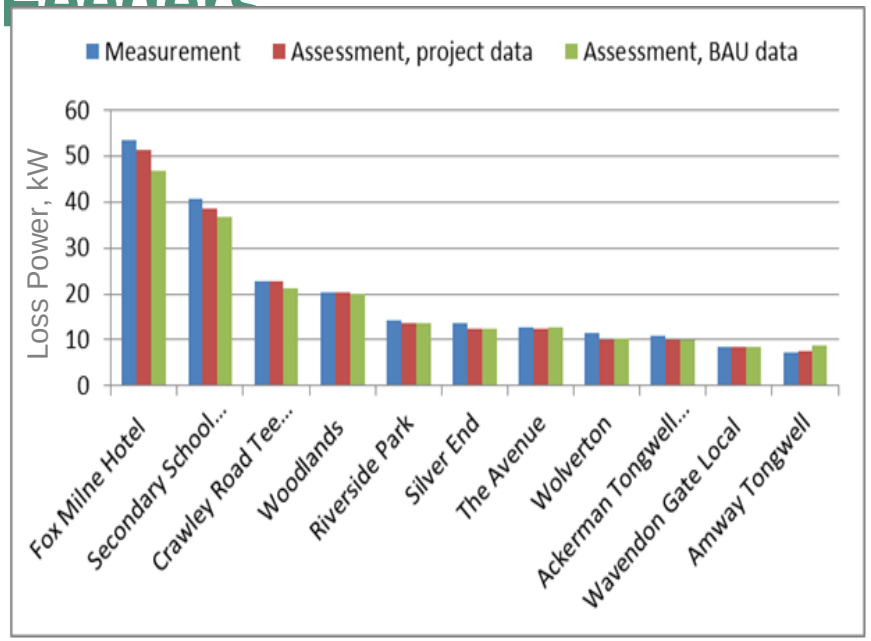
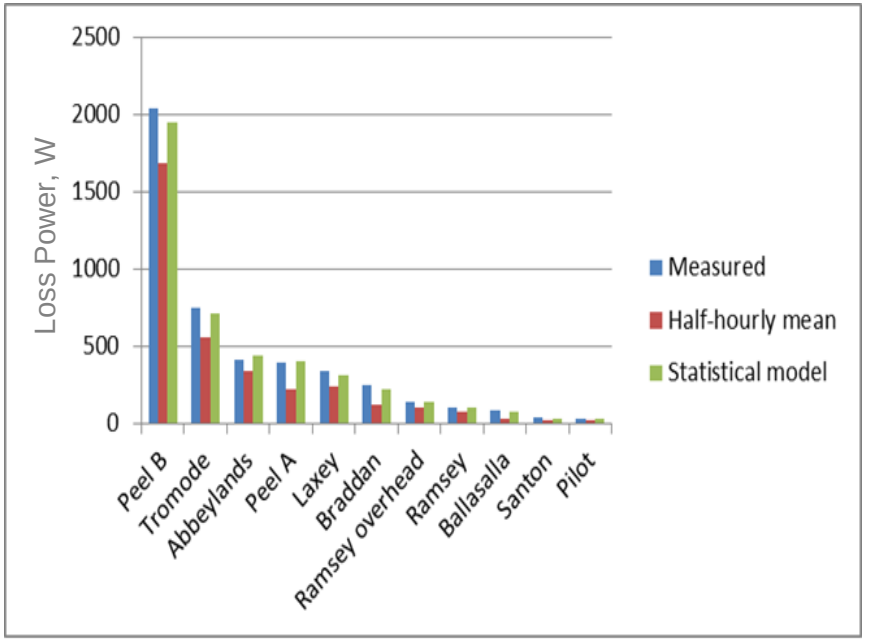
Loss Assessment – Validation against Monitored Feeders



HV Feeder Loss Assessment Validation



LV Feeder Loss Assessment Validation

Assessment method provides assessment of feeder-specific losses that agree well with full monitoring data

