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Everything you need to know about our **Losses Strategy**

August 2020

WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Foreword

We're working on new and effective ways to reduce our losses, both now and in the future.

During the ED1 price review period, we will have reduced our losses with all the mitigating measures adopted, looking to the future, as detailed in our license conditions loss reduction will be an on-going affair. That means taking action now to improve and adapt the network to tackle current losses as well as potential losses in the future.

In our losses strategy, we've outlined the practical measures we're already taking to eliminate losses, including new approaches to transformers, cables and other assets, as well as how we're continuing to share our plans and progress with stakeholders every step of the way.

At WPD, we recognise that the network is changing as it responds to the new demands of low carbon technologies and the UK's commitment to net zero.

Our industry-leading innovation programme is not only helping to drive these changes but also allows us to harness data and new technologies to help anticipate and plan for future losses.

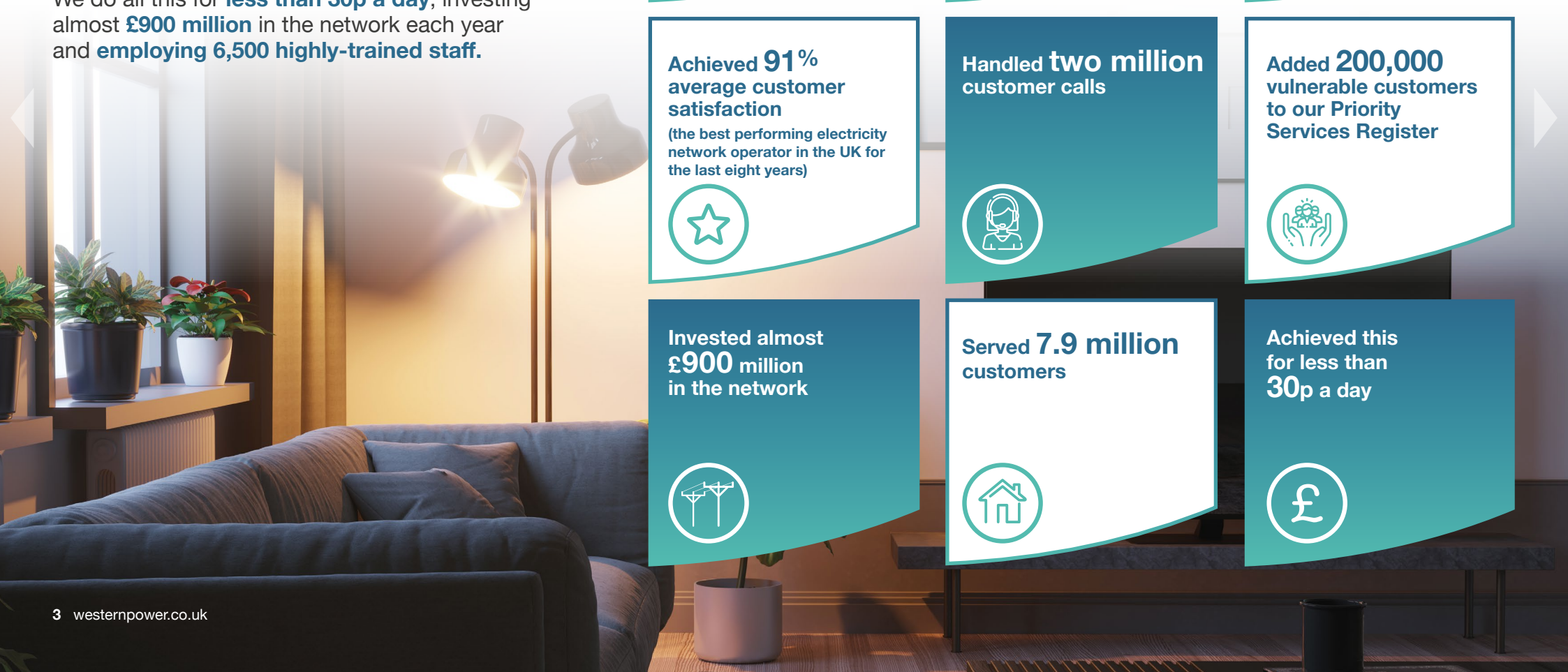
That's why our losses strategy is being shaped to address current losses as well as to meet the challenges of tomorrow.

