



# UK Power Networks

## Distribution Losses Strategy

UK POWER NETWORKS UPDATE 2025



## EXECUTIVE SUMMARY



As the Distribution Network Operator (DNO) for London, the East of England and the South East of England, UK Power Networks is the UK’s largest electricity distributor delivering power to over 8.3 million homes and businesses covering more than 29,250 square kilometres and serving 19 million people from Cromer in the East to Brighton on the South Coast.

Decarbonisation is one of the greatest challenges facing our generation. We are in the middle of a rapid shift in technology, society and energy. Our business, together with the wider energy system, will need to undergo significant changes over the next decade to deliver Net Zero by 2050.

UK Power Networks Distribution Losses Strategy is built upon our vision, values and wider societal need.

We want to be a top-class performer, an employer of choice, responsible and trusted corporate citizen, sustainably cost efficient that enables Net Zero transition for all.

This means that we seek to do what is right for our customers by providing the best possible

service at the lowest possible cost, aiming for efficiency whilst limiting the environmental impact arising from our business activities.

The Distribution Losses Strategy sets out our ambition to lead the creation of an energy efficient distribution network in Great Britain, underpinned by three objectives:

### Objective 1

Maximise the amount of electricity saved every year.

### Objective 2

Integrate losses optimisation in processes and systems.

### Objective 3

Continue working with stakeholders and innovators to integrate learning into our strategy.

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The electrical energy lost in the network represents a cost to customers and contributes to Great Britain's carbon emissions.

In the transition to Net Zero, we will see an increase in energy losses across the transmission and distribution networks as the demand for electricity increases with the decarbonisation of heat and transportation. From the current value of 22.87TWh (NESO, 2025), all forecasts lead to an increase in energy losses up to 56.4TWh by 2050. This represents a 147% increase from 2024 and further highlights the importance of delivering losses optimisation programmes.

As we continue the pathway of minimising energy losses on our network, where reasonably practicable and cost effective, we see savings for our customers and continued reduction of our carbon footprint.

Our strategy for RIIO-ED2, the period between 2023 and 2028, is to embed losses mitigation measures in our wider investment programme whilst continuing to explore new technologies and approaches.

Various measures that demonstrate a long-term benefit to customers and achieve further reductions in losses are highlighted in this strategy, including the following:

- Changes to design policy that drive efficiencies and optimise asset replacement, reinforcement and customer connections.
- Optimising our physical networks and the efficiency of individual assets embedded in these networks.
- Leveraging the power of data analytics whilst exploring new sources such as smart meters.
- Identifying network planning and operational solutions that further optimise energy losses.
- Adopting dynamic management of the network based on consumption data and network insight.
- Carrying out a whole system approach to understanding and managing losses, stretching the influence of our strategies and actions across the boundaries of the network for wider benefits.
- Quantifying energy losses reduction as an outcome from individual investment programmes and how it compares against the overall reduction.
- Create robust processes and better decision-making tools to deliver timely benefits.



In this document we outline our strategy to manage losses on our distribution network to the lowest economically reasonable level, taking account of the costs and benefits of a variety of potential measures.

Producing a Distribution Losses Strategy is also part of our license requirement, and we are required to report losses to our industry regulator, Ofgem, to make sure we are applying best practice, continuously reviewing current and future interventions to further manage losses on our network.

**Nuno da Fonseca**

Net Zero & Network Development Manager

## INTRODUCTION

**Distribution network losses are the difference between the electrical energy that enters the electricity distribution network and the energy that is delivered to our customers. Losses are unavoidable, a consequence of transferring electricity from generators to consumers but can be minimised using appropriate strategies and solutions.**

The electrical energy lost in the network represents a financial cost to our customers and contributes to Great Britain’s carbon emissions due to the carbon intensity of electricity generation. Although the carbon intensity is decreasing with the continuing successful decarbonisation of power generation, it still remains a major contributing factor to emissions.

At a time where energy prices are high, attention on operating an efficient network is key. Reducing losses frees up network capacity, an essential consideration as further reinforcement is required to meet the expected increase in consumption with the electrification of heat and transport sectors, required to meet Net Zero by 2050.

Growth in distributed generation (DG) and other low carbon technologies (LCT) such as EV charging points (EVC) and heat pumps (HP) will lead to increased peak power flow and total energy demand, resulting in greater network losses.

In addition, the operation of a smarter and flexible network means that a greater utilisation of existing assets will be necessary, giving rise to additional network losses.

Delivering the best whole-system approach for our customers through operating an efficient, coordinated and economical distribution network is necessary to manage distribution losses as we progress to a smart and flexible electricity network.

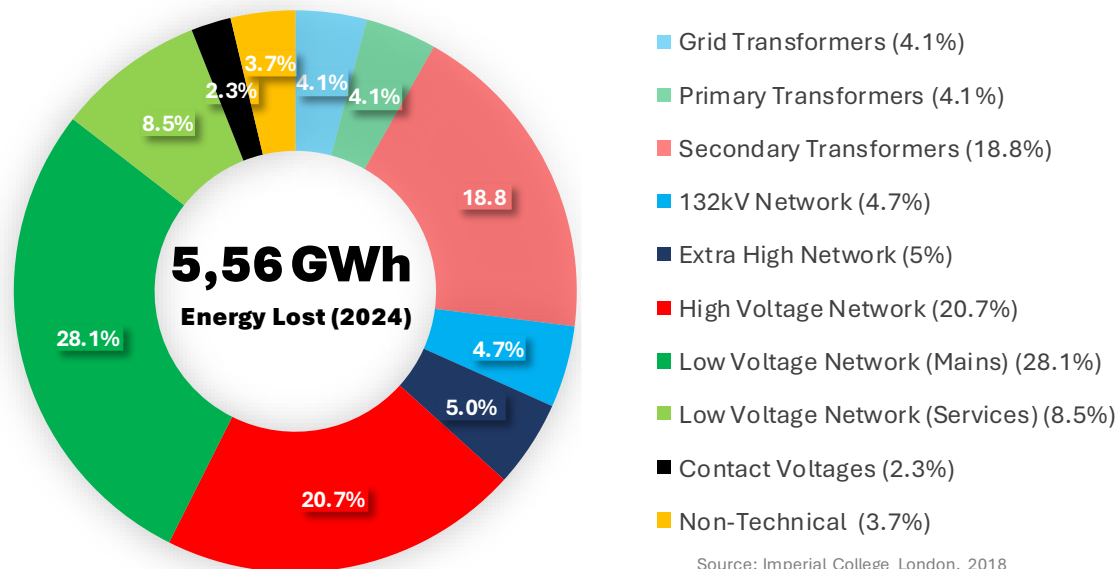
Energy lost on the distribution network is different across voltages and components, with the low voltage network, from the distribution transformers to consumers representing 55.4% of the total <sup>(Figure 1)</sup>.

### Explainer 1 Carbon Intensity

A measure of how clean the generated electricity is, it refers to how many grams of carbon dioxide (CO<sub>2</sub>) are released to produce a kilowatt hour (kWh) of electricity. Electricity generated from fossil fuels is more carbon intensive, whilst renewable energy sources, such as wind, hydro or solar, produce next to no CO<sub>2</sub> emissions, so their carbon intensity value is much lower.

The electricity distribution network, taken as a whole, represents one of the largest consumers of energy in the country. Losses arising from electricity distribution represent a substantial but under-appreciated burden on customers and society.

**Figure 1. UK Power Networks reported energy losses and breakdown by component**



## Why we manage losses

The additional power required to cover the additional energy across the transmission and distribution electricity networks in Great Britain in a year, is estimated at £1.33bn <sup>Explainer 2</sup>.

According to the latest information available from National Energy System Operator, Future Energy Scenarios, the total transmission and distribution losses across Great Britain in 2024 was 22.87TWh (NESO, 2025).

Total electricity losses in GB	
<b>GB Annual Demand</b>	<b>266.7 TWh</b>
<b>GB System Losses</b>	<b>22.87 TWh</b>
Distribution Network	16,975 GWh
Transmission Network	5,895 GWh
<b>GB System Losses</b>	<b>8.57%</b>
UK Power Networks proportion	24.3%

UK Power Networks declared 5.6TWh of energy losses across all the network components in 2023/24, representing 24.3% of the total in Great Britain <sup>(Figure 2)</sup>.

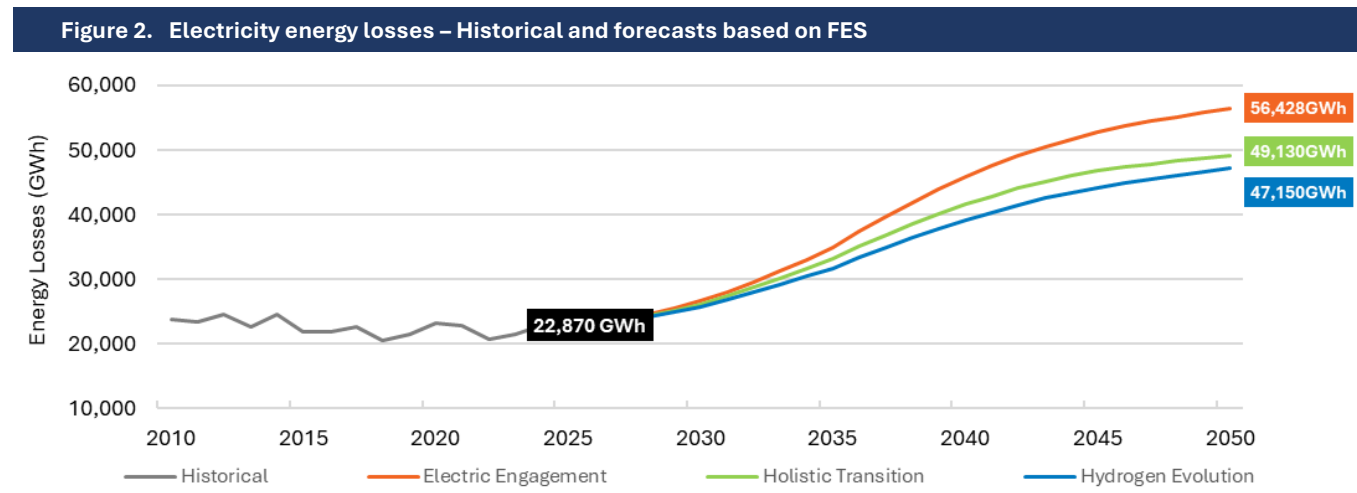
### Explainer 2 Carbon Intensity

2024 total system losses of 22.87TWh, Ofgem RIIO-ED2 value for energy losses at £58.22/MWh.

