UK Power Networks

Business plan (2015 to 2023)

Annex 6: Quality of Supply Strategy

March 2014

“A reliable… an innovative… and the lowest price electricity distribution group.”

UK Power Networks
Delivering your electricity

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Contents

This annex has been updated to reflect UK Power Networks' March 2014 business plan. We have a tracked change version for the purpose of informing Ofgem of all revisions to July 2013 business plan, should this be required.

1 Executive summary

UK Power Networks has set an overall business objective to improve continuity of supply in all three licence areas so that their CI and CML performance from 2013/14 is in the top third compared to other DNOs (Distribution Network Operators).

During the summer of 2009 a review was undertaken which indicated that performance across all three networks had deteriorated since 2004 and a strategy was developed to improve performance to achieve the new Ofgem targets. The Quality of Supply Programme was launched to look at possible 'quick-wins' or short-term initiatives and identify more long term actions to achieve the targets for years three, four and five of DPCR5, The merits of each initiative in the QoS `Programme were evaluated against estimated IIS rewards during DPCR5

Customer Interruptions (CI) and Customer Minutes Lost (CML)

Table 1 below summarises our actual performance over the current period (2010/11 and 2011/12) and target performance for the RIIO-ED1 period which commit us to deliver further improvements in relation to CIs and which refer to the number of customers whose supplies have been interrupted per 100 customers each year CMLs, which refer to the duration of unplanned interruptions to supply each year, measured by average customer minutes lost per customer where an interruption of supply to the customer lasts three minutes or longer.

Table 1 Unplanned interruptions performance - current period performance and RIIO-ED1 targets

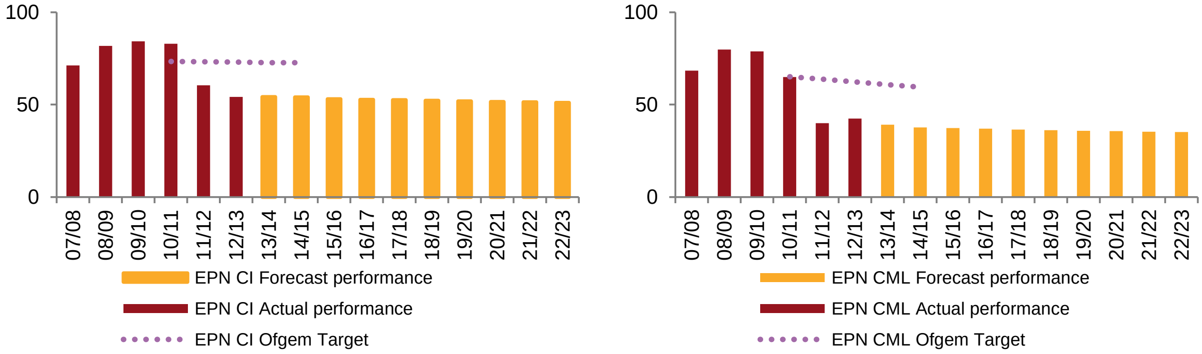
DNO	CI and CML's	DPCR5 average performance	UKPN forecast 2015-23 average performance	% reduction from DPCR5 average	UKPN forecast 2023 target performance
EPN	CIs	61.2	52.1	15%	51.1
	CMLs	44.8	36.5	19%	35.2
LPN	CIs	24.6	22.7	7%	22.5
	CMLs	32.9	30.3	8%	29.6
SPN	CIs	56.5	49.7	12%	49.0
	CMLs	44.2	35.9	19%	34.9

The improvements in EPN's, LPN's and SPN's CI and CML performance during the current period are shown in Figure 1 to Figure 3. In particular, they show that the networks are expected to outperform the CI and CML targets set by Ofgem for the current period, thereby delivering a more reliable service to customers. This improvement has largely been driven by recent investment and operational performance improvements which have focused on the efficient and innovative use of the existing network assets.

Early improvements from the programme are clearly shown by the step change in performance particularly in the EPN and SPN. For 2012/13 EPN is ranked seventh of the fourteen DNOs for customer minutes lost.

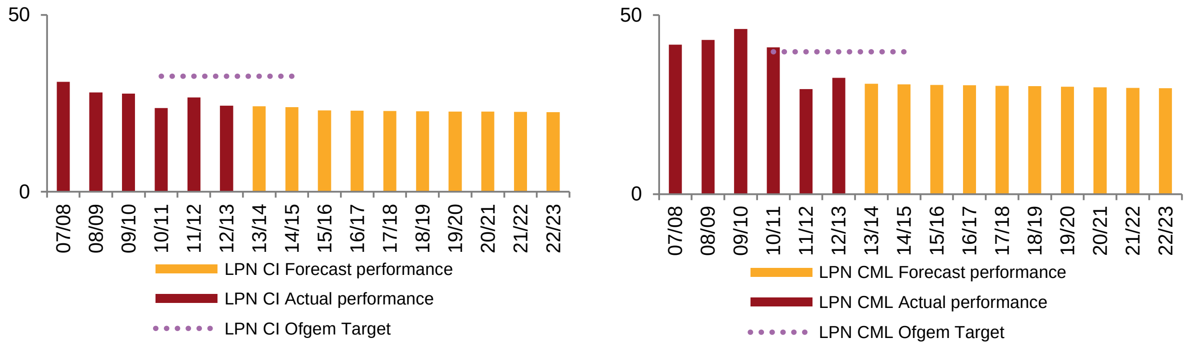
This performance improvement has enabled UK Power Networks as a whole to achieve the best CML performance of all six electricity distribution groups, making us the most reliable electricity distribution group in Great Britain.

Figure 1 EPN's unplanned interruption and restoration performance



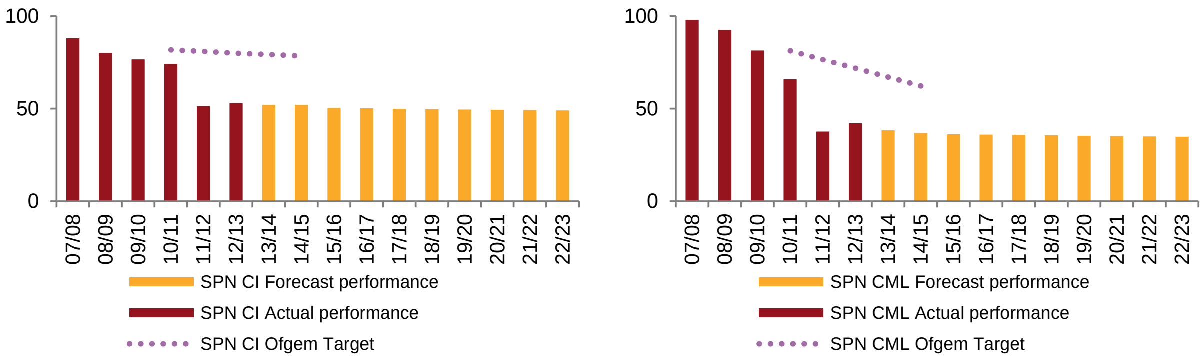
LPN is the most reliable DNO in Great Britain. Figure 2 shows that LPN has consistently delivered high levels of network reliability as reflected in its CI and CML targets set by Ofgem for the current period. LPN has outperformed these targets with outperformance being most pronounced in 2011 and 2012 due to the mild weather. We believe that the expectations of stakeholders regarding operational network performance are higher in central London than in our other network distribution areas. This has been further reinforced through our experience gained during the London 2012 Olympic Games and recent operational incidents in London (e.g. Carnaby Street and Victoria) and the high level of media attention they have attracted. We have included a further £4.5million of ongoing expenditure in RIIO-ED1 to deliver improved operational performance and we expect this to reduce our CI and CML performance by a further 0.2 CI and 0.3 CML. However the CI and CML performance for our central London customers will improve by around 50%.

Figure 2 LPN's unplanned interruption and restoration performance



SPN has the fifth lowest average restoration time of all 14 UK DNOs reflecting the significant improvements in restoration performance over the current period. An improvement in restoration and times and the elimination of over 3 minute interruptions has contributed to the improvement in overall customer interruptions as shown in Figure 3.

Figure 3 SPN's unplanned interruption and restoration performance



Detailed analysis of fault data has been used to identify the main focus areas for improvement in ED1:

- The primary focus in EPN is to reduce the CIs and CMLs occurring on the HV network whilst addressing the CIs on the EHV network and the CMLs on the LV network.
- The primary focus in LPN is to reduce the CMLs occurring on the LV network whilst addressing the CIs on the HV network. LV CI reductions are considered a future initiative following trials of smart solutions.
- The primary focus in SPN is to reduce the CIs and CMLs occurring on the HV network whilst addressing the CMLs on the LV network.

In order to achieve these goals, a number of initiatives have been identified including next generation automation systems (Algorithmic Automation), smarter sectionalisation of overhead line networks, investment and outage optimisation, data integrity, network monitoring and operational response improvements.

All initiatives are in line with UK Power Networks' vision to maintain top third performance during ED1.

2 Introduction

2.1 Introduction

UK Power Networks has set an overall business objective to improve continuity of supply in all three licence areas so that their CI and CML performance from 2013/14 is in the top third compared to other DNOs (Distribution Network Operators) and to eliminate over 18 hour restoration failures. Delivering this objective will reduce fault costs, improve customer service and increase rewards under the regulatory incentive scheme.

To meet this objective it was necessary to achieve a step change improvement in performance within EPN, SPN and, to a lesser extent, LPN during 2011/12 - 2013/14.

This document sets out the initial strategy, targets and initiatives necessary to build on the improvements delivered and planned for DPCR5 and maintain top third performance during the next distribution price control period (ED1). The strategy will be revised as our ED1 plans are further developed.

It should be noted that all initiatives outside of business as usual activities will be assessed on their own merits for return on investment against the IIS (Interruptions Incentive Scheme) mechanism. Opportunities may present themselves during ED1 as availability of network data improves and should not be missed based on a predefined ED1 plan.

Targets to achieve top third ranking have been assessed by considering the potential CI and CML performance of other DNOs and the ease with which they may make improvements, as well as customer expectations.

During the current price control period, DPCR5, the prime initiatives comprise operational improvements and investment in additional HV remote control in the EPN and SPN networks as a precursor to the implementation of algorithmic automation across all networks currently planned in the early part of ED1 following the upgrade of the network control system

Moving into the next price control period, ED1, focus will continue on operational improvements to speed up restoration and reduce frequency of interruption, as well as optimising the Network Asset Management Plan (NAMP) programmes to mitigate faults and customers affected. This will require the CI and CML benefits and impacts from asset programmes to be understood, quantified and managed. Monitoring and identification of opportunities for automation of the LV network, particularly in London, will be introduced and improvements made to the central London distribution systems.

These improvements will be enabled through better asset and network knowledge, as well as planning and analysis tools. The roll out of Smart Metering coupled to enhanced distribution substation monitoring provides the opportunity to improve the visibility of network loading and voltage profiles. Further vector capture of network records in Netmap will facilitate accurate network modelling, speeding connection designs and pre-emptive reinforcement, and also enable improved condition and performance analysis of circuits. Condition management and diagnostic techniques should be further enhanced to manage underground cable and link box performance in particular.

Improved communications will be necessary to carry the increased data flows and overcome intermittency and obsolescence issues and improve the effectiveness of secondary control systems. These should be developed as part of an overall communications architecture that is designed to enable Smart Grids.

3 Background

3.1 ED1 price control and RIIO

In November 2008 Ofgem initiated a full review of the regulatory price and revenue setting framework which was referred to as RPI-X. The RPI-X framework had been used since electricity privatisation in 1990 to regulate Britain's energy networks. Ofgem recognised three drivers to reviewing this framework:

- The potential need for significant changes to the regulatory framework for energy networks to facilitate the move to a low carbon economy.
- The need for the regulatory framework to facilitate investment to ensure security of supply and alignment with the European agenda.
- Concerns that the framework had become too complex making it difficult for stakeholders to understand, respond and engage in the process.