Peter White
DSO Development Engineer

What we do

Western Power Distribution is the electricity distribution network operator for the Midlands, the South West and South Wales.

Our job is to deliver a safe, reliable and resilient electricity network to our **7.9 million customers.** We do all this for **less than 30p a day**, investing almost **£900 million** in the network each year and **employing 6,500 highly-trained staff.**



This year, we've:

- Added **2.9GW** of extra capacity by operating the network in a smarter, more efficient way
- Taught **84,000** school children about electrical safety
- Recruited **77** new engineering trainees
- Achieved **91%** average customer satisfaction (the best performing electricity network operator in the UK for the last eight years)
- Handled **two million** customer calls
- Added **200,000** vulnerable customers to our Priority Services Register
- Invested almost **£900** million in the network
- Served **7.9 million** customers
- Achieved this for less than **30p** a day

Loss Reduction Measures

Our aim is to keep distribution losses as low as possible, while ensuring any changes make sound economic sense.

We're already working on several projects which have resulted in changes to the way we work, including the phasing out of some cables to reduce losses.

We're also looking at the design of new low voltage networks for the homes of the future, as well as exploring new ways to provide upgraded services to older properties where LCTs are being fitted.

As part of our commitment to the government's Road to Zero strategy, we're preparing now for the possible impact of LCTs, such as the growth of EV charging, on the LV and 11kV networks.

We're working with local councils to make sure we can meet additional demand from EV charging by introducing solutions such as charging hubs with low loss, pad mounted transformers.

We've been busy

Replacing pre-1958 transformers and phasing out less efficient cables

Uprating our minimum cable sizes to reduce losses

Working with local authorities on plans to create low loss EV charging hubs

Our plans, your voice

Our stakeholders are at the heart of everything we do. So, while developing our losses strategy, we carry out a comprehensive and continuous programme of stakeholder engagement.

We invite stakeholders with a particular interest in losses, including other network operators, electricity suppliers, customer groups, academics, consultants, regulatory bodies and those involved in manufacturing.

Since the publication of our first losses strategy in December 2014, we've been consulting with stakeholders and incorporating their views into the revised document every year.

By sharing best practice with fellow network operators, for example, WPD has been able to learn from others' strategies. We've recently purchased about 90 25kVA amorphous cored single phase Pole Mounted Transformers (PMT) following work carried out in this area by UKPN and Scottish Power.

These single phase amorphous PMTs are now being installed on the WPD 11kV network as part of our 'business as usual' activities.

Cutting our losses

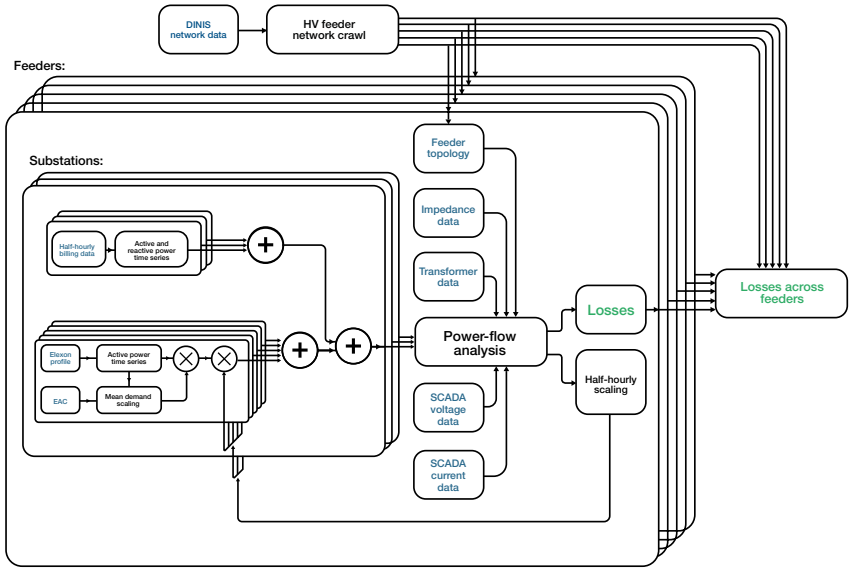
To reduce losses effectively, we need to have a better understanding of them. That's why we're working hard to quantify current losses, identify where they happen and why, and develop methods to predict the effects of any actions we take to cut losses.