The National Energy System Future Energy Scenarios (FES) sets out credible scenarios to achieve Net Zero by 2050 and meet UK Government’s commitment to a decarbonised power sector by 2035. Introduced in 2024, the new pathways – Holistic Transition, Electric Engagement and Hydrogen Evolution – explore strategic routes to net zero based on stakeholder engagement, research and analysis.

Holistic Transition	Electric Engagement	Hydrogen Evolution
Net zero is met through a mix of electrification and hydrogen, with hydrogen mainly used around industrial clusters. Consumer engagement is very strong through adoption of energy efficiency improvements and demand shifting, with smart homes and electric vehicles providing flexibility.	Net zero is met mainly through electrified demand. Consumers are highly engaged in the transition through smart technologies that reduce energy demand, such as electric heat pumps	Net zero is met through fast progress for hydrogen in industry and heat. Widespread access to a national hydrogen network is assumed. Some consumers will have hydrogen boilers, although most heat is electrified. There are low levels of consumer engagement within

In all pathways, we see an increase in energy losses across transmission and distribution networks as demand for electricity increases, from the current value of 22.87TWh of energy lost, each of the three pathways leads to a higher level of energy losses. up to 56,4TWh per year <sup>(Figure 2)</sup>.



## Understanding technical losses

Technical losses arise from physical reasons and depend on the energy flowing through the network and the characteristics of network components such as overhead conductors, underground cables, and power transformers.

Technical losses are made up of a **fixed component**, a function of the network itself, and a **variable component** which is dependent on the level of load on the network, but also affected by the power factor, network imbalance and the current harmonics.



### Fixed losses

A function of the network itself, fixed losses depend on the number of components and the equipment connected to the network. Expressed by heat dissipated from energised network components, they are referred to as ‘fixed’ or ‘no-load’ losses as they are independent of how much electrical energy the network delivers and are present even when no energy is being delivered.

Most fixed losses are due to the physical properties of materials, they result from inefficiencies and imperfections of electrical insulation in various components and the energy required to create and maintain the magnetic field in power transformer. This leads to the flow of very small currents within the transformer, with similar effect seen in overhead conductors, underground cables, and other network equipment. Called ‘dielectric’ losses, they vary with voltage, diameter of conductor and weather conditions.

### Variable losses

Created by the heating effect of electricity passing through cables, conductors and transformer windings, variable losses have a non-linear relationship with the current.

All conductors, whether they are coils inside transformers, wires in overhead lines or underground cables and even in switchgear, fuses, or metering equipment, have an internal electrical resistance which causes them to heat up when electric current is passing. Energy is lost in proportion to the square of the electrical current.

Additionally, variable losses are dependent on the length and the cross section of the network line as they vary in proportion to the conductor resistance. The resistance of a conductor decreases as its cross-sectional area increases. Therefore, the effect of losses is reduced with larger cable sizes. A similar principle also applies to the variable losses in transformers, where the cross-sectional area of windings, and the materials used in them, influence the variable losses.

Additional factors such as network imbalance, power factor and power quality can also have an impact on variable losses, as they increase the currents flowing through the conductors.

### Power Quality

The overall management of power quality and its limits is the subject of specific Engineering Recommendations (G5/5, P28 & P29) and Distribution Code (DCODE, 2024). From a losses perspective, two aspects are most relevant: Harmonic background: Total Harmonic Distortion and Phase imbalance.

#### Power Quality: Harmonics

Harmonic effects are distortions to an Alternate Current (AC) profile and develop from distorting loads usually associated with industrial processes, for example arc furnaces, or more widely from domestic customers equipment such home appliances, air conditioning units, LED lights, computers and other non-linear loads.

A common measure used amongst network operators is Total Harmonic Distortion (THD), the ratio of the sum of the powers of all harmonic components to the power of the fundamental frequency of 50Hz.

As well as potentially causing interference with communication and electronic protection systems, the presence of harmonics contribute in a direct proportion to variable energy losses, where a 10% THD increase will cause a 10% increase in losses, de-rating plant and equipment.

The presence of harmonics in transformer windings increases hysteresis and stray losses, especially eddy currents as they are proportional to the square of the frequency.

Maintaining control of harmonics is a necessary exercise, carried out by an effective application of engineering standards when assessing new non-linear loads connecting to the distribution network as it provides the best opportunity for containing harmonic background levels within G5/5 limits.

#### Power Quality: Imbalance

The electricity network operate as a three phase system and is designed with balanced loading across each phase.



The dynamic nature of electricity consumption and the prevalence of single phase customer supplies means that network power flows are not evenly distributed across all three phases, higher currents in at least one phase leads to excess current flowing through the neutral conductor if present. Due to the quadratic dependence of losses with current, this load unbalance significantly increases energy losses.

Imbalance is found on most parts of the low voltage network due to the prevalence of single-phase customers with variable consumption and generation profile, in particular due to domestic solar photovoltaic and energy storage.

On the High Voltage network, imbalance is due to the uneven distribution of single-phase transformers or two wire spurs with different loads on each phase for three-phase customers.

#### Power conversion efficiency (Power Factor)

Power in electricity networks is defined by real power (P), as the capacity of the system to do work measured in watts (W), reactive power (Q), as the power that flows back to the source from inductors and capacitors and apparent power (S), as the scalar product of voltage and current measured in Volt ampere (VA).

Power factor is the ratio of the real power (P) to the apparent power (S). Where it is less than unity, the current has to increase to deliver the required amount of real power, which results in energy losses. This has historically been an issue for commercial and industrial customer installations, where most motor loads or power electronic loads are present but developments in domestic power electronics and heat pumps mean that is appearing more frequently on the LV network.

### **Electricity network ancillary equipment**

Technical losses also include the energy involved in running network ancillary equipment such as transformer cooling fans and pumps, as well as other auxiliary energy supplies directly associated with electricity networks such as battery chargers, heating, lighting, air compressors, tunnel ventilation systems and others.

We are continuing the deployment of smart metering in our substations to accurately determine electricity consumption, investigate the benefits of micro generation and other actions to further reduce energy lost.

## **Understanding non-technical losses**

Non-technical losses represent energy that is consumed but not properly measured or accounted for. They are caused by factors that are external to the network and reflect energy lost that is not directly related to the distribution of electricity and independent of the physical characteristics of the network and its components.

This type of loss involves the abstraction of electricity via theft, data issues with unmetered supply equipment inventories or records held by electricity suppliers, adding to the costs as seen by legitimate customers. Non-technical losses cannot be reduced by upgrading equipment or altering network, instead investigations, audits and collaborations with other industry stakeholders is required.

The most common forms of non-technical losses are:

### **Conveyance losses**

These are situations where a premise has no supplier associated, illegal services are present, or existing services are split and self-energised with rogue meters or direct-to-main connections. These losses can also occur where new connections are unauthorised, where the process is incomplete and where reconnection takes pace after the formal disconnection process was concluded.



### **Supplier losses and data issues**

Accurate accounting of energy depends on suppliers ensuring that they have the correct registration and energisation status for every customer.

This arises where the occupier seeks to avoid charges by making an illegal connection, tampering with the electricity meter, installing bypasses or simply wiring the consumer unit directly to the cut-out assembly. These situations, whilst rare in occurrence, are treated very seriously and result in immediate disconnection of and prosecution under the law.

Network losses datasets may be subject to delays from domestic customers or small generators due to infrequent meter readings. Initial estimates are made with the most up to date data available at that time as further reconciliations come in.

Consumption data is sourced by Elexon, the company that manages the Balancing and Settlement Code.

### Unmetered supplies

Not all supplies connected to the electricity distribution network are metered. Certain items such as streetlights, advertising and telecommunications infrastructure are not individually metered as they represent modest and predictable loads that are neither practical nor cost-effective to measure using conventional means. Circumstances where unmetered supplies are permitted are identified in *The Electricity (Unmetered Supply) Regulations*.

The Unmetered Supplies Operator (UMSO) is responsible for the maintenance of the Unmetered Supply Inventories and Unmetered Supplies (UMS) Certificates and ensuring the set up and appropriate trading of new UMS Meter point Administration Numbers (MPAN).

Energy billing is estimated based upon the declared inventory, rating of the equipment and the approximate time of use.

Such estimates can be inaccurate where the customer has not kept up to date list of what is installed. In order to reduce these energy losses, UK Power Networks works alongside customers with unmetered supplies to improve the accuracy of this information and produce more accurate bills.

Electricity losses are reported through the GB Settlements arrangements. This process is used by electricity suppliers to determine the amount they must pay for purchases from generators and is defined in the Balancing and Settlement Code (BSC).

Electricity distributors obtain information about the electricity entering and leaving the system by reference to the industry-standard data flows to bill suppliers for distribution network charges.