The review has culminated in the introduction of a new regulatory framework where Revenues will be driven by Incentives, Innovation and Outputs, referred to as RIIO. This will apply to the next price control period that will run for eight years from April 2015 and is to be called Electricity Distribution 1 (ED1). However, during RIIO-ED1 Ofgem will retain the right to call for a limited midterm review after four years, specifically to deal with adjustments to outputs or substantive changes to requirements

The overriding objectives of the RIIO framework for DNOs are to encourage them to play a full role in delivering a sustainable energy sector and to deliver network service with long-term value for money for existing and future customers. To deliver these changes the RIIO model enables the setting of outputs that DNOs are expected to deliver. The intention is that these outputs act as a 'contract' between the network companies and their customers. Ofgem has defined six categories of output:

- Safety
- Reliability and availability (currently CI and CML)
- Conditions for connections (currently GSoP, LC15 obligations)
- Environmental (currently Network Losses, DNO Carbon Footprint, O/H line undergrounding in AONB)
- Social obligations (currently Worse Served Customers, Priority Services Register)
- Customer service (currently Broad Measure of Customer Satisfaction)

Each of these output categories will have an associated set of output measures, targets and secondary deliverables. Each DNO will suggest output measures following discussions with stakeholders. Ofgem will ultimately approve a core set for the industry, which will then be supplemented by company-specific outputs. Targets for the output measures will be proposed by the DNOs, in response to stakeholder input on requirements and the level of service they are willing to pay for. Secondary deliverables are company specific measures/targets, which will support improvement in future price controls e.g. delivery of a programme of investment.

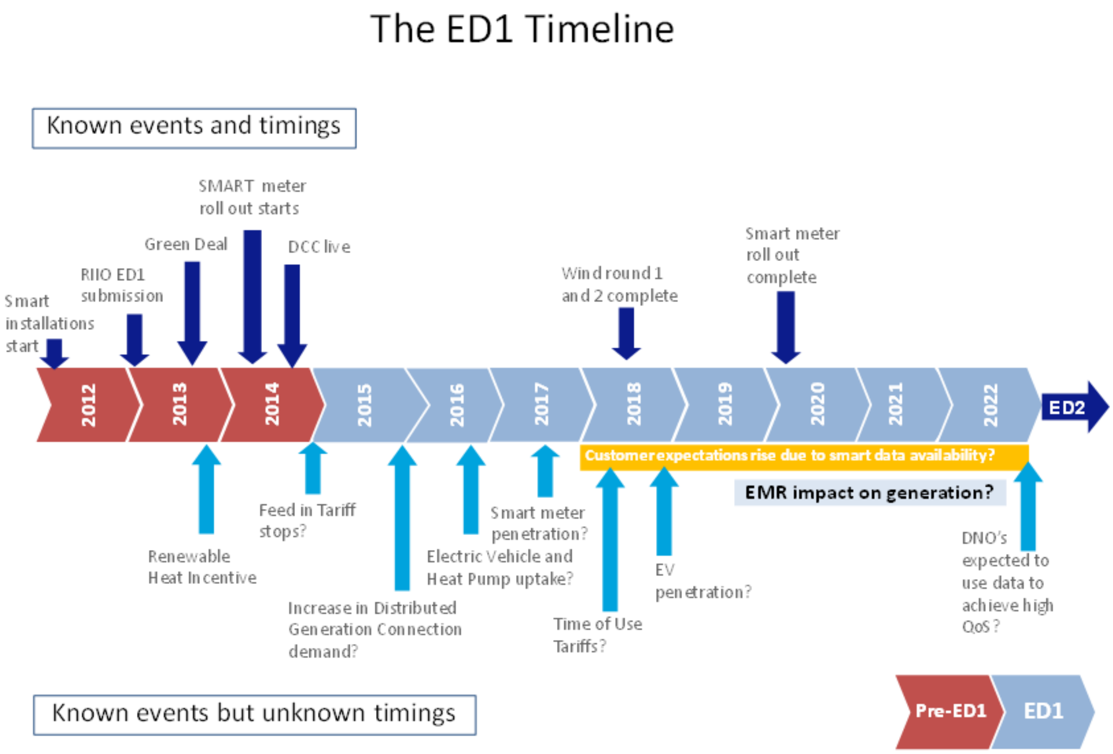
The business plan, which will be the subject of our future price control negotiations with Ofgem, sets out the commitments to our customers and stakeholders and how these will be delivered. We must demonstrate that we have engaged fully with stakeholders in the development of the plan and that it accurately reflects the requirements of the communities we serve.

There will be penalties associated with failure to deliver agreed output targets, but we will be rewarded if we can deliver our commitments for less than forecast in the business plan. RIIO will include various incentive schemes, reflecting Ofgem's and other stakeholders' priorities. Many incentives will be similar to those in DPCR5 – some will have rewards/penalties attached, whilst others will rely on reputational impact to drive behaviour. Incentive schemes are the key mechanism through which DNOs can outperform their price control settlement or feel the consequences of failure. Should a DNO beat its targets, Ofgem is happy for it to outperform its settlement. Should the DNO fail, financial performance could be very poor.

3.1.1 Development opportunities during ED1

External initiatives to transform the UK to a low carbon economy will accelerate as we move into and through ED1.

Figure 4 External developments during ED1



Demand on the LV and HV networks are likely to change unpredictably as customers respond to incentives to take up renewable power and heat sources and opportunities and information provided by smart metering.

3.2 Factors affecting performance

Continuity of supply, as measured by customer interruptions (CI) and customer minutes lost (CML) is dependent on:

- Occurrence of faults and other network outages, including overloads and planned work
- Customers affected by the fault
- Speed of restoration

During DPCR5 the focus has been mainly on reducing the customers affected by a fault and quicker customer restoration, as these produce earlier improvements in performance. Going forward, a better understanding of the impact of faults and remedial interventions on CI and CML performance will enable NAMP (Network Asset Management Plan) work programmes to be optimised to reduce the occurrence of network faults and outages.

3.2.1 Reducing customer interruptions

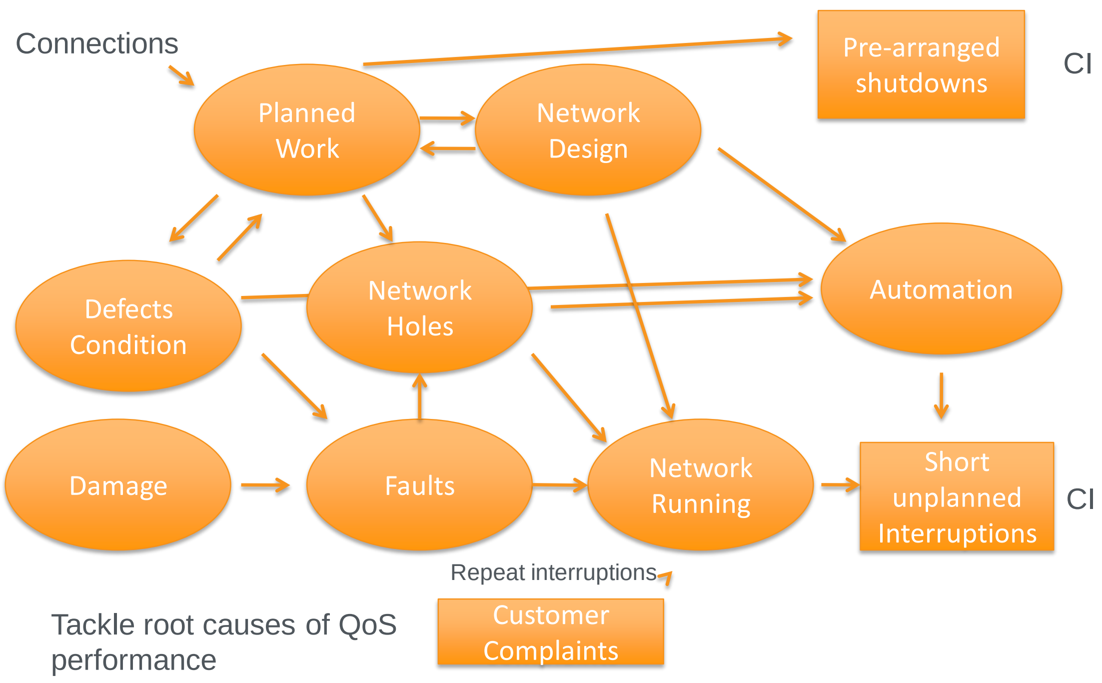
For regulatory purposes a Customer Interruption (CI) is defined as an interruption to customer supply lasting longer than three minutes. In addition to these sustained interruptions, short interruptions of less than three minutes are measured and reported but are not subject to regulatory incentives.

The diagram below (Figure 5) illustrates how network activities impact CIs.

Customer Interruptions (CI) may be reduced by:

- Reducing the number and duration of faults and defects on the system, which in turn impact the network running arrangements, increasing customers affected by a fault and reducing the availability of automation schemes
- Reducing third party interference, resulting in fault impact as above
- Reducing the frequency and duration of planned work, thereby reducing planned CIs from pre-arranged shutdowns and the impact of abnormal network running arrangements on unplanned CIs
- Improvements to network design to reduce the numbers of customers affected by a fault
- Investing in automation systems to restore customers in under 3 minutes

Figure 5 Impact of activities on Customer Interruptions



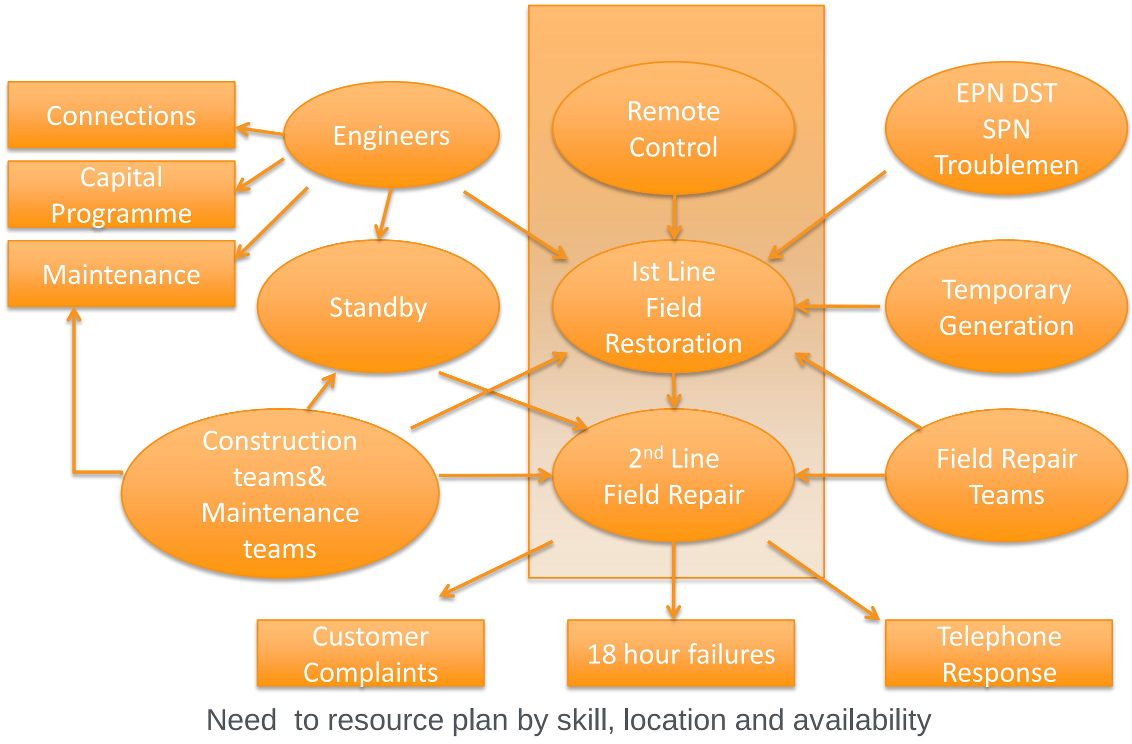
3.2.2 Reducing customer minutes lost

The diagram (Figure 6) illustrates how activities impact Customer Minutes Lost (CML).

CMLs may be reduced by:

- Reducing CIs, as discussed previously
- Increasing, through investment, the ability to restore customers by remote control
- Increasing, through investment and maintenance, the availability and number of sectionalising points and interconnections (circuits, switches and link boxes)
- Quicker dispatch and first field response to restore customers not connected to a faulty section
- Provision of alternative supplies (e.g. generation)
- Quicker fault repair and final restoration

Figure 6 Impact of activities on CMLs



3.3 Security standards

The distribution licence requires networks to comply with the Engineering Recommendation P2/6 unless a derogation to depart has been agreed by Ofgem. This standard is currently under review, a process that may take until 2016 to complete.

3.4 DPCR 5 quality of supply improvements

The DPCR5 settlement set targets and incentive rates for quality (continuity) of supply performance over the five year period to 31 March 2015, in terms of customer interruptions (CI) and customer minutes lost (CML).