Loss rates are calculated over three years to ensure stable and robust figures. To see the effect of reducing losses, WPD needs to determine the baseline level of current losses – something that is being calculated for several highly monitored LV and HV feeders by the Losses Investigation Project.

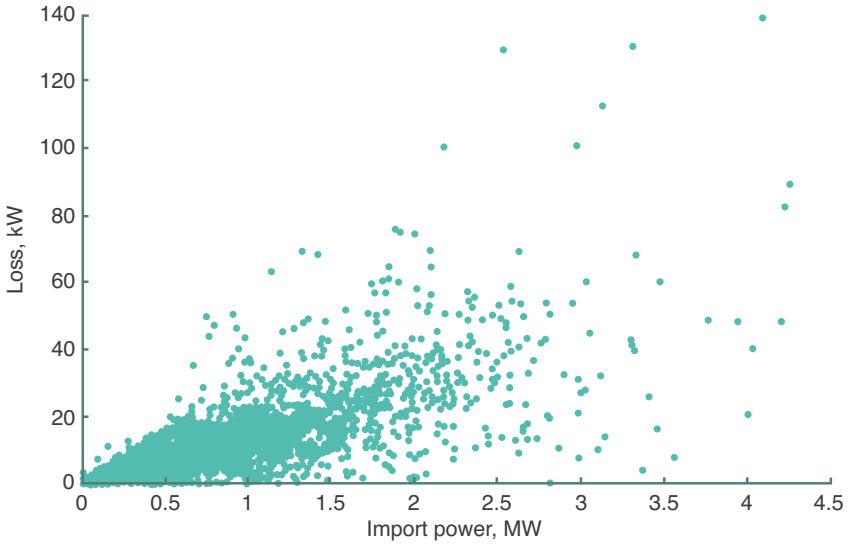
The measurement at the customer end can be very inaccurate, particularly for domestic customers where some meter readings may be estimates. Other monitored points along the network, typically substations, can help identify where the losses occur.

When transformers are replaced in LV distribution cabinets, they are now installed with more accurate current transformers, which are wired to a terminal block where more advanced monitoring equipment can be attached. However, currently there are areas of the network, especially at LV, where there is no monitoring at all.

HV Feeder method - See page 16 of the DSO Losses Strategy Document



Scatter plot of mean total loss power versus feeder mean power
- See page 17 of the DSO Losses Strategy Document



The smart approach

The roll out of SMETS 2 smart meters could revolutionise network monitoring. Providing the communications with the Smart Meters is achieved, Smart meter data will be readily available in providing data for the relevant circuits and updated on far shorter timescales, would provide vastly improved data. Smart meters are also being installed at other points on the WPD network, so there will be a more complete picture of load flow across the network.

Smart meters look set to enable network operators to implement a number of key strategies to manage losses. Firstly, customers could be incentivised to use less energy at peak times by using time-of-use tariffs, thus reducing losses.

Secondly, it would enable areas of high loss to be identified, so that targeted action could be taken to address them.

Finally, it would allow for real-time network management, meaning generation from both distributed and non-distributed sources and power flow across the network could be controlled to match present demand.

The model solution

The most powerful tool to forecast what will happen on the WPD network in the future - and to determine what is happening on the unmonitored parts of the network - is computational modelling. Modelling effectively creates a virtual, fully monitored network which can then examine and test new ideas. Using these modelling tools, we expect to be able to map where losses occur on the network, allowing for a targeted approach to loss reduction. Modelling can also be used to predict the effect of future changes to the network, so that any future actions can be evaluated before being carried out.

Modelling should become even more useful when used in partnership with smart meter data.

By feeding the data into the model, we can produce models of the network in real-time. Data at specific metering points can then be predicted and compared to the real data, to establish the success of the model.

This will make it possible to create more targeted losses strategies, leading to far more effective loss reduction activities.

In harmony?