From a UK Power Networks perspective, maintaining an updated and accurate record of unmetered supplies is therefore important to minimise any inaccuracies in losses reporting.

Our approach to energy loss management takes a holistic perspective and therefore we seek to increase our understanding about how interactions

between our networks and other parts of the energy system affect losses throughout it.

### Knowledge sharing with the public

UK Power Networks regularly refreshes the Distribution Network Energy Losses website to explain this concept to wider audiences.

On this website we publish the reports we have produced so we can share our learning with others, continuing to work with academia, equipment manufacturers, suppliers, customers and the wider industry at every opportunity.

Further information is also available in UK Power Networks Open Data Portal which features one of the UK's biggest sets of information about the electricity network.

## Distribution Network Energy Losses

<https://www.ukpowernetworks.co.uk/distribution-network-energy-losses>



## An international perspective

### 3rd CEER Report on Power Losses

A recent report carried out by the Council of European Energy Regulators – CEER – examined power losses in transmission and distribution electrical grids in 40 European countries, with a particular focus on the levels of energy losses, their definition and regulatory treatment.

This report is particularly important for UK DNOs and OFGEM, enabling the benchmarking and setting out the direction of energy losses and their incentives in future price control of RIIO-ED3.

### Key findings

The definition of power losses is not standardised and varies from country to country. In most cases, losses are understood to be the difference between the energy flowing into and out of a grid, but there are countries that do not use this approach.

Non-technical losses have different definitions and different components included, with some countries not distinguishing technical and non-technical losses as both components are incorporated in reported values.

With one exception, all countries include non-technical losses in reported volumes at distribution network level or at a total system level with transmission network.

Energy losses in distribution networks varied between 1.95% and 22.63% in 2022 (Figure 3) and generally follow a decreasing trend from results published in 2018.

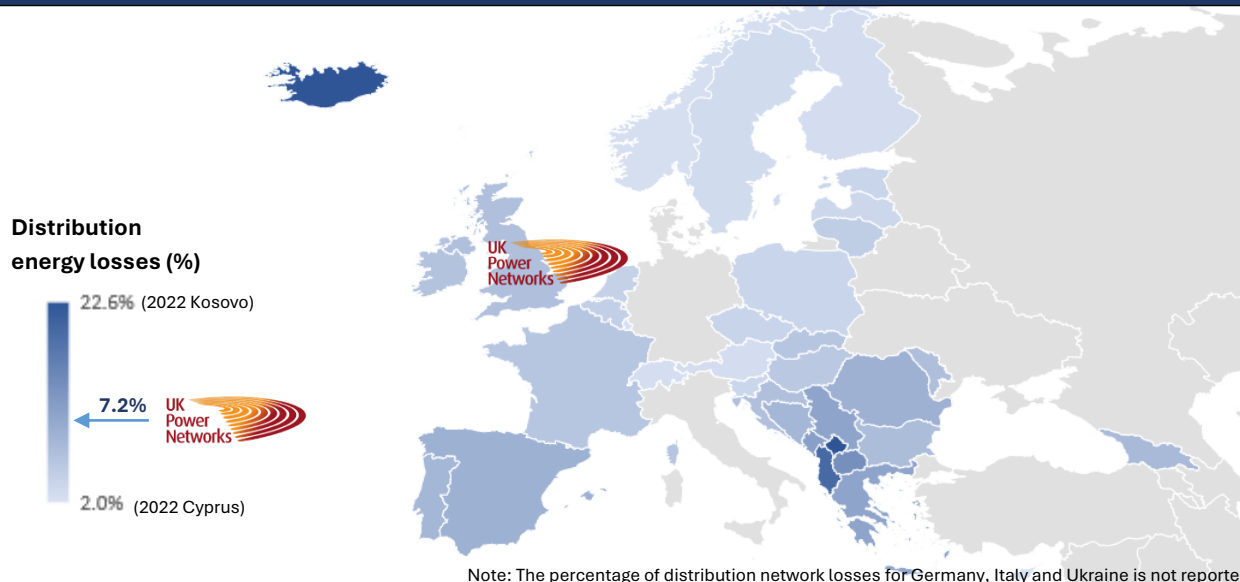
Most European system operators are responsible for procuring the equivalent energy losses in the respective grids, where in the UK that responsibility is divided between electricity suppliers and National Energy System Operator.

Amongst the strategies suggested by the Energy Efficiency Directive to optimise networks and improve network efficiency, the most effective are incentive-based regulation and deployment of smart grids.

### CEER recommendations

1. Consensus on a clear differentiation between technical and non-technical losses to simplify the benchmarking of power losses.
2. Clear incentives are required to reduce distribution energy losses, rather than passing the cost to consumers. These include replacement of older transformers with new high efficiency versions as well as tariffs that promote local renewable energy resources.
3. Increase smart meter adoption to enable more efficient energy supply and demand balancing whilst reducing non-technical losses from incorrect meter reading and energy abstraction.

Figure 3. Distribution energy losses (CEER 2025)



## LOSSES MITIGATION MEASURES

Our strategy for RIIO-ED2, the price control period between April 2023 and March 2028, is to embed losses mitigation measures in our wider investment programme whilst continuing to explore new technologies and approaches.

Various measures that demonstrate a long-term benefit to customers and achieve further reduction in losses are highlighted in this strategy. In this section we explore such measures, the knowledge gained from various innovation projects and the potential energy losses reduction following successful implementation.

### Managing technical losses

We have identified four initiative groups to the management of technical losses in the distribution network. Starting from well-established **Design Policy**, determining the most appropriate asset specifications and application of the most appropriate size for the intended application to achieve a reduction in energy losses over the lifetime of the asset.

**Network Operations**, utilising enhanced operability tools to improve standard network operation arrangements and optimise the network in real-time, very closely linked with **Network Planning** designing the network with a losses reduction mindset together with other drivers including the potential acceleration of replacement of high loss assets, further maximising network capacity and enable the connection of DER.

The initiative groups are all underpinned by **Data & Analytics**, utilising more available data, integrated systems and analytics that become available to better model and understand losses on our network and improve the planning and operation of the network to optimise losses.

### Transformers

#### Design Policy

**Power transformers represent 27%** of the total electrical energy lost in the network.

With the introduction of Ecodesign directive 2009/125/EC, the replacement of transformers with more efficient units has become normal practice. The EU Directive mandated the adoption of low loss transformers for distribution networks in two phases from 2015 (Tier 1) to 2021 (Tier 2), with UK Power Networks leading the way by implementing the 2021 (Tier 2) specification ahead of legislative requirements.

Given the diverse range of networks and utilisation levels the ratio between fixed and variable losses varies considerably. The variable losses in a transformer are much lower when the unit is partially loaded and increase quadratically as a unit becomes fully loaded. It is therefore possible to reduce



the overall losses by oversizing transformers when they are installed.

Due to the high cost of transformer replacement, it is not cost effective to consider losses reduction as the sole justification for the investment. We therefore seek opportunities with other investment drivers such as customer connections, condition-based replacement or network reinforcement to support the change in specification and size of the transformers,

further reducing losses in the most cost-effective way.

### Grid and Primary transformers

We have 2,293 Grid and Primary transformers on our networks with different technical characteristics, voltage ranges, sizes, condition and age.

As assets are replaced in RIIO-ED2 and beyond, our policy is to increase their capacity to cater for the increase in low carbon technologies up to 2050.

### Distribution transformers

We have 119,566 distribution transformers on our networks ranging from small single phase pole mounted transformers supplying electricity to a single dwelling to 1MVA three phase ground mounted transformers supplying electricity to hundreds of homes and businesses.

When replacing existing transformers there is a significant reduction in losses from Ecodesign transformer specifications. Previously developed analysis to support the selection of transformer size has been proven effective and has been embedded in our Engineering Standards so that all transformer selection and installation include loss inclusive design by default.

## Rationalised overhead conductors and underground cables

### Design Policy

**Overhead conductors and underground cables represent 52.3%** of the total electrical energy lost in the distribution network.

From our analysis of the cost difference and energy losses between the minimum standard cables size, which meets thermal ratings requirement, and larger cables with lower resistance, resulted in rationalising our range of cable sizes particularly at low voltage and 11kV to achieve commercial benefits, due to economies of scale when purchasing from suppliers, as well as losses reduction benefits from larger cable sizes.



### Low Voltage network

We estimate that 36.6% of electrical energy losses on our networks occur on our low voltage networks, highlighting the importance and value of installing lower loss LV cables.

The challenges with LV networks are the sheer scale and the limited availability of consumption data for the circa 7,425,405km of LV underground mains and service cables and 764,000 spans of LV overhead lines.

With the rollout of smart meters, LV visibility programme at secondary transformers and data analysis tools, we've been able to determine the utilisation on the LV networks accurately, further improving the understanding of energy losses at this voltage level, improving our forecasting ability to meet Ofgem regulatory reporting requirements in RIIO-ED2. Our analyses shows that increasing standard cable sizes is a cost-effective practice.

### High Voltage Network

We estimate that 20.7% of energy losses occurs across the 46,000km of underground cable circuits and 277,400 spans of overhead conductor on the High Voltage network.

Benefiting from real-time visibility of load data, we see a wide range of utilisation across the high voltage network and a similar step improvement

and cost-efficiency of the increased standard cable size.

### Extra High and 132kV Network

We estimate that around 9.7% of energy losses on our network occurs on the Extra High and 132kV EHV circuits. We have circa 4,661km of underground cable circuits and 47,200 spans of overhead conductor on the Extra High Voltage network, as well as circa 1,310km and 7,380 spans on the 132kV network.

The replacement of these assets requires a bespoke costs and benefit analysis, carried out alongside the primary investment driver.