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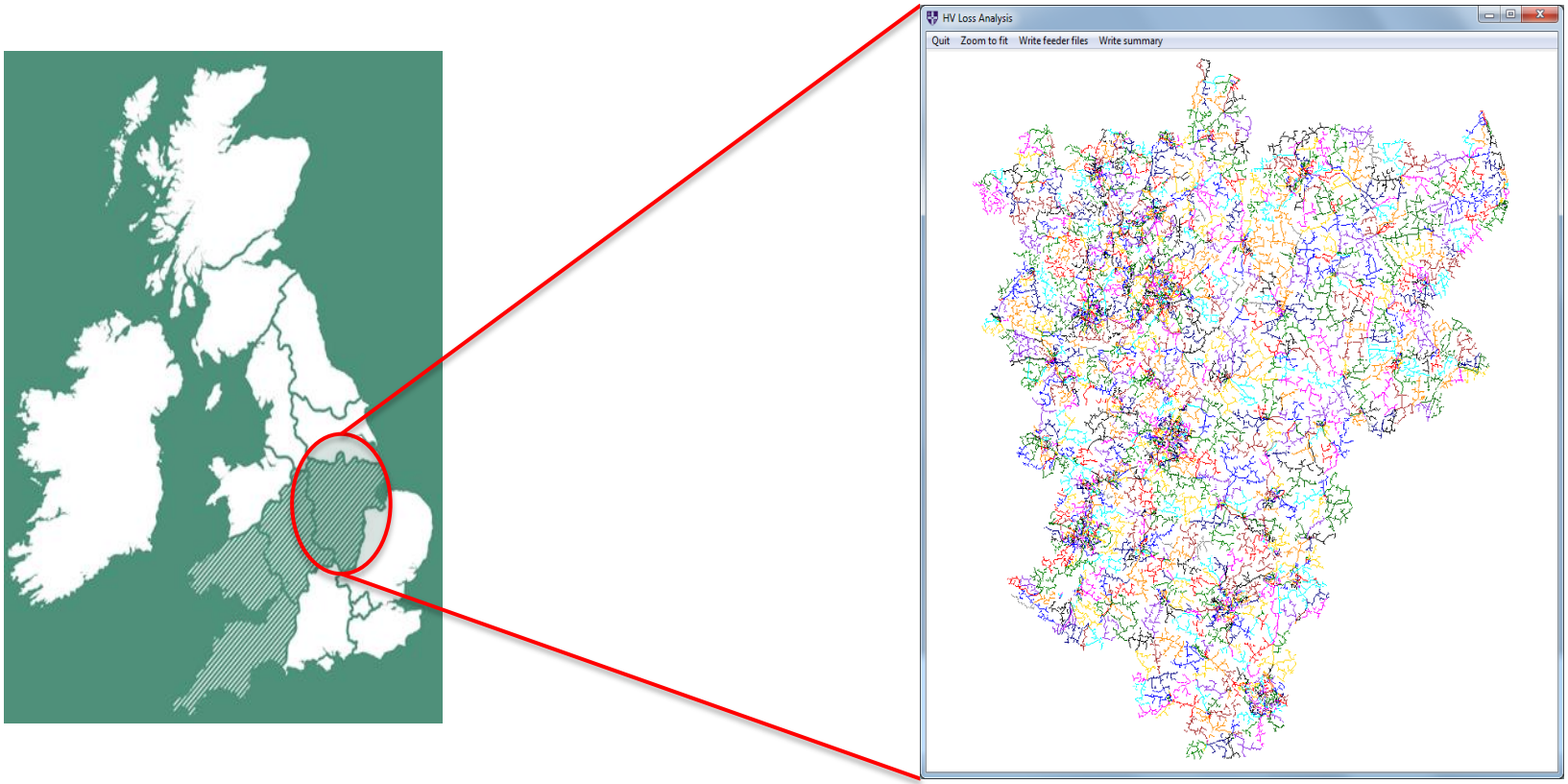
Loss Assessment – Large-scale Application



Successfully applied to over 2,100 HV feeders and 69,000 LV feeders in the East Midlands region