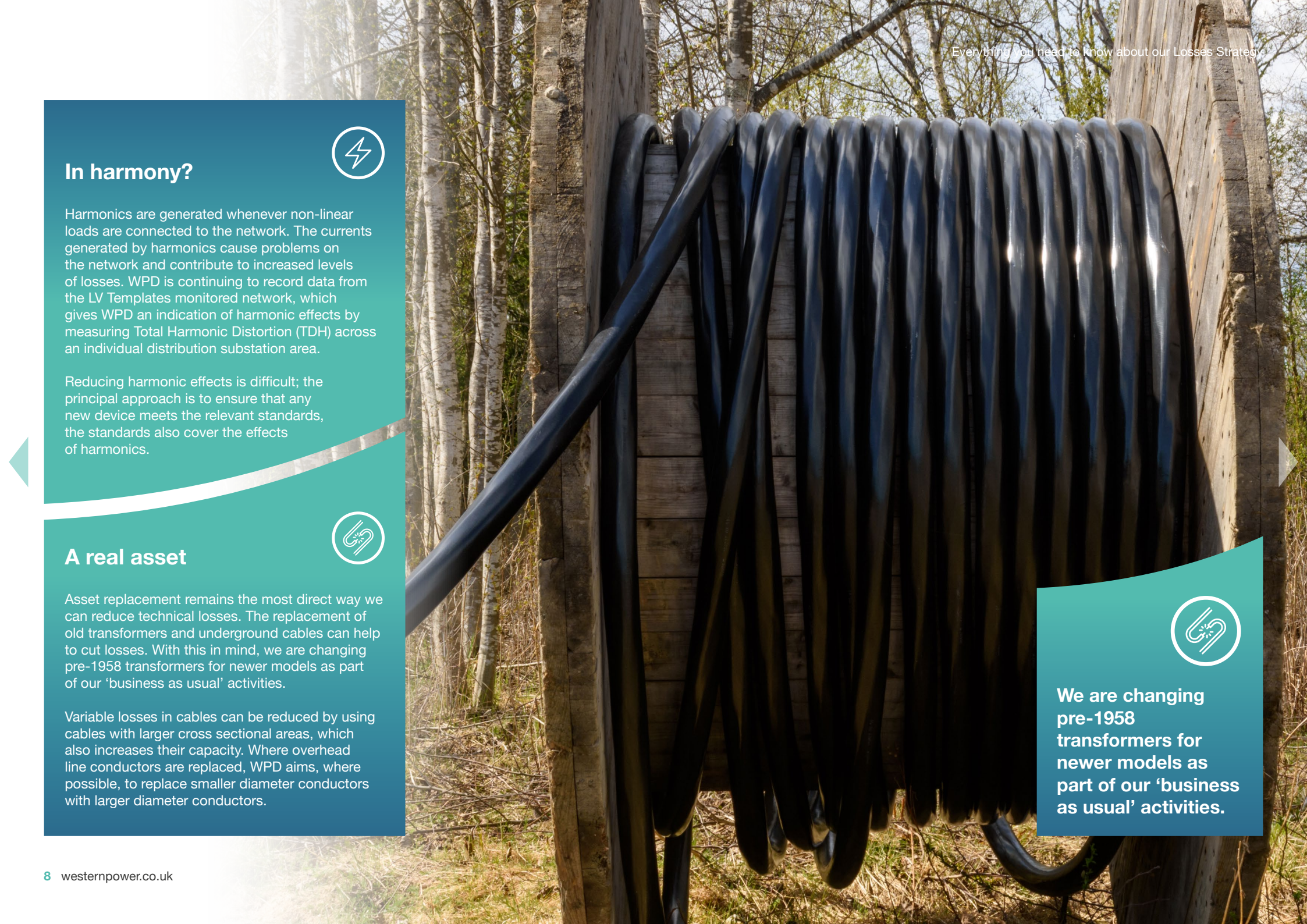
Harmonics are generated whenever non-linear loads are connected to the network. The currents generated by harmonics cause problems on the network and contribute to increased levels of losses. WPD is continuing to record data from the LV Templates monitored network, which gives WPD an indication of harmonic effects by measuring Total Harmonic Distortion (TDH) across an individual distribution substation area.

Reducing harmonic effects is difficult; the principal approach is to ensure that any new device meets the relevant standards, the standards also cover the effects of harmonics.

A real asset

Asset replacement remains the most direct way we can reduce technical losses. The replacement of old transformers and underground cables can help to cut losses. With this in mind, we are changing pre-1958 transformers for newer models as part of our ‘business as usual’ activities.

Variable losses in cables can be reduced by using cables with larger cross sectional areas, which also increases their capacity. Where overhead line conductors are replaced, WPD aims, where possible, to replace smaller diameter conductors with larger diameter conductors.