The cable core size and material choice depends on installation conditions and rating requirements, taking into account future network development plans. The energy lost in a cable circuit is proportional to the currents flowing in the metallic sheaths of the cables, therefore, by reducing or eliminating the metallic sheath currents through different bonding methods, it is possible to increase the cable rating.

Where reasonable and feasible, UK Power Networks shall maximise the use of the highest distribution voltage possible within an area and minimise the use of lower voltages to customer connections and low load density areas.



### Small section overhead conductors

#### Network Planning

UKPN put forward a RIIO-ED2 reinforcement investment case for HV OHL Small Section Conductors (SCC) in Eastern Power Networks (EPN) and South Eastern Power Networks (SPN) licensed areas (Engineering Justification Paper ED2-EJP-NP-103).

The £21.2m investment programme delivers the reinforcement of 3.34% of small section conductor on the UKPN network, equating to 783km of 11kV overhead conductor, addressing many network issues and with the added benefit of reducing network losses by replacing small section conductors with lower impedance, lower losses conductors.

### Switching out underutilised plant

#### Network Planning

To meet security of supply standards requirements P2/8 (ENA, 2023), our substations usually operate with two or three transformers in parallel, to cater for unplanned outages without impacting our customers. At times of low demand, it is possible to switch off one of the transformers.

As the total energy lost is a combination of both fixed and variable losses, switching off the transformer reduces fixed losses but results in a redistribution of the variable losses to the remaining units. At times when a transformer is loaded at less than 45% of its given rating and the combined fixed losses are greater than the combined variable losses, this process results in a reduction of the total energy losses.

The system is not suitable for high load sites and is dependent on the plant at that location. Altering the network configuration can lead to technical and security of supply implications that need to be considered.

### **Optimising network configuration**

HV and LV distribution networks are typically configured in a radial topology. However, to minimise customer minutes lost under fault conditions, the networks are designed in such a way that the load can be supplied from another adjacent feeder via a Normally Open Point (NOP) switch.

Moving open points to better balance customer numbers between two or more feeders usually results in improved balancing of load and hence lowers losses.

### **Distributed Energy Resources (DER)**

Historically power stations were large and normally centralised, connecting directly to the National Grid transmission system at 275kV or 400kV, but in recent years we've seen a significant increase in renewable energy and storage of smaller scale and distributed across the network: Commonly called Distributed Energy Resources (DER).

This disruption to the historical power flow from generators, via transmission and distribution

networks to the customer is beneficial as the energy produced locally is used locally. Provided that voltage and fault-level standards are met, DER can provide opportunities for improved network management, including management of losses.

This includes optimising power flows to achieve a better overall balance between generation and demand and flatten network demand.

Even where a suboptimal level of balance might cause a localised increase, the overall impact is an overall reduction in energy losses by reducing upstream power flows to serve downstream demand. Moreover, if more of the losses are being supplied by renewable energy sources, then the overall carbon footprint of losses will be reduced.



## Network utilisation

### Network Planning

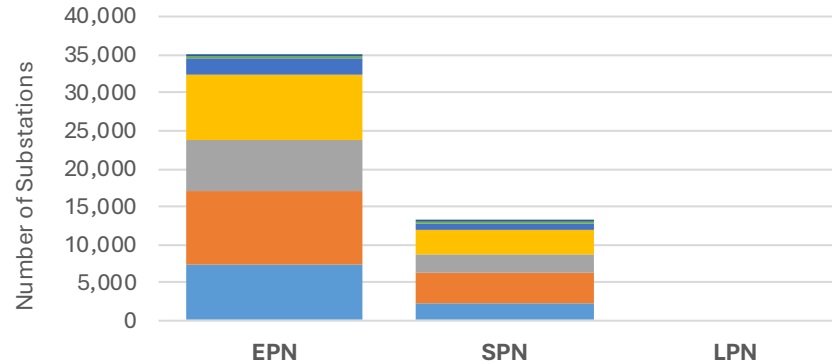
All potential decarbonisation scenarios place the distribution network (Figure 2) in the centre stage with the electrification of transport and heat, as increasing volumes of renewable generation, and novel technologies such as battery storage. This is likely to result in a significant increase in utilisation of the network, particularly at LV and HV, as customers connect new sources of distributed energy resources.

The outcome is that as utilisation increases, losses will also increase.

Ofgem introduced a new requirement in RIIO-ED2 for DNOs to report utilisation of secondary substations, both pole mounted and ground mounted, and thus track progress of the expected demand increase of electrical vehicles and heat pumps. Figure 4 represents UK Power Networks submission for the regulatory year of 2024/25.

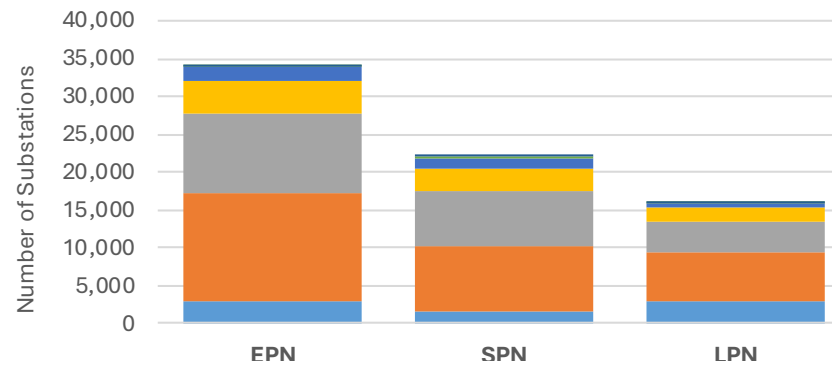
Figure 4. Secondary substation utilisation – UKPN 2024/25

#### Pole Mounted Transformers



	EPN	SPN	LPN
20.8%	16.4%		
28.0%	31.4%		
19.1%	19.0%		
25.4%	26.0%		
6.2%	6.8%		
0.4%	0.3%		
0.0%	0.0%		

#### Ground Mounted Transformers



	EPN	SPN	LPN
8.3%	7.3%	19.0%	
42.2%	39.3%	40.0%	
31.1%	33.0%	25.8%	
12.1%	13.5%	11.4%	
5.7%	6.5%	3.7%	
0.5%	0.4%	0.1%	
0.1%	0.0%	0.0%	

## Upgrading network voltage

### Network Planning

As losses are proportional to the square of the current, and current is directly proportional to the voltage, increasing network voltage can reduce losses for the same energy transfer. For example, phasing out legacy 2kV, 2.2kV or 6.6kV networks to 11kV, although driven by capacity requirements, also reduce losses by up to 66%.

UK Power Networks proposed phasing out of the 2kV legacy network was put forward for RIIO-ED2 (EJP-NP-008).

## Power Quality - Harmonics

### Network Planning

UKPN has rolled out fixed Power Quality monitoring at Grid and Primary substations and comprehensive information about the total harmonic content is now available for 418 substations, with additional information provided by temporary monitors installed ahead of customer connections.

Reducing harmonic effects can be costly so the principal approach is to ensure that customers use devices that produce minimal harmonic effects or install harmonic filtering devices.

## Power Quality – Imbalance

### Network Planning

Power flow unbalance gives rise to higher than necessary currents in one or more phase conductors of a cable or overhead line and hence higher than necessary losses overall. On LV networks, where balance is traditionally poor due to the lower demand diversity, the effect is further exacerbated as the residual current in the neutral which gives rise to further variable losses.

Previous Distribution Losses Strategies recognised the impracticality and excessive cost involved in

tackling imbalance in the existing Low Voltage network as the sole investment driver and suggested that its application is carried out in conjunction with connection of services, both underground and overhead, which should be applied to all new developments irrespective of whether they are installed by an ICP, IDNO or UK Power Networks. Another opportunity presents itself with UKPN condition-based LV link box renewal programme in the form of improved load sharing between electrically adjacent LV feeders and substations.

In relation to the High Voltage network, the investment programme to replace small section conductors offers an opportunity to address imbalances, even with single phase transformers as they can be reconnected to a different phase.

Additional opportunities are taken during 11kV overhead resilience works to economically upgrade single phase (2-wire) spurs to 3 phase and achieve equal phase distribution of connected single-phase transformers and any 2-wire spurs.

## Voltage management policy

### Network Operations

Maintaining voltage at the highest permissible level within the statutory limits ensures that losses associated with resistive loads are minimised.

For LV networks, distribution transformer tap positions are set to provide the most optimal voltage profile that can be achieved and maximise the available statutory bandwidth of 216V - 253V. Operating at the lower end of the bandwidth usually gives rise to local energy losses but also provides maximum headroom to embedded DER which reduces wider system losses as the energy generated is consumed locally.

Automatic Voltage Control systems (AVC) are setup in accordance with documented policies to manage 33kV and 11kV voltages in real time and further consideration is given to advanced voltage systems, such as GenAVC and SuperTAPP n+, particularly where there is a significant presence of distributed generation resources.

The use of modern voltage regulators on 11kV overhead line and LV networks is being considered as a result of increasing DER on 11kV and LV feeder, as well as automated reconfiguration systems, such as Automatic Power Restoration Systems.

Increased visibility of network parameters is required before such system are implemented.

Visibility is achieved from existing transducers, power quality monitors and smart meters which enables the improvement of our network modelling tools and more accurate planning of the network.