Table 2 DPCR5 Performance targets (customer interruptions & customer minutes lost)

	2010/11	2011/12	2012/13	2013/14	2014/15
EPN CI	76.1	75.9	75.7	75.5	75.4
EPN CML	71.1	69.7	68.3	66.8	65.4
LPN CI	33.4	33.4	33.4	33.4	33.4
LPN CML	41.0	41.0	41.0	41.0	41.0
SPN CI	85.0	84.2	83.3	82.5	81.7
SPN CML	87.6	82.9	78.1	73.3	68.5

During the summer of 2009 a review was undertaken which indicated that performance across all three networks had deteriorated since 2004 and a strategy was developed to improve performance to achieve the new Ofgem targets. This strategy comprised two parts: an Operational Recovery Plan and a Network Optimisation Plan. The initiatives under these plans are outlined in the Quality of Supply Strategy issued in December 2009.

In September 2010 the Quality of Supply Programme was launched. The performance improvements under the programme were divided into two categories, the first looking at possible ‘quick-wins’ or short-term initiatives and the second being more long term actions to achieve the targets for years three, four and five of DPCR5, as well positioning the business for optimising reputation and QoS financial performance under the subsequent review and control period (ED1).

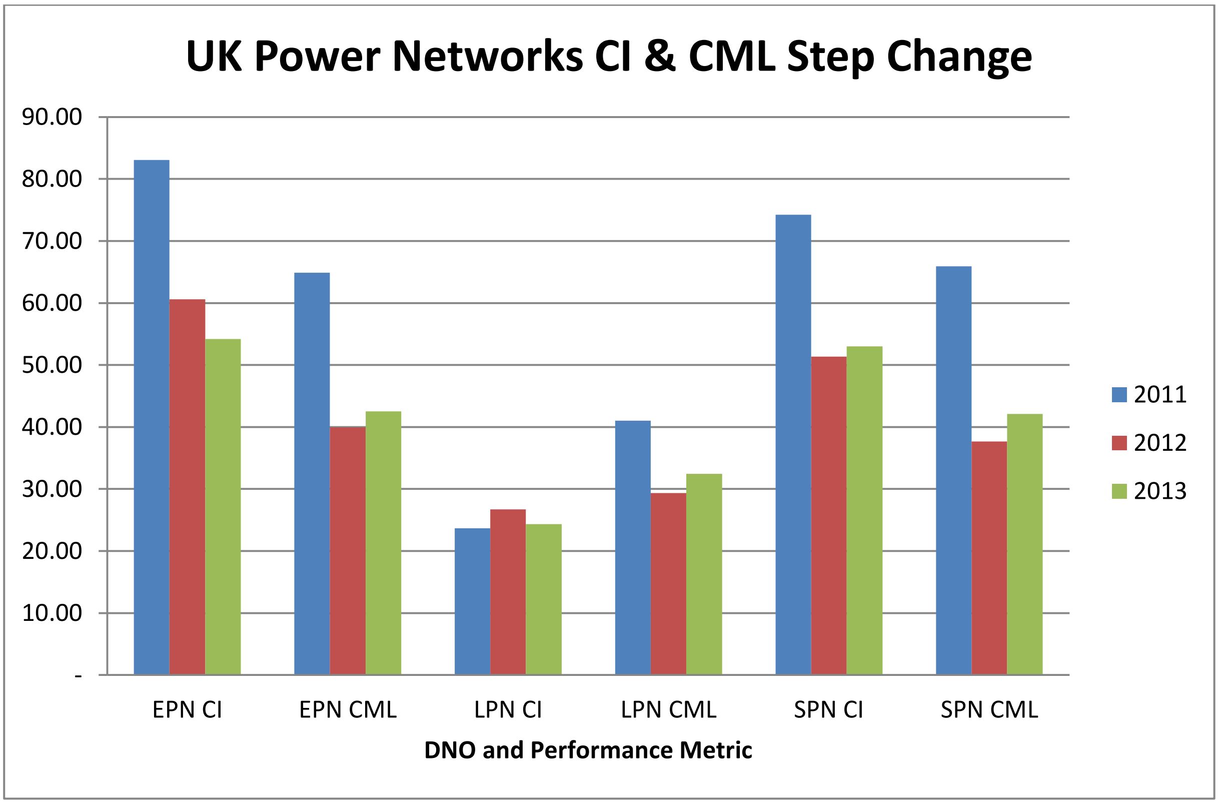
Following development and approval in principle of the step change improvement proposals (presented to the EMT on 2 March 2011) the Quality of Supply Programme plans and organisation were revised to align with these proposals.

Initiatives comprised operational improvements and investment in additional HV remote control in the EPN and SPN networks, as well as the implementation of algorithmic automation across all networks. The algorithmic Automation project has been delayed due to the procurement of ENMAC hardware and software upgrades and as such will not be operational until the beginning of RIIO-ED1. Further details on these initiatives are contained in Appendix A.3.

The merits of each initiative in the QoS Programme were evaluated against estimated IIS rewards during DPCR5 using a base case projection. Sensitivity analysis for annual fault rate and HV automation and control performance was used to derive a best and worst case projection around the base case.

Having completed three years of DPCR5, UK Power Networks has already begun to realise the benefits of the Quality of Supply Programme. This is noticeable when comparing year one to years two and three where a step change in performance, particularly for the EPN and SPN regions, occurs. This is highlighted in Figure 7 below:

Figure 7 Graph showing the step change in performance improvement since the beginning of DPCR5



4 Scope and objectives

4.1 Scope

The scope of this strategy covers initiatives that can be implemented to deliver improvements in CI and CML performance, as well as over 12/18 hour failures, from April 2015 to March 2023.

This strategy forms part of the overall UK Power Networks' strategies and plans to sustain network performance, connect new customers and address worst served customers.

4.2 Objectives

The overall objectives are:

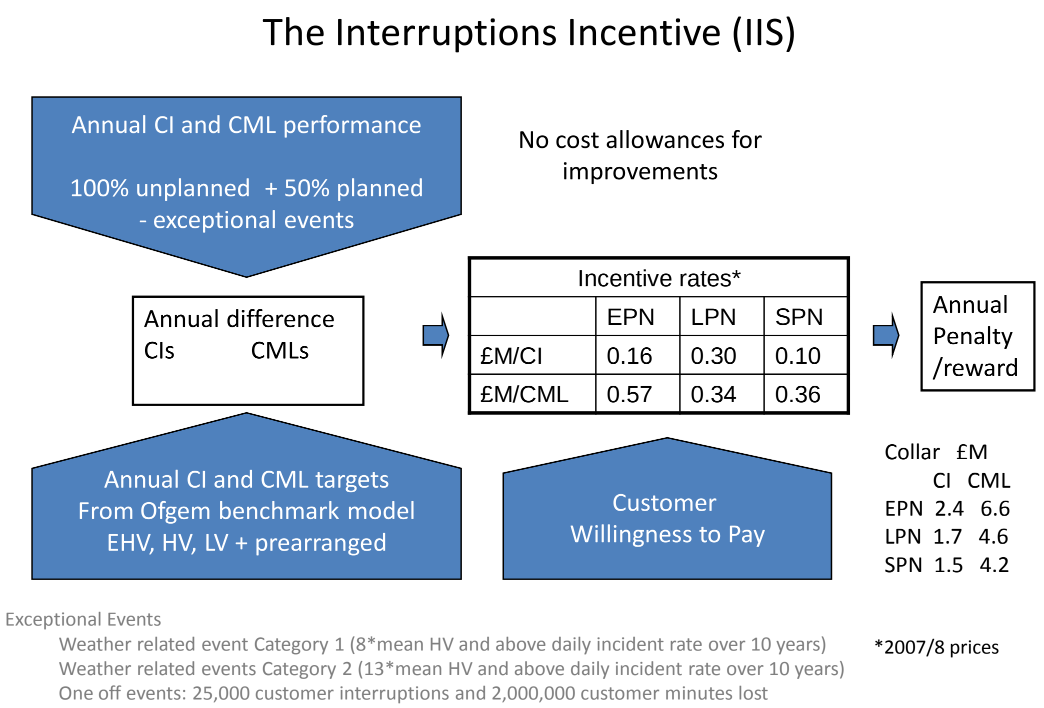
- To continue to improve quality of supply in all three licence areas so that their CI and CML performance during ED1 is in the top third compared to other DNO's
- Reduce the number of 12 hour failures by more than 30 per cent
- To optimise cost benefit from the ED1 Interruptions Incentive Scheme and other Customer Service Incentives

5 Regulatory incentives and mechanisms

5.1 DPCR5 interruptions incentive

The operation of the Interruptions Incentive for CI and CML performance is illustrated in Figure 8 below:

Figure 8 The interruptions incentive mechanism



Annual targets are set by Ofgem for CI/100cc and CML/cc for planned and unplanned incidents and a weighting of 100% for unplanned and 50% for planned interruptions applied in calculating the overall target. The planned allowance was based on DNOs own projections and the unplanned allowances derived from separate benchmarking of EHV, HV and LV using Ofgem models.

The EHV benchmarking used 10 year averages to reduce volatility.

The HV benchmarking used groups of ‘like’ circuits, with CI and CML dependant on the number of customers in each band, the performance of each band and upper quartile CML/CI.

The difference between the actual and target annual performance, after deducting exceptional events, is calculated and multiplied by the incentive rate to derive a penalty or reward which is settled by adjustment to DUoS charges. The incentive rate is informed by customer willingness to pay assessments.

There were no cost allowances included within the DPCR5 for funding Quality of Supply Improvements.

5.2 Restoration time

Under normal circumstances payments are made to customers if an unplanned interruption exceeds 18 hours. Under severe weather this time is extended. For ED1 the 18 hour threshold has been reduced to 12 hours.

5.3 Worst served customers

In DPCR5 Ofgem define Worst Served Customers (WSCs) as those experiencing on average at least five high voltage interruptions per year over a three year regulatory period, i.e. 15 or more permanent outages over three years with an additional requirement for a minimum of three in each regulatory year. In ED1 a WSC will be defined as a customer experiencing an average of 4 higher voltage interruptions over the three year period i.e. 12 over a three year period. The minimum of three faults per year still stands.

Ofgem allowed in the DPCR5 settlement a funding cap of £1,000 capital expenditure per customer for improvement schemes to identified WSCs, under a logging up arrangement. Customers must be informed of the proposed improvement works and once the work has been completed, monitoring of the service to the WSCs is carried out for the next 3 regulatory years. For UK Power Networks to re-claim the money spent on the improvement works there must be a minimum 25% reduction in the average number of higher voltage interruptions measured in the 3 years post expenditure.

For some circuits the principal cause of faults is tree encroachment. If restrictive cuts exist it may be economic to underground spans using WSC funding. However, if tree cutting needs to be brought forward this is an operational expense that it not eligible of WSC funding.

After analysis of fault trends it may not be feasible to achieve the 25% reduction in faults within the £1,000 per customer cap.

Apart from the change in definition of a WSC there are no differences in ED1.

The application of the Worst Served Customer incentive is outside the scope of this document although improvements in restoration times and a reduction in fault impact from automation will naturally have an impact on this.

5.4 Broad measure of customer satisfaction

From 1st April 2012 Ofgem introduced incentives based on a broad measure of customer satisfaction, covering connections, supply interruptions and general enquiries.

it is anticipated that improvements in line with this strategy will have a positive impact on the scores of UK Power Networks' three licence areas although faults only applies to 30% of the overall score. This will be achieved by reducing the frequency and duration of interruptions. This is based on research shown in section 5.

5.5 ED1 incentive mechanism

The Reliability and Safety Strategy decision for the RIIO-ED1 electricity distribution price control document published on 4th March 2013 details the IIS mechanism for ED1. Below is a summary of changes:

Planned and unplanned data has been separated since different methods are used to calculate the targets. DNOs have the option to propose different targets to those set by the regulator in line with a well justified business plan. It is not appropriate at this stage to attempt to alter targets set by the regulator.

Unplanned CI and CML targets are included in the document however these are indicative and will be amended following receipt of the 2012/13 IIS return from DNOs.

Planned targets will be set using a three-year rolling average with a two year lag.

Incentive rates have been altered and now include a cap and collar. The rates are outlined in Table 3 below:

Table 3 Proposed ED1 incentive rates including cap and collar

DNO	IIS CI (£m)	CI Cap/Collar (£m)	IIS CML(£m)	CML Cap/Collar (£m)
EPN	0.53	5.69	1.29	15.69
LPN	0.34	3.6	0.83	9.93
SPN	0.34	3.77	0.82	10.39

These incentive rates are affected by the Information Quality Incentive (IQI) sharing factor and will vary based upon assessment of the business plan. They are also subject to yearly variance based upon the regulatory inflation index.