We are changing pre-1958 transformers for newer models as part of our ‘business as usual’ activities.

So, what's new?

Innovation projects are key to helping us develop new methods to reduce losses, which is why they are a cornerstone of the losses strategy.

A number of these projects focus on network monitoring and automated control, as well as developments such as energy storage and heat recovery.

Here are just some of the projects that are helping to shape our losses strategy:

Many of the elements in our loss strategies are based on recommendations from the **SOHN losses report**, produced by SOHN Associates and Imperial College London. Using a network modelling tool and intelligent forecasting for future demand, this report aimed to come up with as many potential solutions as possible to reduce losses. These included heat recovery, active network management and asset replacement.

The **LV Templates** project set up a highly monitored network in South Wales to see if it was possible to create a template for the temporal load and voltage behaviour of substations nationwide. The project was based in an area with a dense population of LCTs and found that 82% of UK substations fitted one of the templates.

The project also provided data on voltages on the LV network, concluding that the network voltage could be reduced and remain within statutory parameters. By reducing the voltage, we can reduce overall demand and contribute to loss reduction. WPD has since completed a programme of voltage reduction in South Wales, reducing overall losses. Based on these results, we've now launched a programme of voltage reduction across all WPD regions, with more than 1400 substations already covered. The project is due to be completed in 2020.

We've also been using findings from our **Losses Investigation** report focusing on HV feeders, where one minute resolution logging equipment was installed at primary substations to give comprehensive information about actual power flows and losses for each HV feeder. For LV feeders, similar equipment was installed at distribution substations. The process highlighted how HV feeders with high losses could be identified, allowing the cost benefits of mitigation to be assessed. Following the completion of the HV feeder loss estimation process, feeder-specific loss estimates have been produced for 2,130 feeders in the East Midlands and will be generated for the remaining WPD licence areas.

Our study of **new and retro fit homes** in Wales also looks set to reduce losses. As part of this ground-breaking project to create the 'housing estate of the future', we're monitoring 11kV mains feeders and each home in a development of new build homes, each fitted with a full suite of LCTs and supplied by three phase service cables. The same is being done at a development of retro fit homes in Wales. It is expected that there will be loss reductions in the LV service cables, LV mains cables and in the substations supplying the housing estates. This project is being carried out in partnership with Pobl and Sero Homes.

Projects that have a losses benefit

Our Network Equilibrium project is looking to balance voltages and power flows across the network, using three methods to integrate distributed generation more efficiently. These include Enhanced Voltage Assessment (EVA); System Voltage Optimisation (SVO) and a Flexible Power Link (FPL). These models are designed to help minimise losses and reduce the voltage at strategic points on the network.

Open LV is designed to provide data to customers or groups of customers in communities, to help them gain a better understanding of their electricity usage as a community. In time, it is hoped this will enable local networks to perform in a more efficient way, balancing demand and generation, and reducing losses as peaks are reduced.

The Industrial and Commercial Storage Project used four separate sites to explore different storage options. The fundamental idea of the energy storage system will be to store energy at times of low load and dissipate energy at times of high load in order to actively manage the load on both the LV and HV networks. The project illustrated how storage can be used to eliminate peaks and reduce losses, for instance, batteries designed to capture surplus electricity generated by a solar PV system can allow consumers to store solar electricity for use later in the day.

Open LV flow chart

Conditions
Policy context, Locational/geographical conditions, Social conditions, Technology/energy infrastructure, Information about community organisation.

Overall programme objectives
- Trial and demonstrate an open, flexible platform that could ultimately be deployed to every LV substation in GB.
- Provide LV network data to customers or groups of customers in communities.
- Use data to bring about change in local electricity understanding, use, and infrastructure.

Rationale	Inputs	Activities	Outputs
What are the assumptions; factors taken into account; what needs to be in place for project to succeed?	What resources will be needed?	What will the project do?	What will be the direct results of activity? What will the project do or make?

Intended outcomes
What are you trying to achieve? What are the direct results of activity - i.e. that can be measured.

Intended impacts
What is the (long term) change you want to see?
- Environmental benefits
- Fiscal and economic benefits
- Social benefits

Making fewer losses: at a glance

All the actions we've taken so far to address losses will enable us to reorganise the network, enabling it to run more efficiently and helping to identify further actions to prevent or reduce energy loss in future.