### Transformer circulating currents

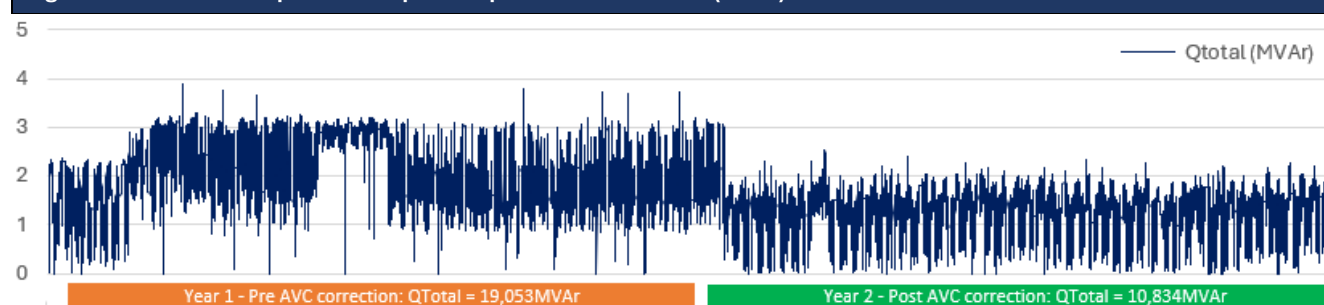
#### Network Operations

If two or more transformers are connected in parallel, any difference in voltage produced by transformers generates circulating currents flowing in both the primary and secondary windings, in particular if they are operating with an abnormal automatic voltage control system (AVC).

For a two-transformer substation, the circulating currents in each transformer are equal in magnitude, opposite in direction and independent of the load current.

The previously reported case of St Ives Primary substation, one equipped with two 33/11kV 18/24/30MVA transformers with an unbalanced automatic voltage control system (AVC) operating with staggered tap positions highlights the importance of taking corrective action as changes made to the AVC scheme resulted in a decrease of the reactive power flow to 10,834MVAh <sup>(Figure 5)</sup>.

Figure 5. Total reactive power flow pre and post AVC correction (MVAh)



### Ancillary equipment

#### Network Operations

In considering the possibility for reducing energy consumption in operational buildings, careful consideration is given to protect the internal environment and the operational equipment housed, in particular indoor switchgear and electronics which are sensitive to humidity. The use of dehumidifiers or heat pumps are being considered as they provide a lower-energy option than traditional direct electrical heating.

Other options include the possible re-use of heat emitted by operational equipment, e.g. transformer coolers at grid or primary substations, especially where, for other reasons, a heat exchanger is used to cool the transformer oil with opportunities for exporting low grade heat off site.

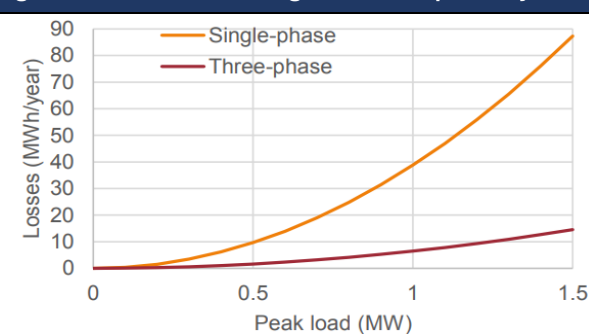
### Upgrade from single to three phase

#### Network Operations

Upgrading from single to three phase can reduce losses significantly. Studies carried out identified the relation between the losses for the single-phase and three-phase spur are presented <sup>(Figure 6)</sup>.

Upgrading from single-phase to a three-phase system achieves a very substantial losses reduction of up to 83%, attributed to the fact that after the upgrade more conductors are used to transfer the same energy at a lower current.

Figure 6. Losses ratio in single and three phase systems



## Managing non-technical losses

Even though non-technical losses represent 3.7% of the total estimated losses on our distribution network, UK Power Networks are committed to mitigate them so far as practicable. Our actions help ensure that we operate efficiently, avoid increased cost for our customer, help lessen the incidence of dangerous situations and serve to promote efficient use of energy.

We manage non-technical losses related to **Electricity Abstraction**, the statutory offense of dishonestly using, wasting or diverting electricity, further enabled by **Electricity Monitoring** improvements which assists in addressing theft of electricity and aid suppliers in meeting their obligations in the areas listed below.

### Supplier losses

#### Electricity Abstraction

UK Power Networks Service Delivery Centre provides a 24-hour/365-day emergency contact point for members of the public, supplier agents and the emergency services. They ensure that leads are correctly re-routed to the appointed revenue protection agent or, where applicable, via the national Stay Energy Safe service.

In certain emergency situations we may also dispatch a UK Power Networks field resource to site to ensure public safety. Our staff and subcontractors identify suspected instances of theft during their daily activities. These are similarly routed back to our Service Delivery Centre for passing on to the relevant supplier.

### Conveyancing losses

#### Electricity Abstraction

This category is much less prevalent but where it does occur it is the responsibility of the distributor to resolve. UK Power Networks has comprehensive processes to identify, investigate and resolve such situations, ensuring that payment of the electricity taken is made at the full market value.

The overwhelming majority of cases are resolved by the customer registering their metering point with a supplier in accordance with normal industry processes. Nevertheless, in a small number of cases UK Power Networks may need to consider disconnection of the unauthorised supply. In the absence of serious safety concerns, we seek to avoid enforced disconnections, but our policy provides for this as a last resort to avoid the indefinite continuation of electricity theft.

### Under-declaration of unmetered supplies

#### Electricity Monitoring

UK Power Networks has legally binding contractual arrangements with all unmetered supplies customers requiring the maintenance of a fully accurate inventory. Our key commitments include:

- Conduct desktop analysis to ensure that customers' submitted data meets expected standards and fully covers the electricity they consume.



- Physical on-street audits will be undertaken if there is sufficient business justification.

### Supplier data issues

#### Electricity Monitoring

This is principally an issue for electricity suppliers but we work with suppliers to support and assist where we can, ensuring accurate data is recorded across all industry systems.

### Supplier losses

#### Electricity Monitoring

Within a typical substation, a variety of electrical equipment such as heaters, lights, battery chargers, Transformer Pumps & Fans are supplied via incoming Low Voltage Alternating Current (LVAC) supplies.

Across the UK Power Networks Grid and Primary substation portfolio, the vast majority of these sites are unmetered. Our unmetered service (UMS) portfolio is the largest in the UK and accounts for 60% of our total electricity bill. The UMS charge is calculated by a methodology of estimation based on three substation archetypes, calculated on the number of circuit breakers installed at the site.

An archetype, and corresponding modelled electricity consumption, is assigned to each substation site, which is used to calculate the total Estimated Annual Consumption (EAC) which is in the region of 32,000MWh each year

Substation archetypes and EAC	
Small	0 to 3 circuit breakers c. 10MWh per year
Medium	4 to 19 circuit breakers c. 26MWh per year
Large	> 20 circuit breakers c. 55MWh per year

A programme of smart meter retrofit installations started in 2020 targeting the first 270 sites across EPN, LPN and SPN. Previous analysis of a 35 substation sample which benefited from the installation of smart meters revealed a net energy reduction of 127MWh per year and savings to consumers of £59k.

Further progress has been made with the installation of 90 smart meters and live data collection to a central portal as part of phase one. The programme continues in phase two for the remaining 1,400 Grid and Primary substations.

### Future areas of focus





Detecting fraud proactively allows us to mitigate safety risks and financial impacts, which can be performed by using network data and Artificial Intelligence capabilities.

Considering that UK Power Networks is best placed to access the necessary network data, we will analyse the cost and benefit and feasibility to proactively detect fraud on our network. We continue to monitor smart meter roll-out across our network and utilise this data together with low voltage monitoring data and data analytics to identify excessive consumption and network losses.



## Managing losses through innovation

Innovation is a driving force behind our performance, ensuring that we are the safest, most reliable and cost-efficient electricity distribution network in the United Kingdom. To help turn this vision into a reality, our innovation strategy focuses on six fundamental themes:

-  Consumer vulnerability
-  Net zero and energy system transition
-  Whole energy system
-  Flexibility and commercial evolution (DSO)
-  Proactive optimised assets and practices
-  Data and digitalisation

Fostering a culture of innovation delivered by passionate people serves our customers and stakeholders as we continue to seek new solutions that deliver further reduction in energy losses as highlighted by the following examples.

### Active response

Active Response is trialling a revolutionary way of managing spare electricity network capacity. By 2030 it is anticipated there will be up to 4.5m electric vehicles in use across the region covered by UK Power Networks.

The charging of these vehicles could significantly increase peak demand and drive higher utilisation of existing electricity components. In order to accommodate an increase in demand, UK Power Networks would traditionally reinforce the network to provide more capacity which takes time, costs money, and causes disruptions to customers.

Active Response trialled responsive, automated electricity network reconfiguration in real-time to move spare capacity. This in turn reduces the need for network reinforcement and installation of new assets that would otherwise increase energy losses. Further information can be found in:

<https://innovation.ukpowernetworks.co.uk/projects/active-response>

### Phase switch system (PSS)

NESO FES shows that irrespective of the scenario, energy demand is going to increase. It is expected that most of the new demand will be connected to low voltage distribution networks, which is likely to cause larger phase imbalance than currently observed, leading to early reinforcement of the LV network. The project demonstrated a reduction in phase unbalance and reduction in total energy losses. Further information can be found in:

<https://innovation.ukpowernetworks.co.uk/projects/phase-switch-system>

### Smart Transformer (Project Stratus/Amp X)

Project Stratus will see smart electricity transformers installed in streets across East Sussex which to provide live data on electricity usage and demand, on a scale never-before achieved, increasing network resilience and lay the groundwork for a low carbon future.