DNOs should provide IIS performance data generated by smart meters to Ofgem where possible, along with the data derived from the current recording approach. There is an expectation that DNOs will have appropriate IT systems in place such that IIS data from smart meters can be easily incorporated into returns during the ED1 period.

The reporting of cut-out failures will require greater detail during ED1 but is not included in the incentive itself.

6 Customer expectations

A range of mechanisms are in use to understand customer expectations including customer satisfaction surveys, willingness to pay [for quality of service] studies, feedback from structured stakeholder engagement and analysis of customer complaints.

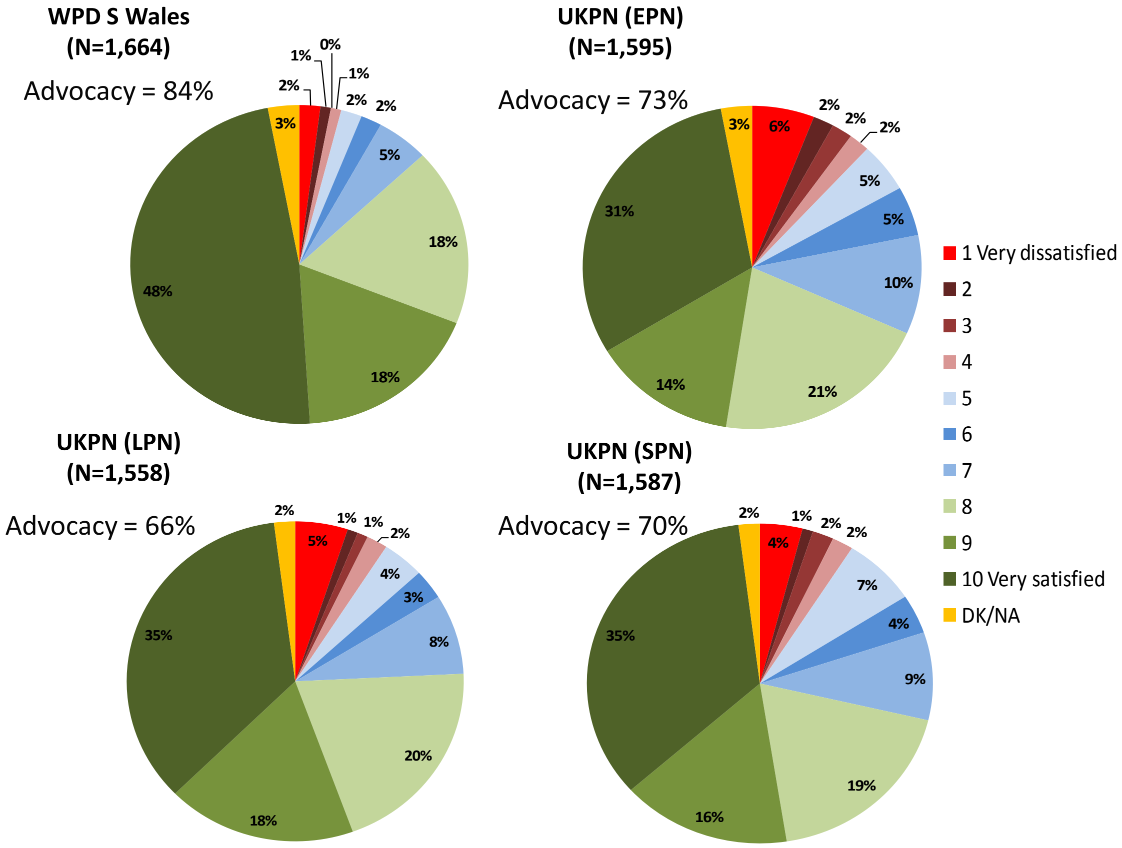
6.1 Customer insight

Customer insight surveys were carried out during May to November 2011. These confirmed that customers don't, of course, want their power cut, but if it does happen they require:

- better notification for a planned shutdown or make any notification received better
- a reason given for the power cut
- the fault fixed quickly and to stick to stated restoration times
- a more accurate and up-to-date phone message

The level of satisfaction from customers surveyed for interruptions is shown in Figure 9. It can be seen that satisfaction levels for UK Power Networks customers fall short of the industry benchmark set by WPD South Wales and are lowest for LPN customers. A range of customer service initiatives are underway to improve information provided to customers, led by the Customer Services Directorate.

Figure 9 Spread of responses from customers surveyed regarding interruptions – May to November 2011



6.2 Customer complaints

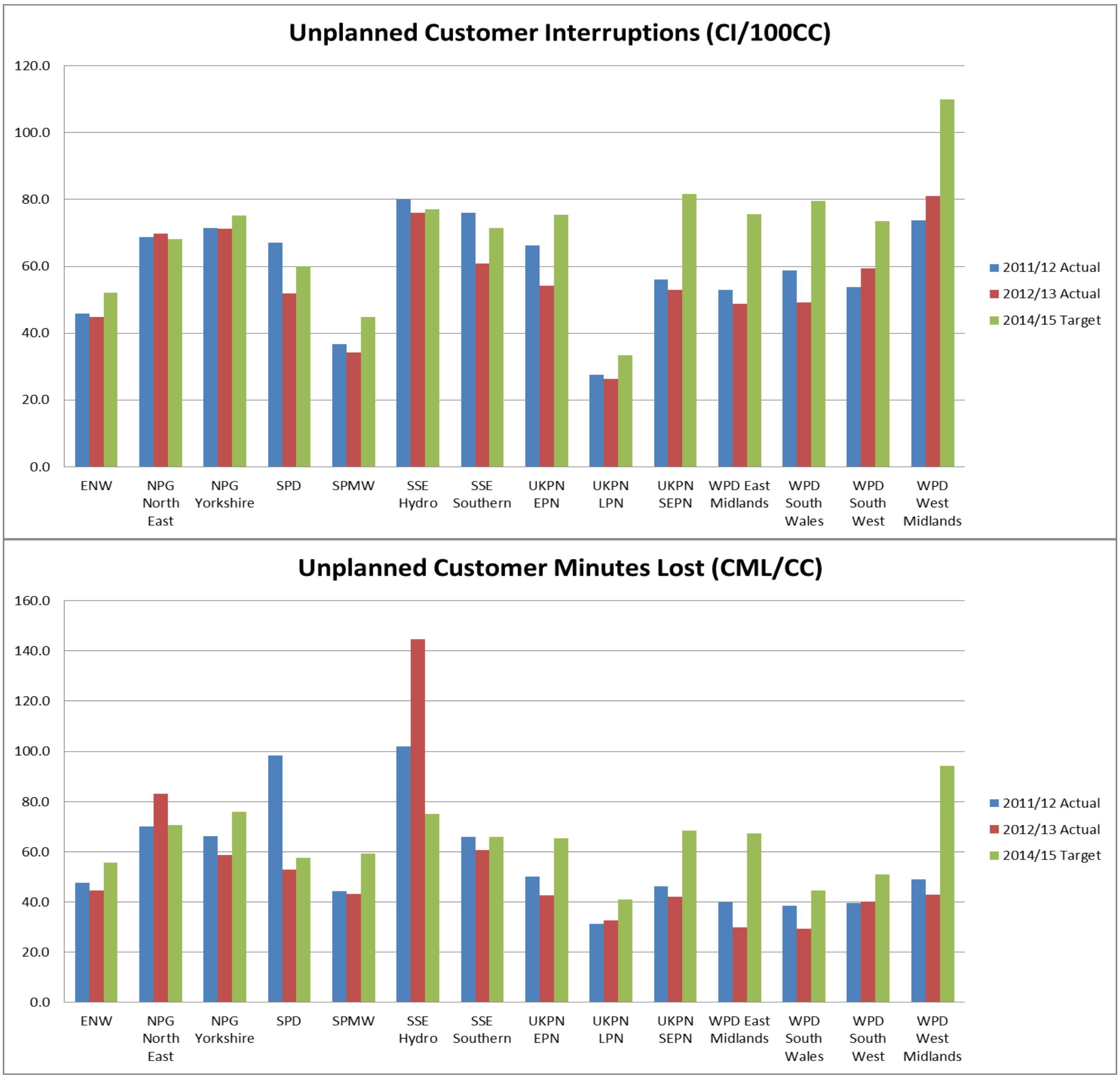
The experience of implementing action plans to eliminate over 18 hour restoration failures and to aim towards all customers being restored within 8 hours has shown a high correlation between customer complaints, affecting as they do a key reason of customer dissatisfaction – duration of power cuts

7 Overview of industry performance

7.1 2012/13 DNO performance

Figure 10 shows DNOs' performances in 2012/13 compared to their 2014/15 Ofgem targets. The data is taken from each DNOs IIS return.

Figure 10 2011/12 DNO performance compared to 2014/15 Ofgem target

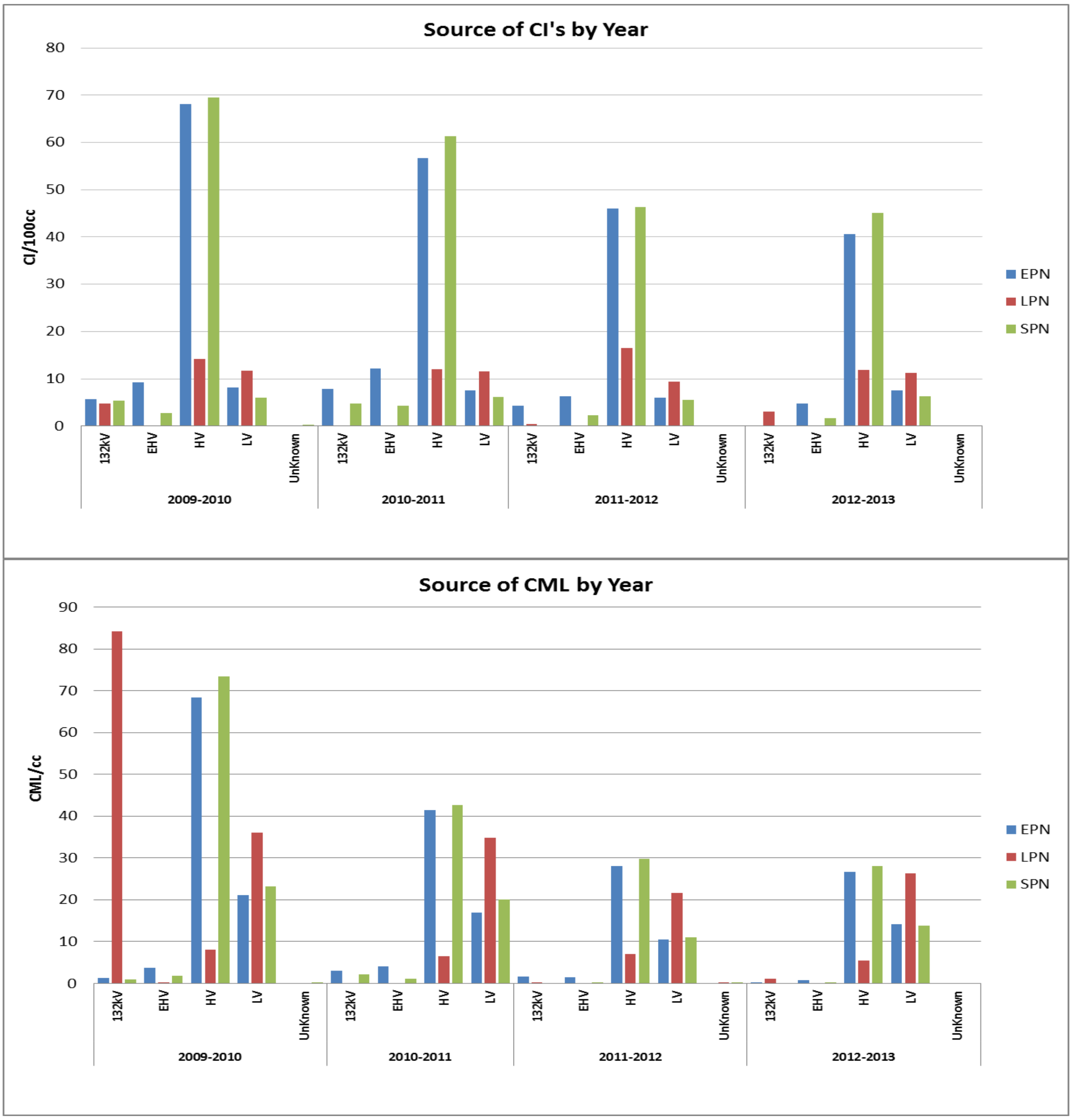


8 Analysis of UK Power Networks performance

8.1 CI and CML performance analysis by voltage

The charts, Figure 11, show the percentage splits of CIs and CMLs between the voltage levels by Region. This data was used to identify the required focus in each DNO in this strategy document.