We're already using the knowledge from our innovation projects to plan changes to our network design policies.

Actions completed before 2018

- Discontinuation of cable tapering on all feeder and service cables;
- A comprehensive programme of stakeholder engagement including biennial stakeholder consultation events;
- Work to reduce cable lengths;
- Rationalisation of transformer sizes and application;
- Voltage reduction scheme across WPD;
- Removal of smaller cross-sectional area cables to reduce variable losses in underground cables;
- Development of a new losses page on the WPD website;
- Creation of a Losses Engineer post within the Policy section.

Actions completed during 2019

- Continued pro-active replacement of 1,996 distribution transformers;
- Design intervention for losses on new installation of 8,184 distribution transformers and 11,880 kilometres of underground cables;
- Purchase of all 88 amorphous cored 25kVA single phase PMTs;
- Installation of amorphous single phase 11kV PMTs;
- Creation of IT systems to receive and analyse smart meter data;
- Updating of existing modelling tool for LV mains on the WPD network, to output direct losses data and be compatible with smart meter data;
- A comprehensive programme of stakeholder engagement including biennial stakeholder consultation events;
- Continued development of the losses page on the WPD website;
- Continued membership of the ENA Technical Losses group;
- Completion of the Innovate UK feasibility study of An Energy Revolution for the market town of Caldicot where a reduction of losses was proposed by using three phase service cables.
- Ongoing voltage reduction across WPD.

Making fewer losses: at a glance

2020 and beyond

Our plans for 2020 are to build on the work done so far and to respond to new areas of potential increased losses. The traditional approach to loss reduction has majored on asset replacement but, as LCTs grow, we are extending this to prepare for the effect of electric vehicles, heat pumps and other LCT demands.

That means a two-pronged approach, beginning with existing commitments to:

- Meet or exceed the Ecodesign 2015 directive on all new transformers purchased;
- Oversize the 11kV ground-mounted transformers which are highly loaded enough to make replacement economically viable;
- Replace pre-1958 ground-mounted distribution transformers;
- Install a minimum size of 25kVA for single-phase pole-mounted transformers and 50kVA for three-phase units;
- Discontinue 4 & 16mm^2 Cu. LV service cables;
- Discontinue 95mm^2 LV Wavecon mains cables and 95mm^2 Al. triplex 11kV cables; and
- Standardise on 185/300/400/630 and 800mm^2 Cu. Single core cables for the 33kV network.

These will be combined with a new emphasis on:

- Electric Vehicle Charging;
- Heat pump installations;
- Conversion of legacy networks;
- Substation footprints;
- Car park charging hubs;
- Three phase service cables (on the ‘housing estate of the future’ project)
- Three phase LV mains cable load balancing;
- Ongoing installation of single phase amorphous transformers;
- Ongoing voltage reduction across WPD.

Future Losses – and Gains

New technologies look set to unlock further loss reductions but many of these are still in their infancy. These include:

Superconductors

The variable losses in a network are directly related to the resistance of the current-carrying conductors.

A superconductor theoretically has no resistance, which would practically eliminate variable losses in cables.

Superconductors must be cooled to very low temperatures or they will still provide a resistance.

Research into superconductors that can operate at higher temperatures is still ongoing, but as of yet none have been found which can operate above -70°C so it is unlikely they will become practical in the near future.