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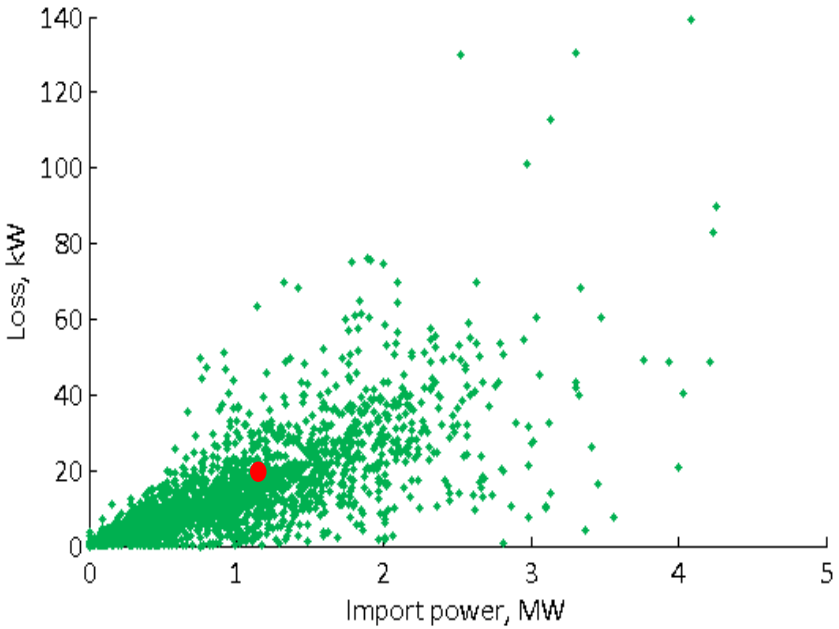
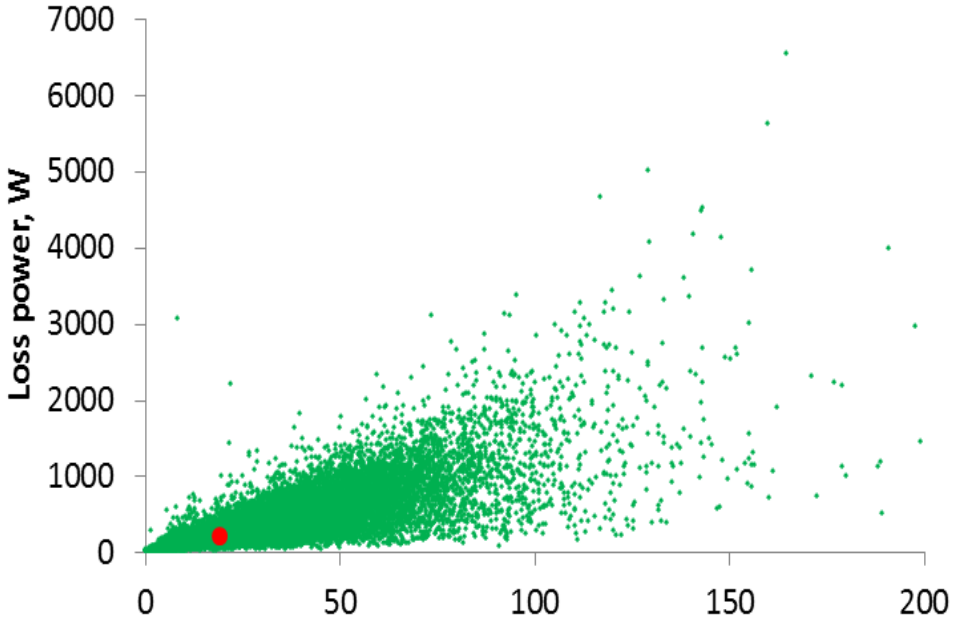
Loss Assessment – overall results



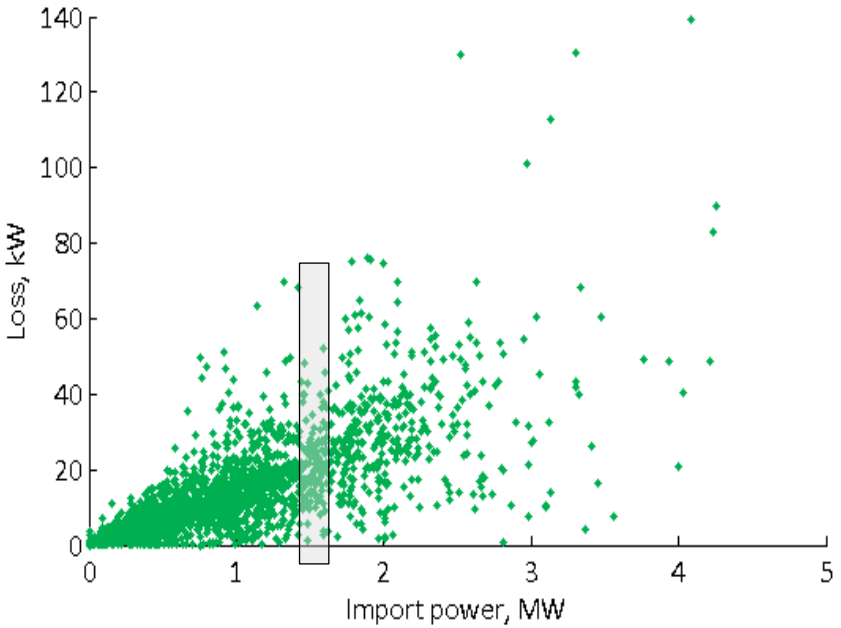
2,130 HV feeders assessment results



69,256 LV feeders assessment results

Mean losses: 1.47% HV and 1.06% LV,
with significant diversity in individual feeder results