The first Smart Transformer of the original eight planned, was deployed at the Browns Lane, Uckfield substation in November 2022. With 3 additional units installed in Q1 2024. Work to complete the scheduled number of STX units is expected to conclude by June 2026. Further information can be found in:

[UK Power Networks spearheads world-first smart transformer trial | UK Power Networks](#)



### Low Voltage optimisation: EcoVAR

Electricity distribution networks can be affected by various power quality issues, specifically voltage fluctuations and phase unbalance. This is expected to grow with the higher integration of electrical vehicles and distributed energy resources including micro generation, domestic energy storage systems and vehicle to grid.

UK Power Networks and ECOJOULE Energy are carrying out a pilot programme for the installation of five EcoVAR Gen1 units at key network locations.

The project is carried out as part of UKPN Business Innovation Funding, a dedicated funding stream for innovative projects with the potential to make provide immediate network improvements.

Each EcoVAR system comprises 10kVA pole mounted power electronics STATCOM units <sup>Explainer 3</sup>, using reactive power compensation to actively control network voltage, resulting in a more refined automatic voltage management, reducing phase unbalance by 50% and providing fast dynamic response to wider network changes, significantly reducing customer issues.

We expect a reduction of energy losses on the high and low voltage networks by up to 10%, by means of voltage support and reduction of phase unbalance following the installation and through its operational lifespan.



#### Explainer 3 STATCOM

A Static synchronous Compensator or STATCOM is a fast acting device capable of providing or absorbing reactive current and regulating the voltage at the point of connection to the electricity network.

### Managing losses through data and analytics

We believe the key to the Distribution Losses Strategy is a full and comprehensive electrical model of the distribution network where much of the information we require sitting within our existing network records or separate network models.

We possess many legacy network records from paper technical documentation to scanned drawings held in Geographical Information System (GIS) and other systems. Information is being digitised as part of network vectorisation programme with new installed network assets recorded in vectorised format as standard.

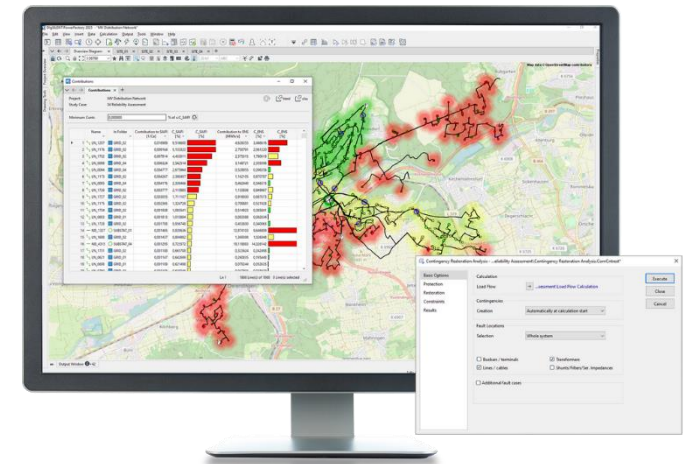
In conjunction with the programme of digital vectorisation, we are moving our entire 11kV and LV network model into a single network modelling

system to leverage benefits gained by digitisation. Detailed network measurements from smart meters and network monitoring enables us to calculate losses for all individual components in near real-time and target optimisation efforts where they are most effective.

#### Computational network modelling

Computational network modelling is key to understand what is happening in unmonitored parts of the network and what will happen in the future.

Network modelling is a comprehensive virtual electrical equivalent of the distribution network, used to determine the most efficient customer point of connection, within required parameters and how it changes future network performance.



Using advanced modelling tools, we can map where losses occur on the network, enabling a targeted approach to loss optimisation and predict the effect of future changes so that the effect on losses of all possible future actions can be considered before changes are carried out.

Network modelling is even more useful when used in conjunction with smart meters, by integrating consumption data and network topology to produce real-time network models.

Once this level of insight is established, it will be possible to accurately calculate energy losses across the entirety of the network in real-time to create dynamic operational losses optimisation strategies, leading to more effective loss reduction measures.



### LV monitoring rollout

Improving the monitoring of the Low Voltage network is key to a smarter electricity network which responds to swiftly changing electricity demand and generation. Improvements to our digital architecture mean we can now collect and store more data to gain a better live picture of how our network is performing.

We are investing to install strategically targeted low voltage monitoring equipment in thousands of substations that will be affected by the rapid uptake of low carbon technologies, like electric vehicles and heat pumps. The data produced through the programme will give us early sight of potential challenges on the network, improve the visibility of network losses, maximising network efficiency to keep costs low whilst ensuring our network is Net Zero ready.

### Envision LV network insight

Envision is developing a software-based machine learning tool that will generate greater Low Voltage (LV) network insights faster and cheaper compared to traditional methods of physical monitoring.

The project is a key step to widening the flexibility market and building a smart grid that enables cleaner, greener energy resources to connect quicker and at lower cost. Better forecasts allows us to plan and invest strategically to facilitate the Net Zero carbon emissions revolution, by identifying low voltage network locations that operate with a high utilisation factor and better target losses reduction.

Further information can be found in:  
[Envision and Foresight - UKPN DSAP](#)

### Learning from smart meters

Data from smart meters provides a rich source of granular data on the LV network that enables us to manage our networks in a more targeted way. Increasingly available and disaggregated data provided to DNOs replaces previously used estimates, based on typical consumption data, with actual data and underpins our plans for a dynamic approach to managing our networks and loss reduction.

Further to the adoption of smart meter, we have seen an increase in customer participation driven by price signals such as time of use tariffs, to reduce their energy costs. The change in the consumption profile resulting from a large number of customers responding to such price signals changes the pattern of load on the distribution network driving higher utilisation of parts of the LV network, thereby affecting the energy losses and the way in which distribution and transmission operators manage network assets.



## PROGRESS OF LOSSES MITIGATION MEASURES

The electrical energy lost in the network represents a cost to customers and contributes to Great Britain’s carbon emissions. UK Power Networks declared 5.6TWh of energy losses across all the network components in 2024, representing 24.3% of the total energy lost in the electricity distribution networks across Great Britain.

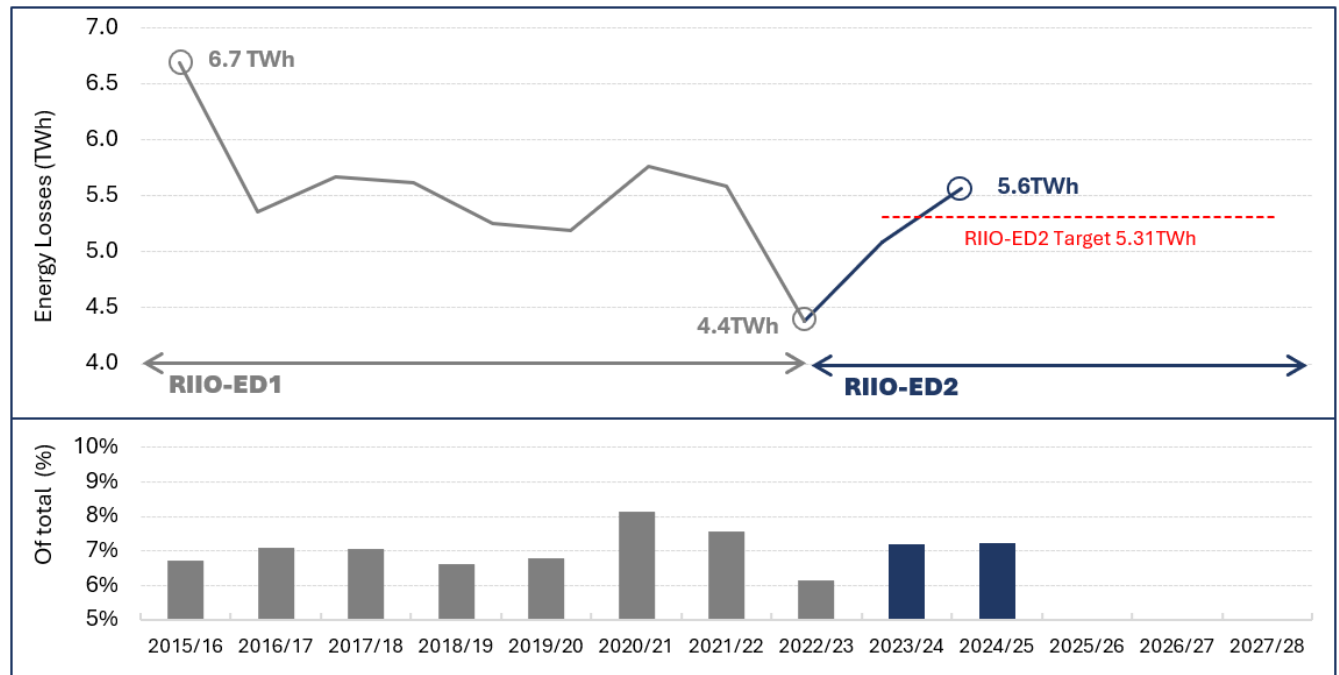
### Historical performance

UK Power Networks has achieved a significant and sustained reduction in Energy losses in the period between April 2015 and March 2023, from a peak of 6.7TWh to 4.4TWh at the end of RIIO-ED1. In percentage terms, this takes from a peak of 8.3% to 6.1% of the total energy distributed (Figure 7).

High penetration of Low Carbon Technologies as part of the transition to Net Zero and the influence of policy incentives and market trends is altering the energy losses forecast.

UK Power Networks will continue to focus on the downward path of minimizing energy losses on our network, where reasonably practicable and cost effective, further reducing our carbon footprint and passing on the savings to our customers.

Figure 7. UK Power Networks Energy Losses (Absolute value and percentage)



## RIIO-ED2 energy losses reduction

UK Power Networks declared an overall energy losses reduction of 57.2GWh in the second year of RIIO-ED2, with the largest proportion arising from the replacement of high voltage distribution transformers (both pole and ground mounted units) for a total of 8.06GWh. A further 43.4GWh from Primary substation circulating current reduction and 16.2GWh from non-technical losses (electricity abstraction) is also included in Figure 8.