Figure 11 Source of CIs and CMLs



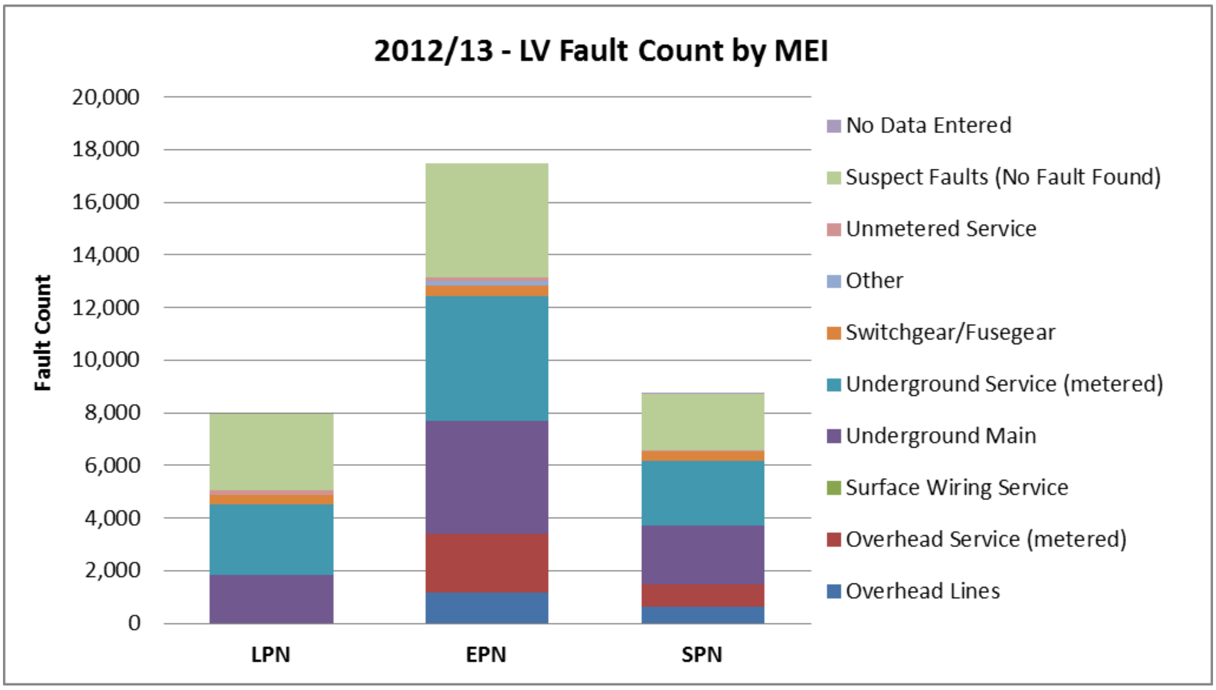
8.2 Fault volumes by voltage – all faults

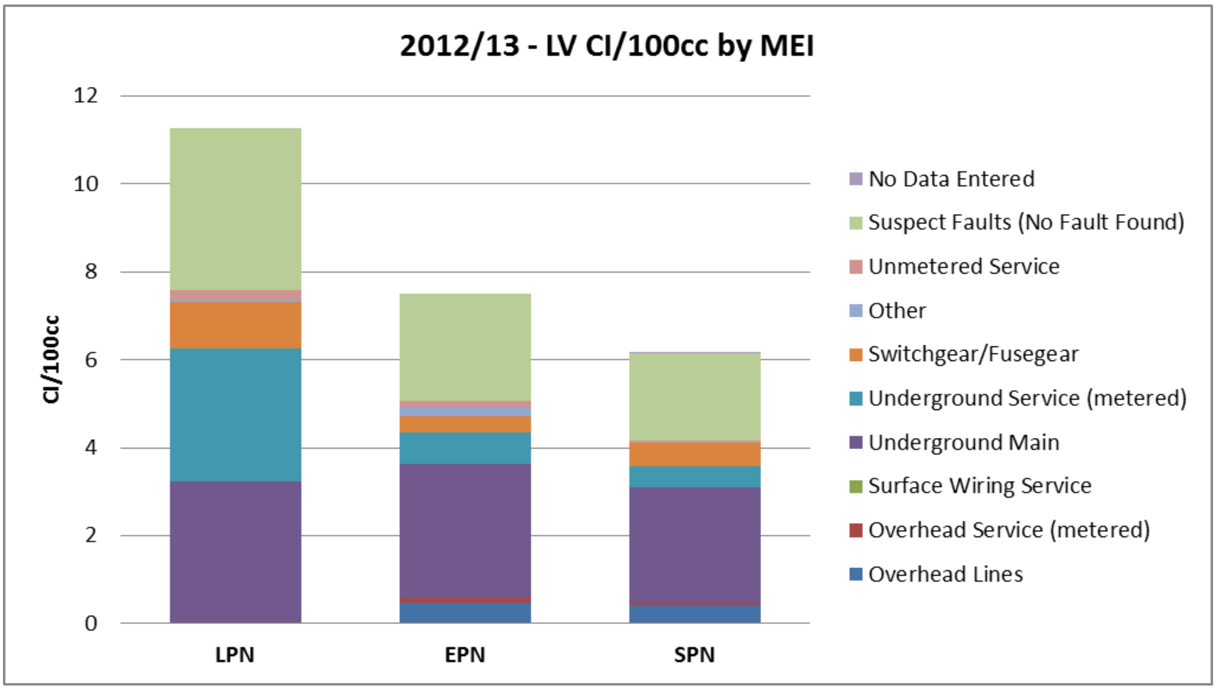
Fault volumes are described in detail including forecasts in the Asset Strategy Report for I&M, Faults and Trees. Trends are steady or improving, with the exception of LPN LV faults which are increasing.

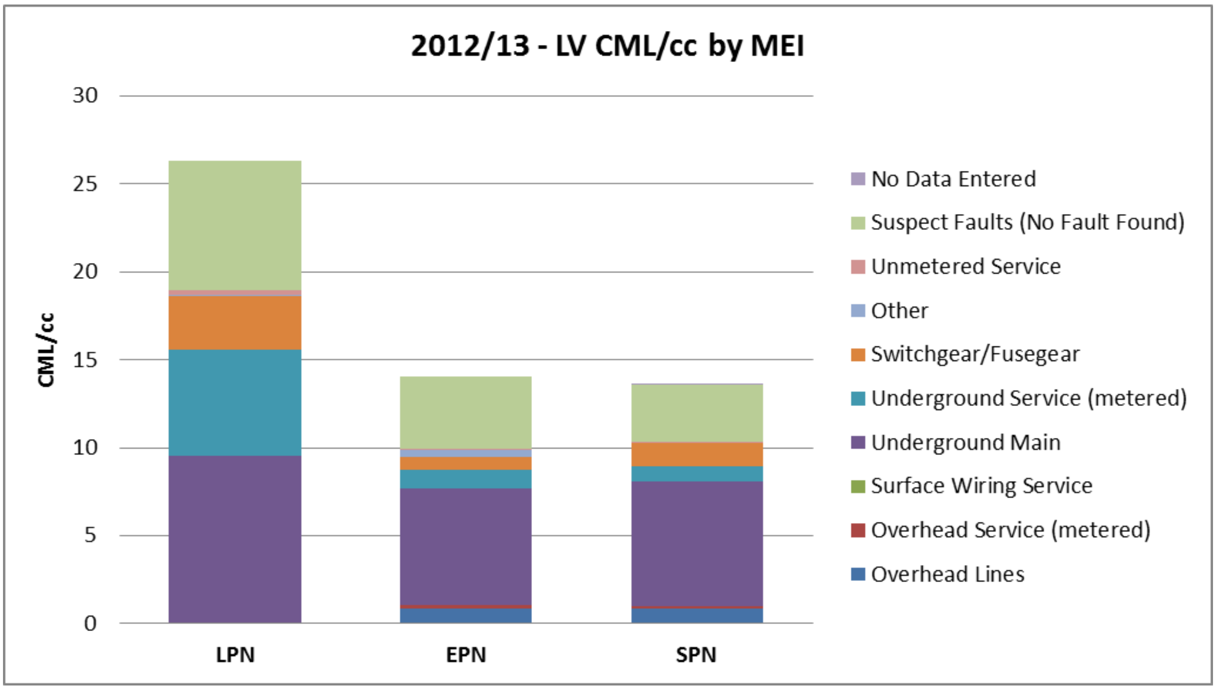
8.3 LV fault cause

The LV fault count, CI and CML performance for each network during 2012/13 are shown in Figure 12. With the exception of no fault found and if allowance is made for the relative size of the networks and the lack of overhead lines in LPN, the fault volumes are broadly proportional to network size. The LV mains fault rates are 6 LPN 9 EPN and 7 SPN faults/100km/year. For underground services the fault rate is 1.3 LPN, 1.5 EPN and 1.4 SPN per 1000 services/year. The CI/fault for LV underground mains faults is 38.4 LPN, 24.0 EPN and 24.0 SPN and for non-damage faults are 31.5 LPN, 19.7 EPN and 20.2 SPN. Also LPN has half the number of customers/link box and twice the number of link boxes/km as EPN and SPN.

Figure 12 LV faults by main equipment involved (2012/13)







There are three fault causes where LPN stands out:

1. Underground metered service faults

1. On average LPN interrupt 28.7 customers/underground service fault compared to 5.4 for EPN and 4.8 for SPN. This is due to differences in operational procedures where in London the main is made dead for an extended duration for service fault repairs and additional cables may be made dead where identification is uncertain in congested situations.

2. LV fusegear/switchgear faults

2. 90% of the resultant CIs in LPN is due to link box failures (239) whereas the numbers of link box failures and proportion of resulting CIs are much lower in EPN and SPN.

3. Non damage (suspect faults no fault found).

3. These may be self-sealing faults or overload fuse operations, both of which may lead to repetitive faults. Visibility of LV loads, completion of network GIS data and provision of adequate network modelling and analysis tools (particularly for interconnected networks) is necessary to enable networks nearing overload to be identified and pre-emptive reinforcement designed and implemented.

The following actions may be taken to address the three fault causes;

- Changes to the operational procedures for LV service fault repairs
  - Possibly including cutting main prior to making dead to limit customers interrupted
  - Better cable/phase identification technology and fault location
  - LV fault limiting device
- Enhanced link box replacement
  - Better link box inspection to identify defective units
  - Planning review of networks with defective boxes to look at optimising link box position to balance customers/section
  - Adequate provision for link box replacements in NAMP
- Further development and implementation of repeat fault procedure
- Reinforcement of overloaded LV networks (to avoid load fuse ops) – linked to central London improvements
  - Fixed or portable load monitoring
  - Better analysis tools
  - Temporary re-sectioning of networks if feasible to relieve overloaded sections (plus temporary reclosing devices)

8.3.1 LV repeat faults

Figure 13 shows the number of LV repeat faults i.e. customers experiencing more than three LV faults in one month and the CI and CML attributable to these repeats. This is an area that will be addressed as part of this strategy.