Loss Assessment – variation in losses for similar loads



2,130 HV feeders assessment results

Factors driving variation in losses

- Feeder resistance (length and cross sectional area)
- For HV feeders - Numbers of distribution transformers / number of HV connections
- Load factor
- Location and relative magnitude of the load along the feeder
- Reactive power, particularly for industrial loads

Variation in losses for feeders with similar loads is driven by differences in characteristics of individual feeders

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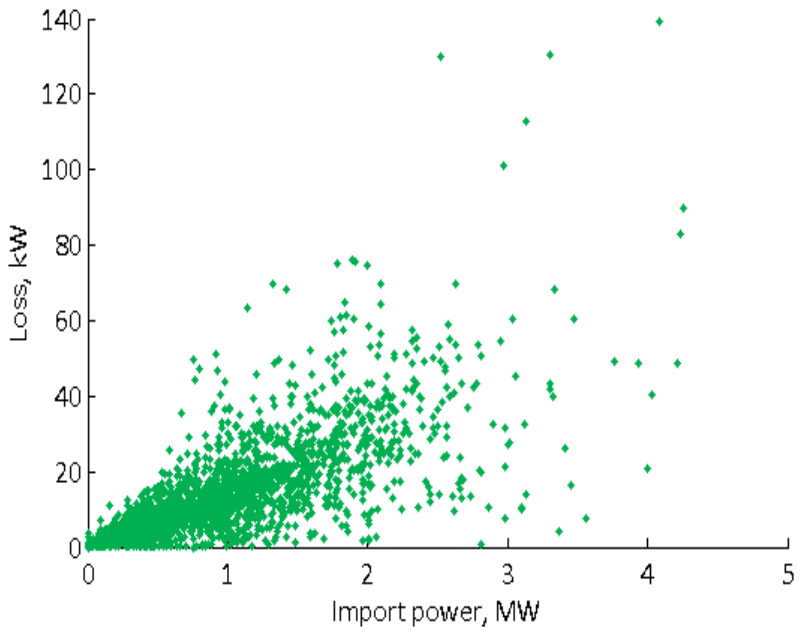
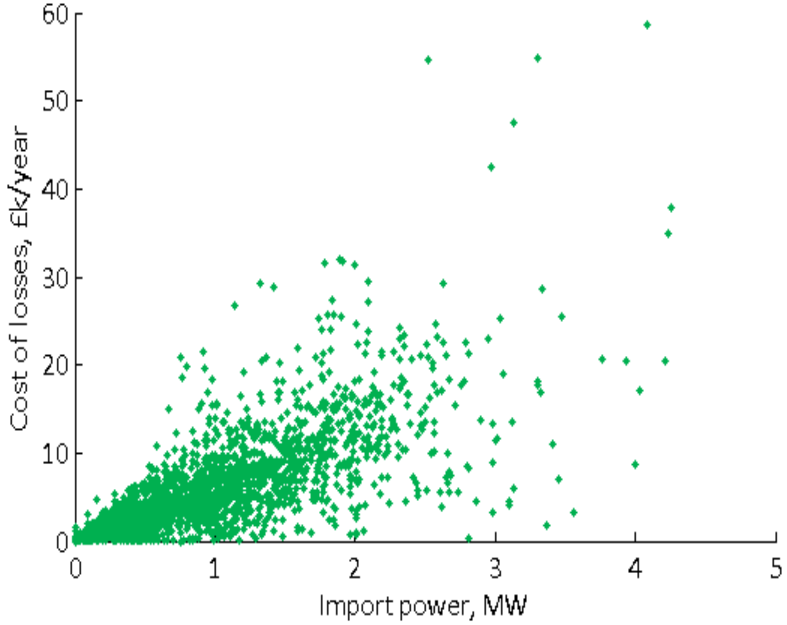
Loss Assessment – Cost of Losses