This reduction is below the 83GWh forecast presented in the 2023 Distribution energy Losses Strategy and is due to lower-than-expected delivery volumes in the year.

Our strategy for RIIO-ED2, a crucial period in the transition of our network to net zero carbon, is to embed these in our wider work programme while we continue to explore new technologies and approaches. Where the measures we identify throughout the period demonstrate a long-term benefit to customers, we will adopt them to achieve further reduction in losses.

Figure 8. Energy losses improvements in 2024/25

### Electricity Distribution Losses

	Unit	2024/2025
Annual Losses	GWh	5,565
Share of Total Electricity Distributed	%	7.81
Carbon Equivalent	tCO <sub>2</sub> e	985,005
Annual Interventions completed	#	2,841
Impact of Interventions (per annum)	MWh	-57,253
Impact of Interventions (per annum)	tCO <sub>2</sub> e	-11,854

### Summary of amount of losses activities

Description	Unit	2024/2025
LV cable	km	289.5
HV cable	km	416.3
Distribution Ground Mount	each	714.0
Distribution Pole Mount	each	1,411.0
Primary Ground Mount	each	3.0
Grid Ground Mount	each	4.0
Voltage Management	each	3.0

### Summary of losses activities reductions MWh

Description	Unit	2024/2025
LV cable	MWh	-1,838.2
HV cable	MWh	-2,472.9
Distribution Ground Mount	MWh	-6,310.2
Distribution Pole Mount	MWh	-1,757.6
Primary Ground Mount	MWh	-372.0
Grid Ground Mount	MWh	-1,100.0
Voltage Management	MWh	-43,402.0

## Alignment with sustainability strategy

UK Power Networks sustainability strategy (UKPN, 2023-24) fulfils an annual requirement under standard condition 47 (Environment Reporting) of the Electricity Distribution Licence and is been prepared on a yearly basis for the three licensed distribution companies, and used to update stakeholders on the performance across the key environmental measures we work to and our efforts to deliver environmental benefits for our customers and the wider communities in the regions we serve.

Figure 9 shows a summary of total energy losses, both technical and non-technical, on our networks and business carbon emissions from data that has been developed from RIG table E3 – BCF worksheets.

**Figure 9. Summary of energy losses and respective carbon emissions**

	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
<b>Total losses (tCO<sub>2</sub>e)</b>						
EPN	448,578	607,329	531,037	359,902	475,074	<b>545,577</b>
LPN	495,864	407,761	341,426	290,718	323,478	<b>318,443</b>
SPN	380,844	328,261	313,823	196,685	254,825	<b>288,214</b>
<b>Total losses (GWh)</b>						
EPN	1,755	2,605	2,501	1,861	2,294	<b>2,635</b>
LPN	1,940	1,749	1,608	1,503	1,562	<b>1,538</b>
SPN	1,490	1,408	1,478	1,017	1,231	<b>1,392</b>

Distribution energy losses account for 96.4% of Scope 1 and 2 Carbon footprint, with the remaining elements including operational transport, temporary generation, building and substation energy usage, business travel and fugitive (SF<sub>6</sub>) emissions.



### Conclusion

The UK Power Networks Distribution Losses Strategy 2025 outlines a comprehensive approach to managing and reducing energy losses across our distribution network. As the largest electricity distributor in the UK, serving over 8.3 million homes and businesses, UK Power Networks is committed to leading the transition to a more energy-efficient and sustainable future.

The strategy emphasizes the critical role of decarbonisation in achieving Net Zero by 2050, highlighting the need for significant changes in technology, society, and energy systems to meet these goals. Various measures have been identified to manage both technical and non-technical losses, including optimising network design, leveraging data and analytics, and adopting innovative technologies.

To optimise energy losses and improve network efficiency, ongoing investment in new technologies and data analytics is essential. Strengthening partnerships with stakeholders, including customers, suppliers, and regulators, will be crucial in implementing effective loss mitigation strategies. Additionally, aligning loss reduction efforts with broader sustainability goals will ensure that UK Power Networks not only reduces costs for customers but also contributes to the UK's overall carbon reduction targets.

In conclusion, the UK Power Networks Distribution Losses Strategy 2025 sets a clear path towards a more efficient and sustainable energy distribution network in preparation of RII0-ED3. By integrating innovative solutions, optimizing existing infrastructure, and fostering collaboration, UK Power Networks is well-positioned to lead the way in reducing energy losses and supporting the transition to a low-carbon future.



## APPENDICES

### References

- Council of European Energy Regulators, 2025. *3rd CEER Report on Power Losses*. [Online]  
 Available at: <https://www.ceer.eu/publication/3rd-ceer-report-on-power-losses/>
- DCODE, 2024. *The Distribution Code of Licensed Distribution Network Operators of Great Britain*. [Online]  
 Available at: <https://dcode.org.uk>
- DCUSA, 2013. *Publication of Revenue Protection Code of Practice*. [Online]  
 Available at: <https://www.dcusa.co.uk/change/publication-of-revenue-protection-code-of-practice/>
- DESNZ, 2025. *2024 UK greenhouse gas emissions, provisional figures*. [Online]  
 Available at: <https://assets.publishing.service.gov.uk/media/67e4060df356a2dc0e39b4cd/2024-provisional-greenhouse-gas-emissions-statistics-statistical-release.pdf>
- ELEXON, 2023. *ELEXON*. [Online]  
 Available at: <https://www.elexon.co.uk/>
- ENA, 2020. *EREC G5 Issue 5 - Harmonic voltage distortion and the connection of harmonic sources and/or resonant plant to transmission systems and distribution networks in the United Kingdom*. [Online]  
 Available at: [https://dcode.org.uk/assets/uploads/ENA\\_EREC\\_G5\\_Issue\\_5\\_2020.pdf](https://dcode.org.uk/assets/uploads/ENA_EREC_G5_Issue_5_2020.pdf)
- ENA, 2023. *EREC P2 Issue 8 - Security of Supply*. [Online]  
 Available at: [https://dcode.org.uk/assets/uploads/files/ENA\\_EREC\\_P2\\_Issue%208\\_\(2023\).pdf](https://dcode.org.uk/assets/uploads/files/ENA_EREC_P2_Issue%208_(2023).pdf)
- ENA, 2024. *Energy Networks Association - SIF*. [Online]  
 Available at: <https://smarter.energynetworks.org/projects/10061347>
- ENA, n.d. *EREC P28 Issue 2 - Voltage fluctuations and the connection of disturbing equipment to transmission systems and distribution networks in the United Kingdom*. [Online]  
 Available at: <https://www.ena-eng.org/ena-docs/Index?Action=ViewDetail&EID=99789&tab=introduction>
- ENA, n.d. *EREC P29 Issue 1 - Planning limits for voltage unbalance in the UK for 132 kV and below*. [Online]  
 Available at: <https://www.ena-eng.org/ena-docs/Index?Action=ViewDetail&EID=92253&tab=introduction>
- European Commission, 2023. *Energy efficiency directive*. [Online]  
 Available at: [https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficiency-targets-directive-and-rules/energy-efficiency-directive\\_en](https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficiency-targets-directive-and-rules/energy-efficiency-directive_en)
- HM Government, 2001. *The Electricity (Unmetered Supply) Regulations 2001*. [Online]  
 Available at: <https://www.legislation.gov.uk/ukSI/2001/3263/contents/made>
- National Grid, 2023. *What is carbon intensity*. [Online]  
 Available at: <https://www.nationalgrid.com/stories/energy-explained/what-is-carbon-intensity>
- NESO, 2025. *Future Energy Scenarios*. [Online]  
 Available at: <https://www.neso.energy/publications/future-energy-scenarios-fes>
- OFGEM, 2023. *Distribution Consolidated Standard License Conditions*. [Online]  
 Available at: <https://www.ofgem.gov.uk/sites/default/files/2023-03/Electricity%20Distribution%20Consolidated%20Standard%20License%20Conditions%20-%20Current.pdf>
- OFGEM, 2024. *Strategic Innovation Funding Round 3*. [Online]  
 Available at: <https://www.ofgem.gov.uk/decision/strategic-innovation-fund-round-3-alpha-funding-decision>
- UK Power Networks, 2024. *UK Power Networks Annual Review 2023/24*. [Online]  
 Available at: <https://annualreview2024.ukpowernetworks.co.uk/>
- UKPN, 2023-24. *Annual Environment Report 2023-24*. [Online]  
 Available at: [https://media.umbraco.io/uk-power-networks/u33l4l11/ukpn\\_aer\\_2023-24-v10.pdf](https://media.umbraco.io/uk-power-networks/u33l4l11/ukpn_aer_2023-24-v10.pdf)
- UKPN, 2025. *EDS 08-2000 LV Network Design*. [Online]  
 Available at: <https://g81.ukpowernetworks.co.uk/library/design-and-planning/lv/eds-08-2000-lv-network-design>
- UKPN, 2025. *Distribution Future Energy Scenarios 2025*. [Online]  
 Available at: <https://dso.ukpowernetworks.co.uk/distribution-future-energy-scenarios>
- UKPN, 2025. *EDS 08-2100 LV Customer Supplies*. [Online]  
 Available at: <https://g81.ukpowernetworks.co.uk/library/design-and-planning/lv/eds-08-2100-lv-customer-supplies>
- UKPN, 2024. *EDS 08-3000 HV Network Design*. [Online]  
 Available at: <https://g81.ukpowernetworks.co.uk/library/design-and-planning/hv/eds-08-3000-hv-network-design>
- UKPN, 2024. *EDS 08-4000 EHV Network Design*. [Online]  
 Available at: <https://g81.ukpowernetworks.co.uk/library/design-and-planning/ehv/eds-08-4000-ehv-network-design>