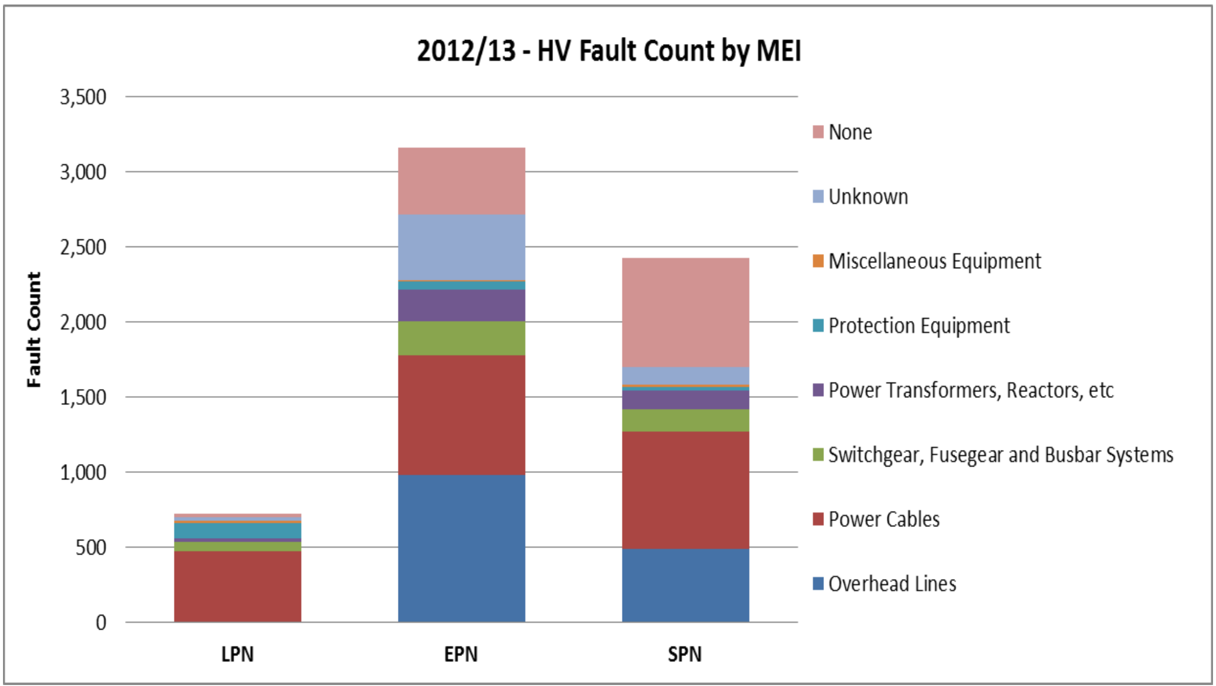
Figure 13 LV repeat faults

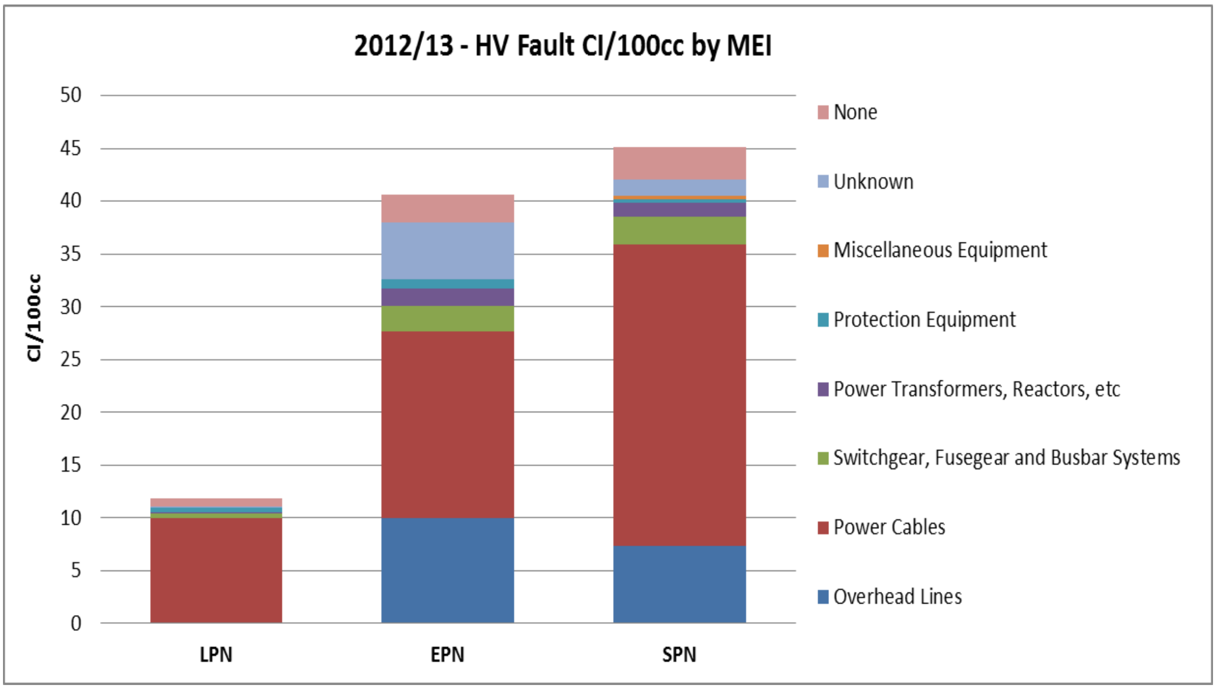
8.4 HV fault cause

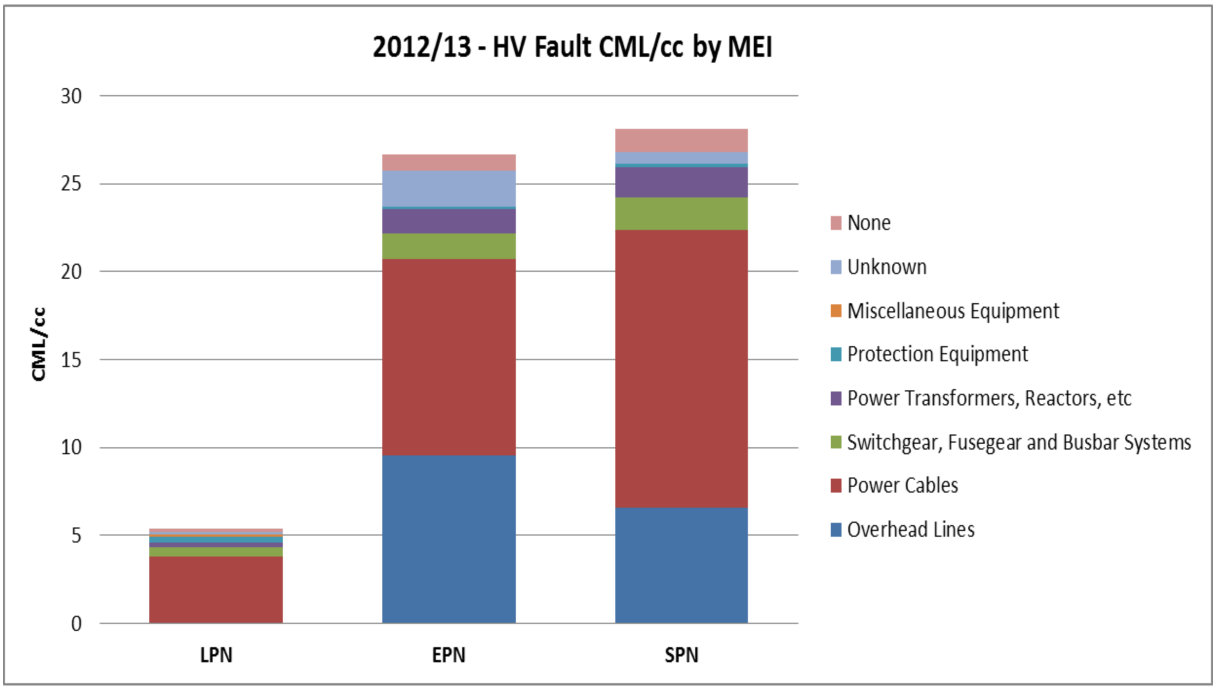
The HV fault count, CI and CML performance for each network during 2012/13 are shown in Figure 14. EPN has a high proportion of faults with unknown equipment involved, of which 82% have a recorded fault cause of no fault found. These are likely to be mainly transient overhead line faults.

The HV underground cable fault rates are 2.7 LPN 4.0 EPN and 6.2 SPN faults/100km/year. For overhead lines the fault rates, after adding in unknown for EPN, are 8.4 EPN and 17.5 SPN, faults/100km/year.

Figure 14 HV faults by main equipment involved (2012/13)

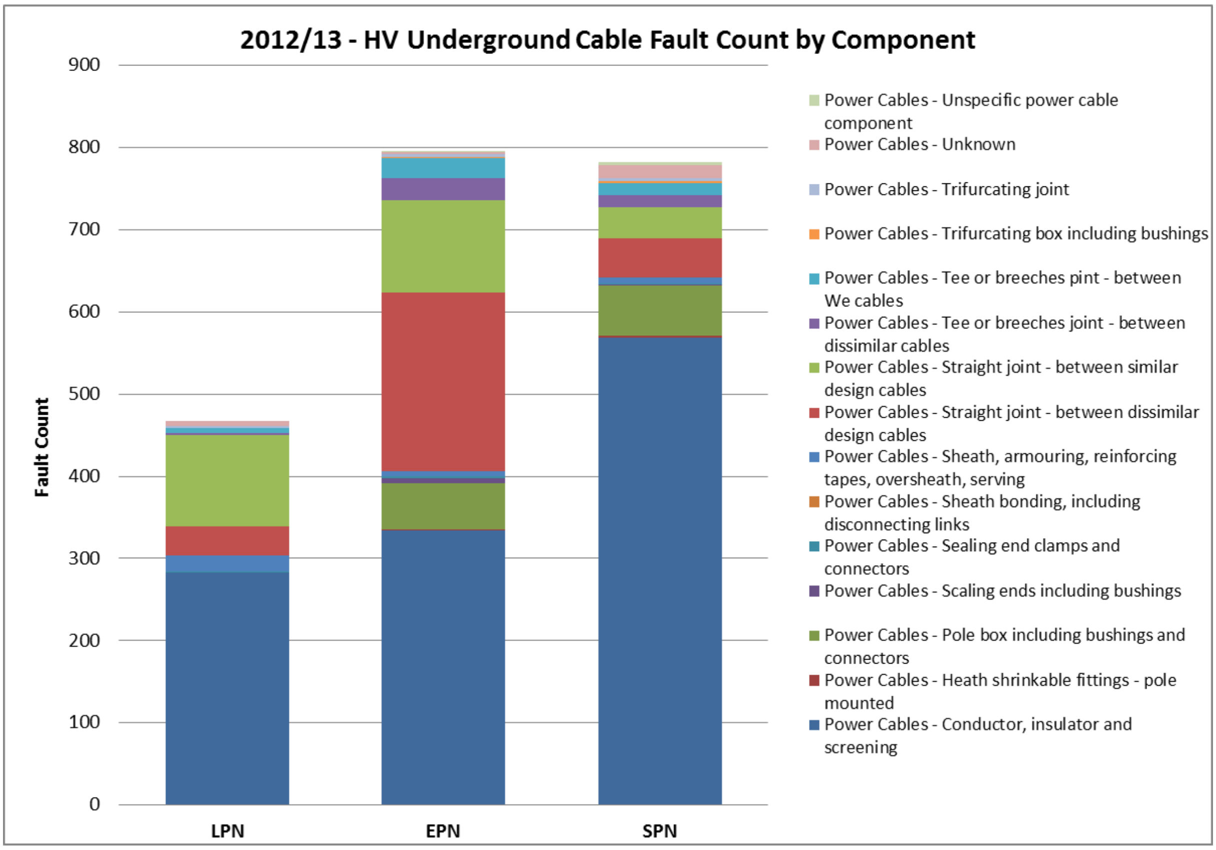


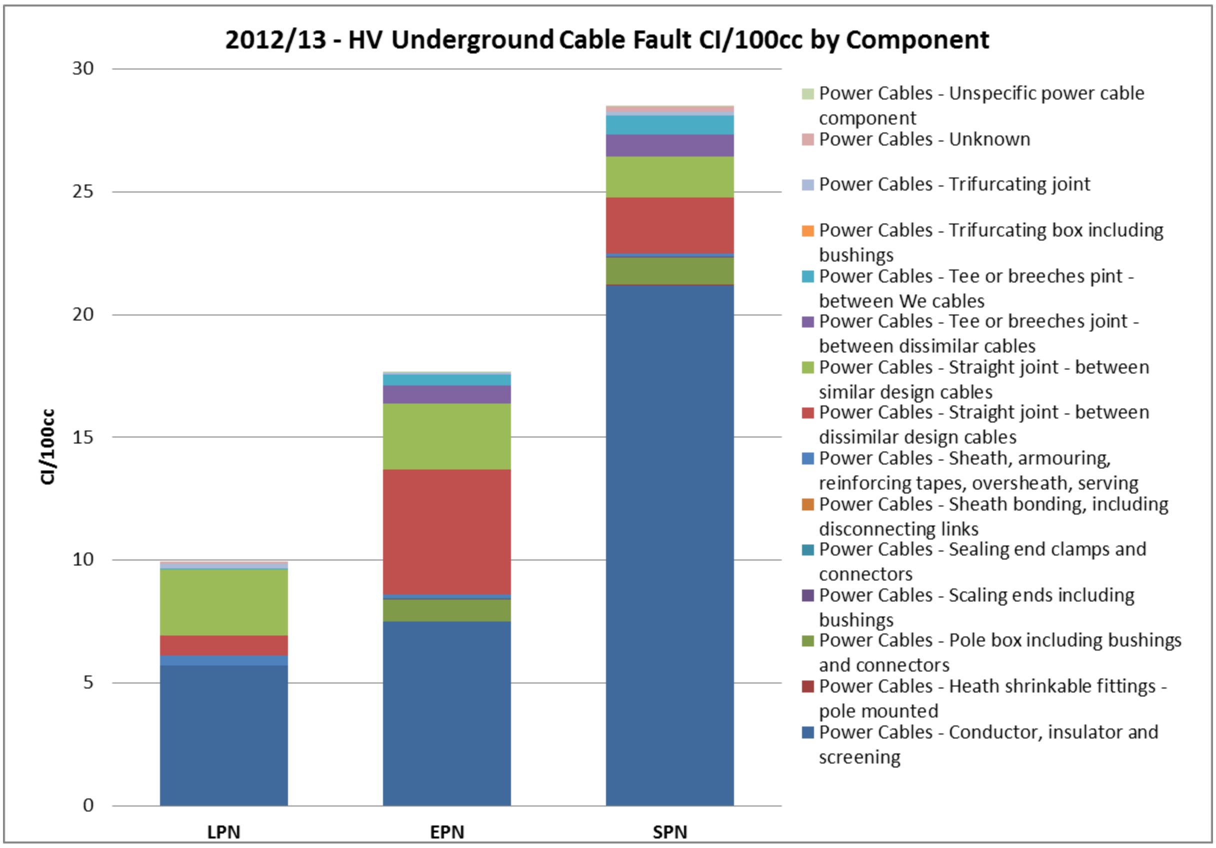




The higher OHL fault rate for SPN is thought to be due to the higher proportion of section and earthed poles, as well as tree density. Further work is necessary to validate and investigate. Underground cable faults are the principal cause of HV customer interruptions and customer minutes lost for all networks.