× £48/MWh



2,130 HV feeders assessment results

Assessment of technical loss power can be translated into an annual cost

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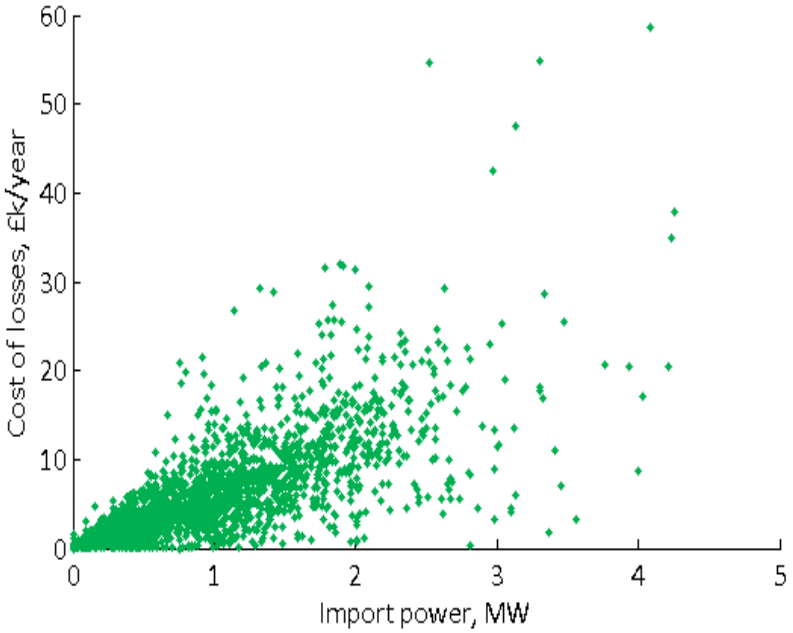
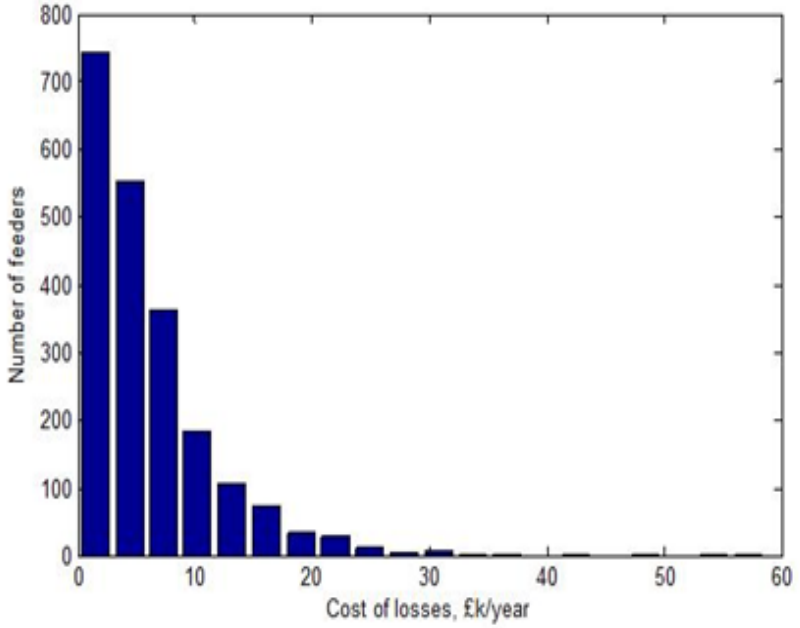
Loss Assessment – Cost of HV Feeder Losses