Heat recovery

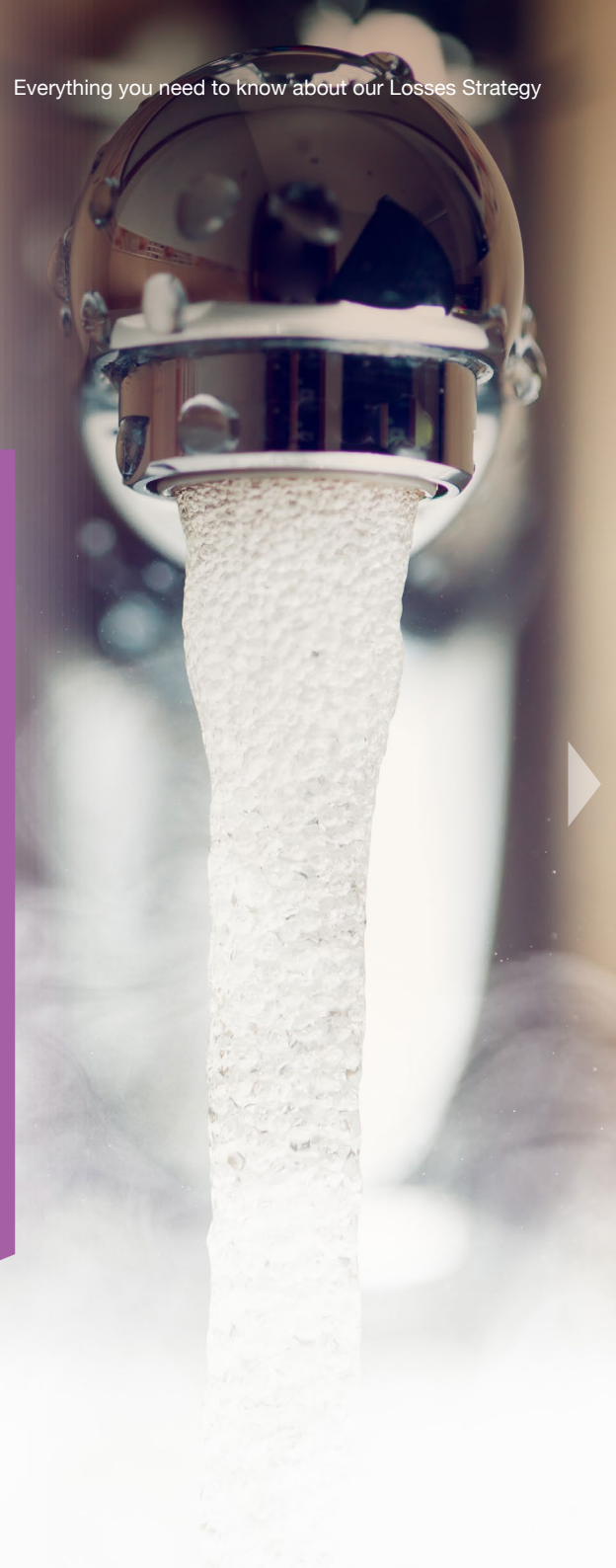
Transformers generate heat during normal operation which is normally lost to the atmosphere. By harvesting the heat, it may be possible to sell this as a commercial product or use it to heat local substation buildings.

At present, it is only possible to sell the heat to customers within a 10 – 20m radius but WPD has carried out a feasibility study with a heat pump manufacturer, using a ground source heat pump to heat substation buildings rather than using storage heaters.

Active network configuration

One way to reduce fixed losses on the network is to switch assets off. An asset on 'hot standby' (energised but not actually supplying electricity) will continue to produce fixed losses. Disconnecting duplicate or reserve assets will reduce losses but will also affect supply security and therefore has to be carefully considered before being adopted.

Developments in network management systems and increasing levels of monitoring and control will make it easier to reconfigure networks to reduce losses without the current concerns over supply security.



Nothing to lose...

Most of the actions we can take to reduce losses now have already been initiated.

We're committed to a wide-ranging and cost effective programme of asset replacement and we're already thinking about the steps we need to take next, as our focus shifts to the demands of electric vehicles, heat pumps and other LCTs.

Innovation projects look set to lead to huge advances in network design in the years to come, many of them linked to the smart meter roll out. By 2023, we expect the network design and active network control measures to be leading our loss reduction activities.

We're looking forward to the challenge.

Table of outputs

Proposal	Interventions per Annum	Savings per Annum (kWh)	Interventions through RIIO – ED1	Savings through RIIO – ED1 (MWh)
Transformers				
Replace pre-1958 transformers	250	2,694,543	1,996	21,556
Install a minimum size of pole-mounted transformer	575	68,072	4,600	545
Discontinue 315kVA ground-mounted transformers	448	1,140	3,584	9
Install low loss amorphous single phase PMT	88	38	88	114
Cables				
Discontinue small size service cables	343 km	412,629	2,744	3,301
Upsizing LV cables	694 km	3,049,799	5,552	24,398
Discontinue small size 11kV cables	448 km	951,421	3,584	7,611
Imbalance				
Correct Imbalance at LV substations	Per substation	1,014	Per substation	

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