Figure 15 HV underground cable faults by main equipment involved (2012/13)



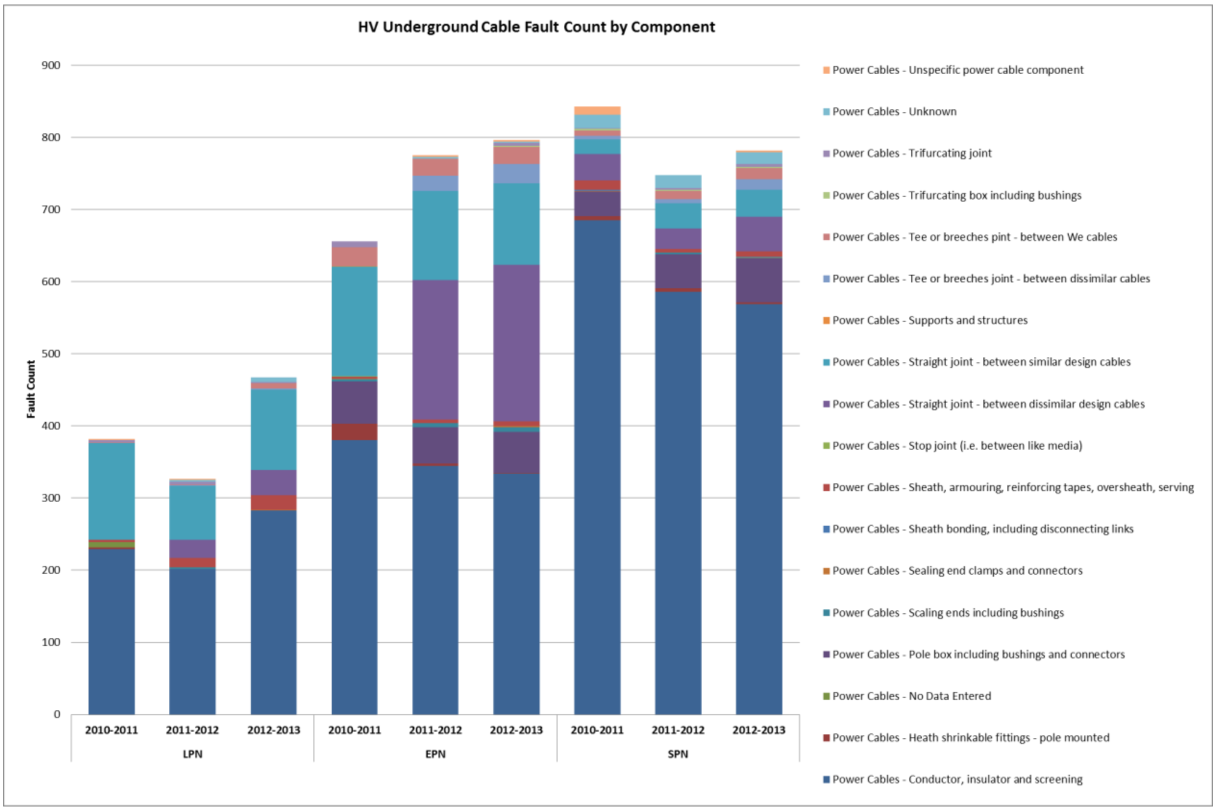


It can be seen that around half the fault volume and customer interruptions from HV underground cable faults are due to joint or termination failures in LPN and EPN, whereas in SPN the major cause is failure of the main cable conductor insulation or screening. Further investigation is required to understand the reason for the higher level of cable conductor or insulation failure in SPN, however it can be seen from Figure 16 that, allowing for reclassification of faults where no data has been entered, the number of failures although variable has remained at similar levels over the past 8 years. During 2011/12 a significant rise was recorded in the number of failures of transition joints between dissimilar cables, especially in EPN where they accounted for a quarter of HV underground faults. EPN would be likely to experience higher failures as the first adopter of polymeric cables, however if this trend continues the impact on CI and CML performance could be significant. Analysis and assessment of failures is hampered by inadequate records of joint type, age and location. Full vector capture of cable networks, including component details and work is required to manage this extensive asset base.

Suitable economic diagnostic methods are required to identify failing cable, joints and terminations. Online condition monitoring, developed under the IFI programme, can successfully be used to detect incipient failures but is restricted to a route length of a few hundred metres, so provides limited coverage for most circuits.

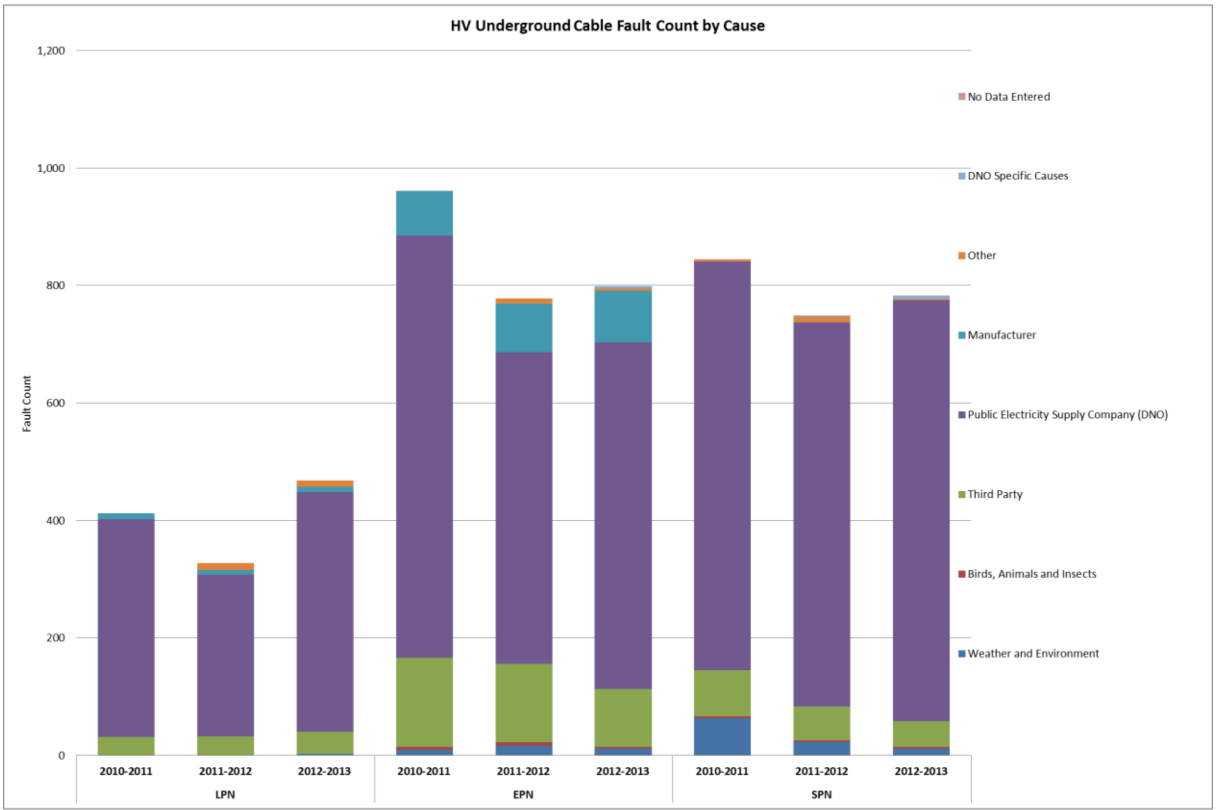
The information in Figure 16 should be used to develop and deliver work programmes to target replacement of unreliable cable sections, joints and terminations.

Figure 16 HV underground cable fault count by component



The proportion of faults caused by third party damage in EPN is 2-3 times that in SPN and LPN (see Figure 17). There would appear to be an opportunity to reduce third party damage in EPN through adoption of management practices in SPN and LPN.

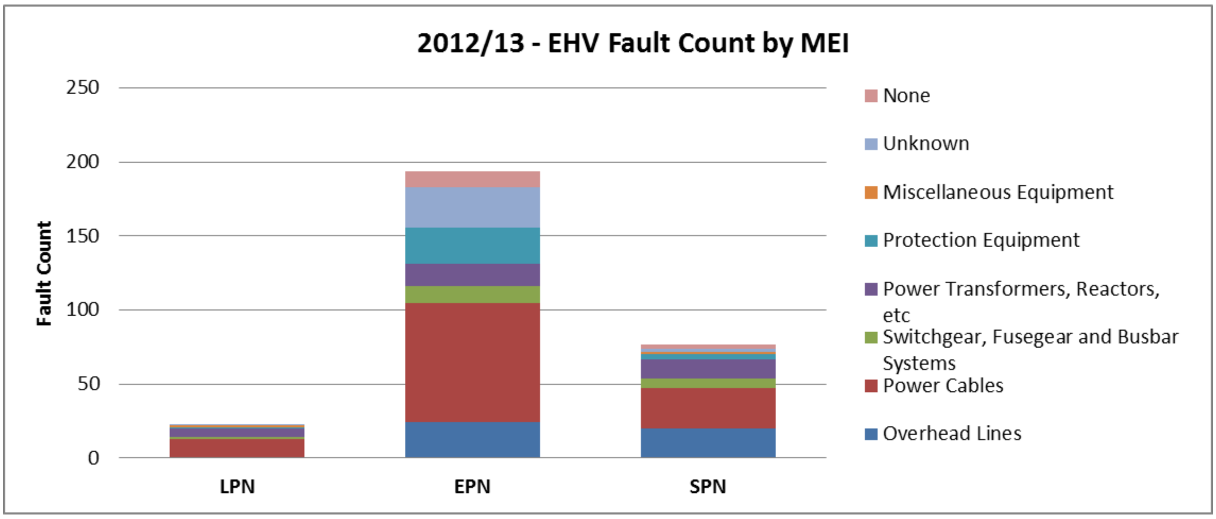
Figure 17 HV underground cable fault by cause

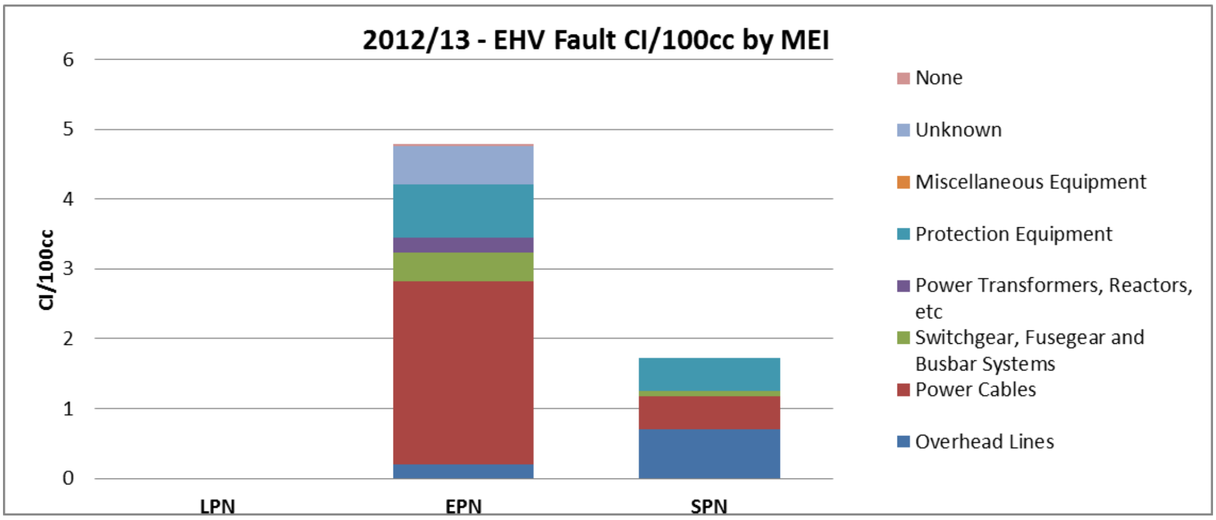


8.5 EHV fault cause

The EHV fault count, CI and CML performance for each network during 2012/13 are shown in Figure 18 and fault rates in Table 4.