2,130 HV feeders assessment results

Small numbers of HV feeders have high cost of losses

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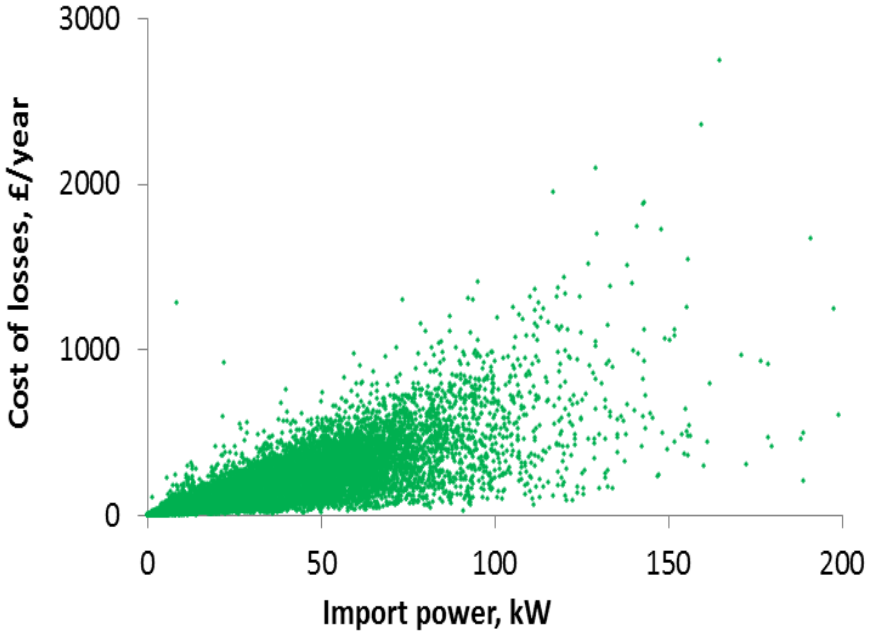
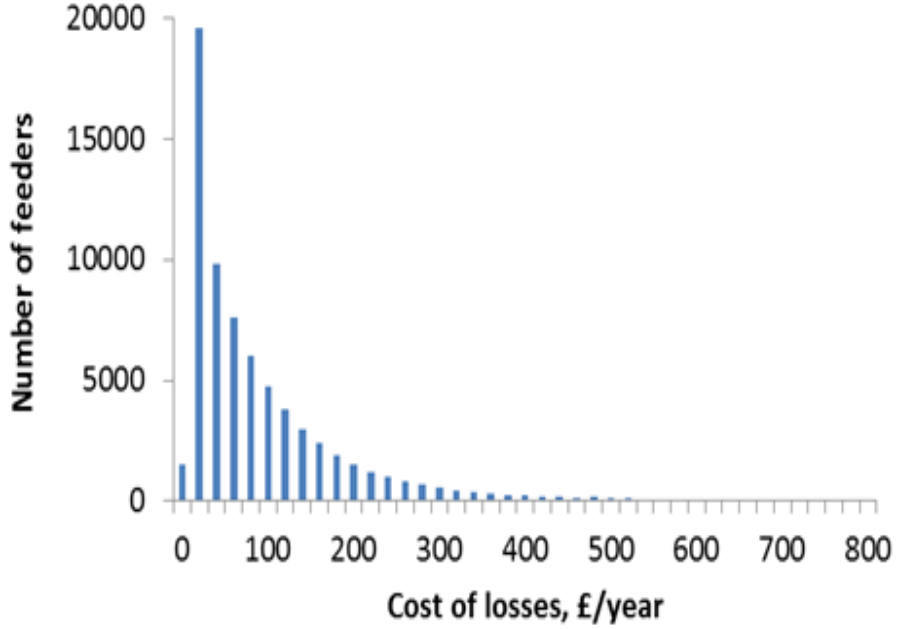
Loss Assessment – Cost of LV Feeder Losses





2,130 HV feeders assessment results

Cost of losses per LV feeder is substantially lower than for HV feeders

Conclusions

1. Provides a Baseline

Project has a provided a baseline for assessed HV & LV technical losses for EM region.

2. Some Significant HV Feeder Loss Costs

Individual HV feeder loss costs can be significant, targets have been identified for possible mitigation action

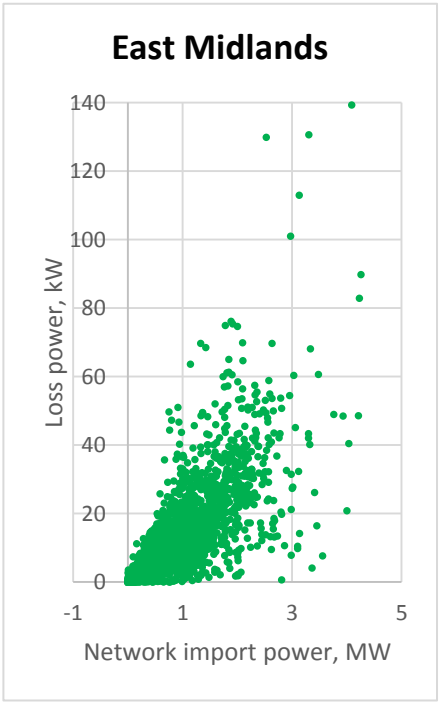
3. High Volume, Lower Cost for LV feeders

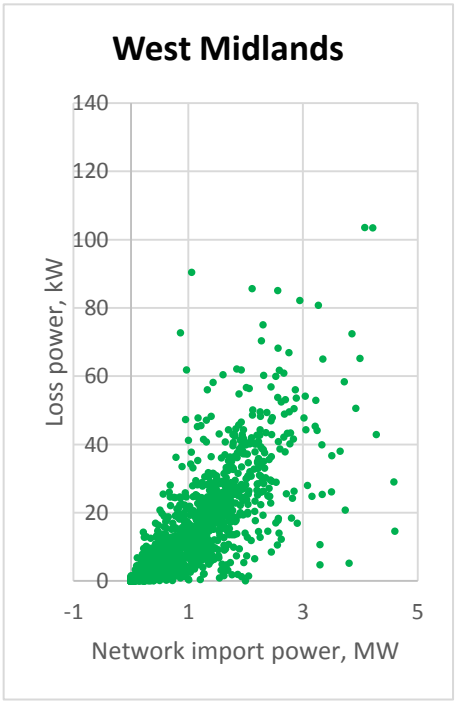
Cost beneficial retrospective mitigation action on individual LV feeders is significantly more challenging than HV.