## Glossary of terms

2009/125/EC	EU Directive Ecodesign of Energy Products	FES	Future Energy Scenarios	RIIO-ED1	RIIO Electricity Distribution - Price Control Period between April 2015 and March 2023
AC	Alternate Current	GB	Great Britain	RIIO-ED2	RIIO Electricity Distribution - Price Control Period between April 2023 and March 2028
AMT	Amorphous Steel Transformer	HH	Half Hour	RIIO-ED3	RIIO Electricity Distribution - Price Control Period between April 2028 and March 2033
APRS	Automatic Power Restoration System	HP	Heat Pump	RMU	Ring Main Unit
AVC	Automatic Voltage Control	HV	High Voltage	SIF	Strategic Innovation Fund
BCF	Business Carbon Footprint	HVDC	High Voltage Direct Current	SPN	Southern Power Network
bn	Billion	ICP	Independent Connections Provider	SSC	Small Section Conductor
BSC	Balancing Settlement Code	IDNO	Independent Distribution Network Operator	THD	Total Harmonic Distortion
CBA	Cost Benefit Analysis	kV	Kilo-Volt	TWh	Terawatt hour
CEER	Council of European Energy Regulators	kVA	Kilo-Volt Amps	UK	United Kingdom
CRGO	Cold Rolled Grain Oriented	LC49	Licence Condition 49	UKPN	UK Power Networks
CVL	Contact Voltage Losses	LCT	Low Carbon Technologies	UMSO	Unmetered Supplies Operator
DC	Direct Current	LDR	Losses Discretionary Reward	V2G	Vehicle to Grid
DER	Distributed Energy Resources	LPN	London Power Network		
DERMS	Distributed Energy Resources Management System	LV	Low Voltage		
DG	Distributed Generation	LVAC	Low Voltage Alternate Current Supply		
DNO	Distribution Network Operator	MAAV	Mobile Asset Assessment Vehicle		
DSO	Distribution System Operator	MPAN	Meter Point Administration Number		
EAC	Estimated Annual Consumption	Mt	Megaton		
EED	Energy Efficiency Directive	NESO	National Energy System Operator		
EHV	Extra High Voltage (including 33kV and above)	NGESO	National Grid Electricity System Operator		
ENA	Energy Networks Association	NOP	Normal Open Point		
EPN	Eastern Power Network	NPS	Negative Phase Sequence		
EU	European Union	NPV	Net Present Value		
EV	Electric Vehicle	RIG	Regulatory Instructions and Guidance		
EVC	Electric Vehicle Charger	RIIO	Revenue = Incentives + Innovation + Outputs		

UKPN energy losses and carbon equivalent summary

	DPCR5		RIIO-ED1							RIIO-ED2	
	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
<b>Total losses (tCO<sub>2</sub>e)</b>											
EPN	1,178,316	1,034,381	1,016,939	838,822	603,788	448,578	607,329	531,037	359,902	475,074	<b>545,577</b>
LPN	913,887	880,009	779,598	644,058	503,865	495,864	407,761	341,426	290,718	323,478	<b>318,443</b>
SPN	663,791	559,249	541,021	489,723	379,314	380,844	328,261	313,823	196,685	254,825	<b>288,214</b>
<b>Total losses (GWh)</b>											
EPN	2,860	2,238	2,468	2,386	2,133	1,755	2,605	2,501	1,861	2,294	<b>2,635</b>
LPN	2,218	1,904	1,892	1,832	1,780	1,940	1,749	1,608	1,503	1,562	<b>1,538</b>
SPN	1,611	1,210	1,313	1,393	1,340	1,490	1,408	1,478	1,017	1,231	<b>1,392</b>
<b>GHG Conversion Factors (kg CO<sub>2</sub>e/kWh)</b>											
	0.412	0.462	0.412	0.352	0.283	0.256	0.233	0.212	0.193	0.207	<b>0.207</b>
<b>Total units distributed (GWh)</b>											
EPN	32,882	32,721	33,295	33,106	32,994	31,973	30,657	31,567	30,130	29,843	<b>32,900</b>
LPN	27,632	27,442	27,266	27,012	26,864	25,779	22,309	23,802	23,828	23,656	<b>25,394</b>
SPN	19,713	19,413	19,468	19,373	19,379	18,763	17,922	18,378	17,500	17,238	<b>18,559</b>
<b>Total losses (%)</b>											
EPN	8.70%	6.84%	7.41%	7.21%	6.46%	5.49%	8.50%	7.92%	6.18%	7.69%	<b>8.01%</b>
LPN	8.03%	6.94%	6.94%	6.78%	6.63%	7.53%	7.84%	6.76%	6.31%	6.60%	<b>6.06%</b>
SPN	8.17%	6.23%	6.74%	7.19%	6.91%	7.94%	7.86%	8.04%	5.81%	7.14%	<b>7.50%</b>
<b>Total losses (TWh)</b>	6.7	5.4	5.7	5.6	5.3	5.2	5.8	5.6	4.4	5.1	<b>5.6</b>
<b>Total units (TWh)</b>	80.2	79.6	80.0	79.5	79.2	76.5	70.9	73.7	71.5	70.7	<b>76.9</b>
<b>% of Total</b>	<b>8.3%</b>	<b>6.7%</b>	<b>7.1%</b>	<b>7.1%</b>	<b>6.6%</b>	<b>6.8%</b>	<b>8.1%</b>	<b>7.6%</b>	<b>6.1%</b>	<b>7.2%</b>	<b>7.2%</b>

## Reported electricity distribution losses

### LPN

#### Electricity Distribution Losses

	Unit	2024/2025
Annual Losses	GWh	1,538
Share of Total Electricity Distributed	%	6.06%
Carbon Equivalent	tCO <sub>2</sub> e	272,226
Annual Interventions completed	#	282.2
Impact of Interventions (per annum)	MWh	-2,753.1
Impact of Interventions (per annum)	tCO <sub>2</sub> e	-570.0

#### Summary of amount of losses activities

Description	Unit	2024/2025
LV cable	km	54.1
HV cable	km	79.7
Distribution Ground Mount	each	148.0
Distribution Pole Mount	each	-
Primary Ground Mount	each	-
Grid Ground Mount	each	1.0
Voltage Management	each	-

#### Summary of losses activities reductions MWh

Description	Unit	2024/2025
LV cable	MWh	-343.3
HV cable	MWh	-473.6
Distribution Ground Mount	MWh	-1,542.2
Distribution Pole Mount	MWh	-
Primary Ground Mount	MWh	-
Grid Ground Mount	MWh	-394.0
Voltage Management	MWh	-

### SPN

#### Electricity Distribution Losses

	Unit	2024/2025
Annual Losses	GWh	1,392
Share of Total Electricity Distributed	%	7.50%
Carbon Equivalent	tCO <sub>2</sub> e	246,384
Annual Interventions completed	#	770.7
Impact of Interventions (per annum)	MWh	-7,987.0
Impact of Interventions (per annum)	tCO <sub>2</sub> e	-1,653.7

#### Summary of amount of losses activities

Description	Unit	2024/2025
LV cable	km	80.1
HV cable	km	134.6
Distribution Ground Mount	each	217.0
Distribution Pole Mount	each	337.0
Primary Ground Mount	each	1.0
Grid Ground Mount	each	-
Voltage Management	each	1.0

#### Summary of losses activities reductions MWh

Description	Unit	2024/2025
LV cable	MWh	- 508.3
HV cable	MWh	- 799.8
Distribution Ground Mount	MWh	- 1,972.5
Distribution Pole Mount	MWh	- 404.4
Primary Ground Mount	MWh	- 200.0
Grid Ground Mount	MWh	-
Voltage Management	MWh	- 4,102.0

### EPN

#### Electricity Distribution Losses

	Unit	2024/2025
Annual Losses	GWh	2,635
Share of Total Electricity Distributed	%	8.01%
Carbon Equivalent	tCO <sub>2</sub> e	466,395
Annual Interventions completed	#	1,787.3
Impact of Interventions (per annum)	MWh	-46,512.8
Impact of Interventions (per annum)	tCO <sub>2</sub> e	9,630.5

#### Summary of amount of losses activities

Description	Unit	2024/2025
LV cable	km	289.5
HV cable	km	416.3
Distribution Ground Mount	each	714.0
Distribution Pole Mount	each	1,411.0
Primary Ground Mount	each	3.0
Grid Ground Mount	each	4.0
Voltage Management	each	3.0

#### Summary of losses activities reductions MWh

Description	Unit	2024/2025
LV cable	MWh	- 986.5
HV cable	MWh	- 1,199.6
Distribution Ground Mount	MWh	- 2,795.5
Distribution Pole Mount	MWh	- 1,353.2
Primary Ground Mount	MWh	- 172.0
Grid Ground Mount	MWh	- 706.0
Voltage Management	MWh	- 39,300.0



This document serves as an update to UK Power Networks Losses Strategy in accordance with section 49.5(b) of the Standard conditions of the Electricity Distribution Licence.

We have undertaken a revision of the 2023 Distribution Losses Strategy, detailing activities to reduce and manage electricity network energy losses. During RIIO-ED1 we have assessed these activities and prioritised those that are viable and cost effective, continuing their adoption in the RIIO-ED2 price control period that started on 1<sup>st</sup> of April 2023.

We believe that these changes make it very clear to the reader what we are doing to reduce or manage losses and that identified activities are based on up to date cost benefit analyses.

**UK Power Networks Holdings Limited**

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