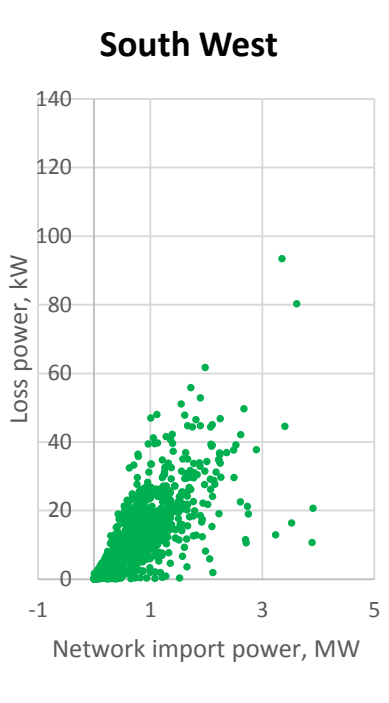
4. Evidence Supporting Policy Changes

Loss assessments provide further evidence of the benefit of recent WPD policy changes on future LV system design.

Loss Assessment – Follow-on HV work







Provisional results for West Midlands and South West HV feeders are showing very similar results to original East Midlands work…

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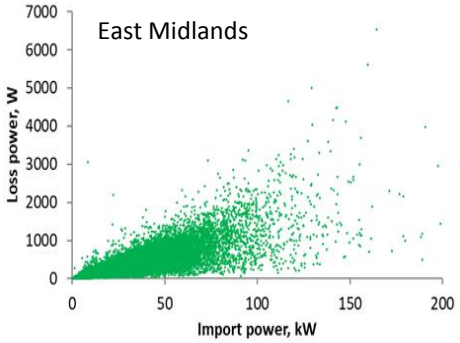
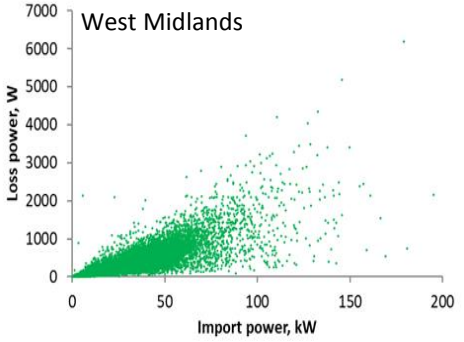
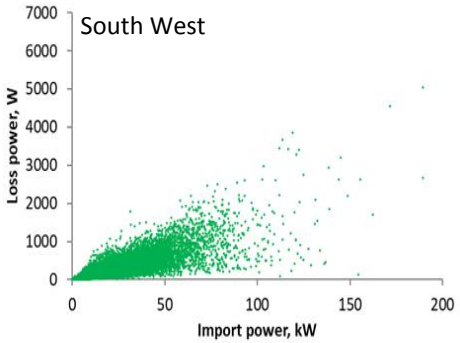
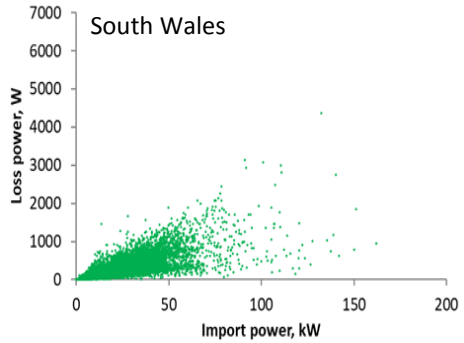
Loss Assessment – Follow-on LV work









Similarly, provisional LV feeder assessment results are very similar to original East Midlands work…

Collaborative Working

Paul Jewell

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Collaborative Working

- The SOHN losses report was commissioned by WPD and UKPN to provide an assessment of all the ways in which losses could be reduced. The report was written in partnership by SOHN Associates and Imperial College London, to provide an academic viewpoint on the range of the problem.

- You have already heard of how WPD were collaborating with Manx Electricity and Loughborough University on the Losses Investigation project.

- All the DNO's and ESB are collaborating through the Energy Networks Association via a Technical Losses Group, this group is in the process of producing a joint proposal to put to Ofgem on the Regulatory Incentive Mechanism.

Collaborative Working

- A contract was issued to WSP vis the ENA Losses group which related to the understanding of losses and the way the network will change as Low Carbon Technologies are added.

- The work developed a benchmark position for all DNOs and also show the scale of increases/decreases which will be seen before losses interventions are developed.

- WPD are working with a transformer manufacturer to produce an amorphous cored 1MVA padmount transformer to supply charging hubs which could be used to supply for example 6 off 150kW rapid chargers. The design is circa 90% complete. WPD have a number of Local Councils interested in using this concept. Other member of the ENA Losses Group are following this project and what it achieves.

Collaborative Working

- WPD are currently conducting their own analysis of the LEAN project using the tools provided by SSEN to assess the potential benefits of TASS on the WPD network.

- Through the ENA Losses Group, taking guidance from Scottish Power and UKPN, we have purchased 100 single phase amorphous cored 25kVA pole mounted transformers.

- The ENA Losses Group are in the process of producing an amorphous cored transformer specification for ground mount and Pole mounted transformers, with a view that the specification then becomes an Industry specification the DNOs and IDNOs can use.

Transformer Auto Stop Start for Losses Reduction

Presentation by Sarah Rigby and Maciej Fila (SSEN)

Presentation slides available in separate PDF

Peter White

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Future Projects

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Future Projects

- For the UK to meet the Road to Zero by 2050 transport and heating need to be de-carbonised.
- Plug in electric vehicles (EVs) are becoming more main stream. Currently there are over 60,000 EVs in the UK, and that number is predicted to rise to more than 7 million in the next 30 years. This will strain the current networks, and increase losses.
- Electric Nation has shown WPD the average ADMD of a single house will increase by circa 2kVA when fitted with a 7kW type 2 EV charger.
- Currently there is insufficient data on heat pumps to be of significance, therefore what heat pumps will do to the ADMD of a house is unknown.

Future projects (Cont.)

- WPD along with their partners Sero Homes and Pobl have started the Parc Erin Hosing for the Future project where all the circa 250 houses will be fitted with the complete suite of LCTs and supplies by three phase service cables.

- These houses will meet the new Building Performance Regulations which are changing in April 2020; all new buildings shall have a 7kW type 2 EV charger fitted.

- In addition the houses will be fitted with heat pumps this would push the load up on the single phase service cable, thus increasing the losses. Hence why three phase service cables will be used, the estate will be fully monitored to replicate the IOM Losses Investigation thus providing an audit trail to give to Ofgem prior to changing WPDs Policy on service cables.

- From the project a number of outputs will be achieved an ADMD for heat pumps plus guidelines for Planners with respect to new housing estates how they need to be configured.

Future projects (Cont.)

- With the likelihood of 6 million EV's being used on the British roads by 2030 and 23m heat pumps needing to be connected to the UK electric network by 2050 the more difficult scenario will be the retro fit to existing housing estates.

- With the majority of housing stock in the UK being 1950, 1960 and 1970s where the service cable is a looped 0.0225in² PILC, then the retro-fit of properties will be interesting.

- WPD have a second losses project which is due to start shortly in Bleanu y Maes in Swansea where circa 700 house will be retro fitted PV, ES, HPs and three phase service cables. Again this project will be monitored as per IOM Losses Investigation with a view to gain further information for the Ofgem audit trail.

- A number of new solutions will be trailed with a view to meeting various problems that exist in any retro fit project.

Future Projects

- WPD are working with a transformer manufacturer to produce an amorphous cored 1MVA padmount transformer to supply charging hubs which could be used to supply for example 6 off 150kW rapid chargers. The design is circa 90% complete. WPD have a number of Local Councils interested in using this concept.

- Although WPD have shown that a district heating system from Primary transformers is not feasible at this time. WPD have completed a proof of concept with a heat pump manufacturer to use a ground source heat pump which is incorporated into the oil circuit of a primary grid transformer to provide the heat to heat up the substation buildings rather than use storage heaters.

- This has now been taken a step further and WPD are working with a transformer manufacturer to build a pilot substation to verify the proof of concept work, if successful this will be rolled out as BAU.

Future Projects

- WPD have examined the issues of converting the legacy 6.6kV network in Bath into an 11kV network and it is scheduled that the primary 33/6.6kV substation at Twerton will be changed to 33/11/6.6kV during 2020 which will be last major obstacle in converting Bath to an 11kV network, once the conversion is complete the next objective will be to roll out the conversion on the other 6.6kV legacy networks throughout WPD to reduce losses on the existing 6.6kV networks.

Any Questions Open Forum

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Next Steps

- We will be finalising our Losses Strategy through December ready for publication in January 2020.
- If you have any views on the information you have heard today, or on any other aspects of our Strategy, please get in touch with us.
- Paul Jewell : pjewell@westernpower.co.uk
- Peter White : pwhite@westernpower.co.uk

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Thank you for your time.

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