Figure 18 EHV fault by main equipment involved 2012/13





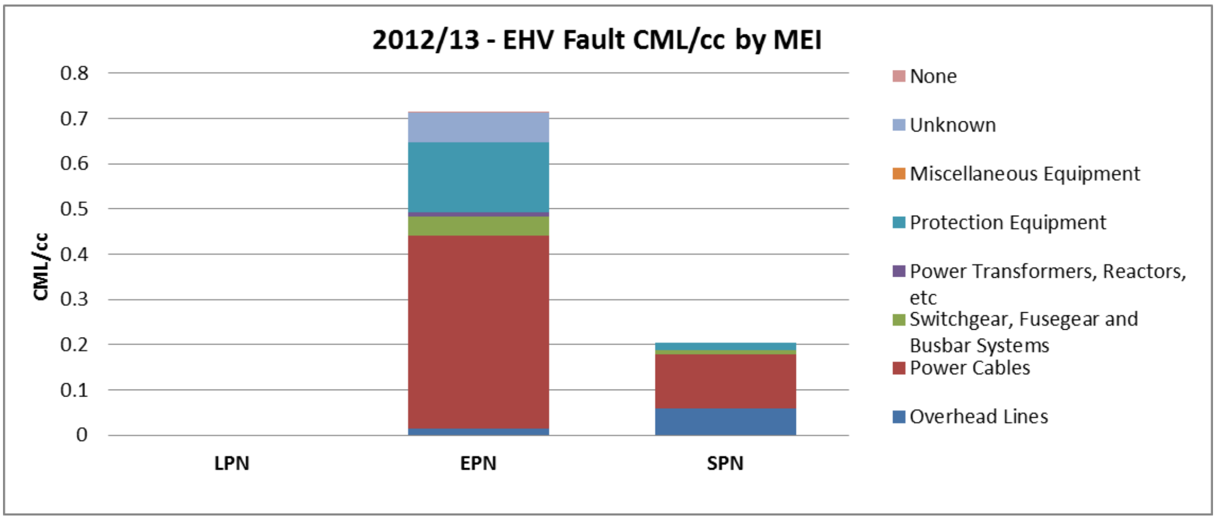


Table 4 EHV fault rates (2011/12)

	Overhead lines Per 100km	Underground cables Per 100km	Switchgear/fusegear/bus bars Per CB	Transformers Per transformer
LPN	-	1.0	0.7	1.3
EPN	1.9	2.7	1.8	1.7
SPN	3.3	1.5	1.0	3.8

EPN fault rates for underground cables and switchgear etc. are considerably higher than LPN and SPN, but have been reducing over time. EPN has the lowest proportion of fluid filled cables (EPN 27%, SPN 36%, LPN 50%), which may explain some of the difference in fault rate as damage to fluid filled cables may be detected by fluid loss and planned remedial action taken before a cable failure occurs.

The high fault rate for transformers in SPN is due to low oil level leading to Bucholz gas operation. The SPN OHL and unknown fault rate has increased over the last few years, mainly due to weather and environment causes which are likely to be linked to tree trimming effectiveness.

As the EHV network is generally designed to N-1 circuit security, a single circuit fault should not normally result in customer interruptions unless there is an outage for an associated circuit for planned work or repair, a switchgear fault affects a solid busbar, or protection mal-operates.

The average faults per circuit are 0.04 LPN, 0.15 EPN and 0.13 SPN per annum. Average customers per circuit are 3.9k LPN, 2.6k EPN and 2.8k SPN.

Around 40% of CIs and 45% CMLs from EHV faults in EPN are due to switchgear failures.

There are opportunities within EPN to reduce the customers affected by faults or restore them within 3 minutes by:

- Applying automation and remote control to 33kV ringed networks
- Replacement of hand reset tripping relays with self or remote resetting types
- Replacing or applying limited remote control facilities to primary switchboards circuit breakers that have no existing remote control

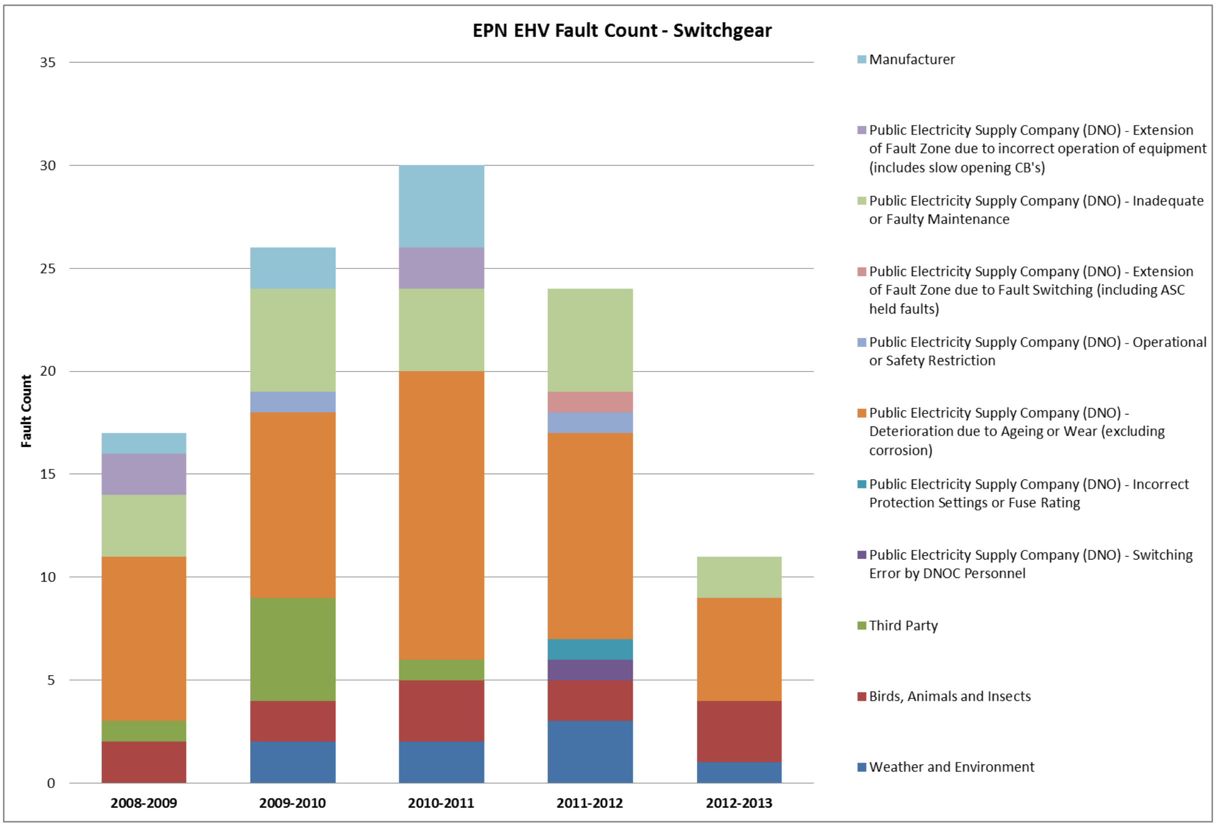
The risk of interruptions can be reduced by maximising the availability of the network by:

- Limiting unplanned outages by quicker fault repairs
- Reducing the frequency and duration of planned outages by changes to project design and construction and maintenance working practices
- Ensuring equipment, including protection, is correctly designed and adequately maintained and commissioned

8.5.1 EPN EHV switchgear faults

Figure 19 shows the switchgear faults broken down by cause. Birds, animals and the environment account for around 20% of faults. Replacing outdoor open terminal equipment with metal enclosed indoor equipment could eliminate these faults (this would need to be identified as part of condition based asset replacement) and in the interim applying vermin guards etc. or insulation to existing external equipment would reduce their likelihood. A further 20% of failures are due to incorrect or inadequate maintenance.

Figure 19 EPN EHV switchgear, fusegear and busbar fault count by cause

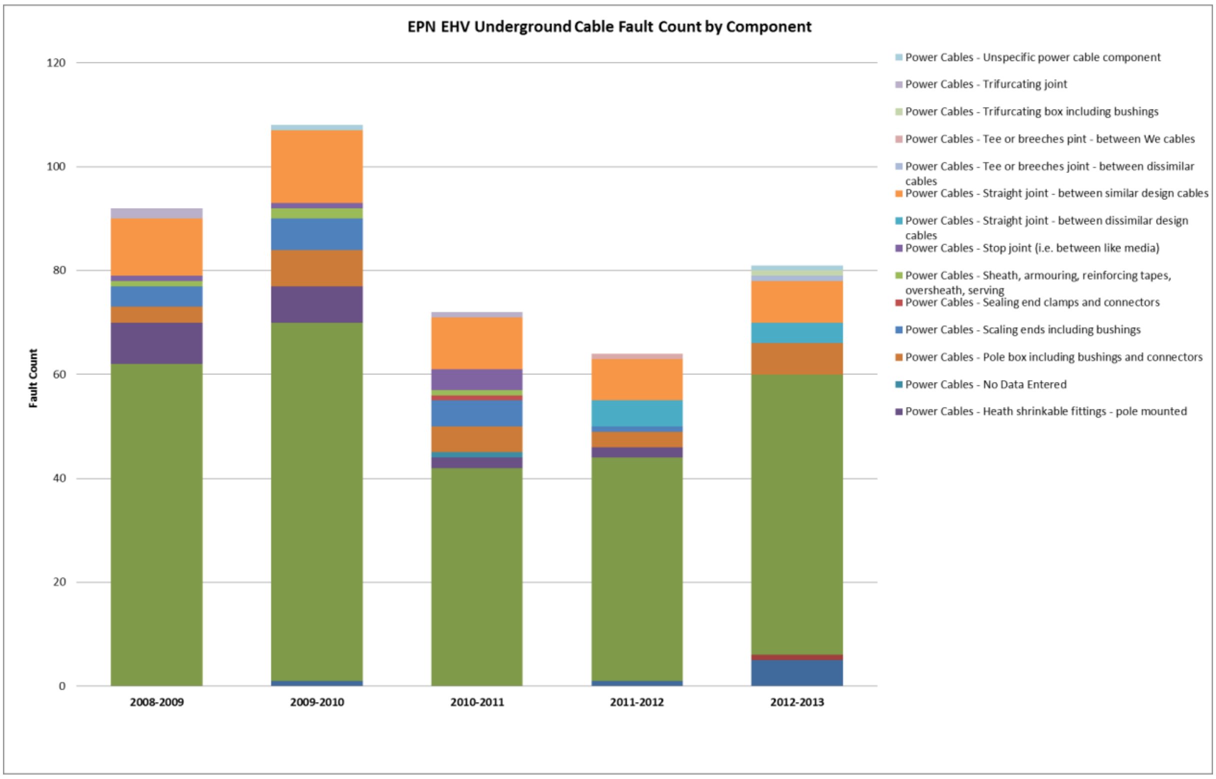


In most years there have been incidents due to incorrect operation of equipment (e.g. stuck/slow circuit breakers and mal operation or incorrect setting of protection). Completion of the protection integrity programme and further improvements in maintenance practice and achievement should minimise failures from this cause.

8.5.2 EPN EHV underground cable faults

Figure 20 shows the EPN EHV underground cable faults by component involved with a reducing trend. Reductions are mainly due to lower failures due to insulation/conductor/screening and oil stop joints. Further investigation is necessary to understand the underlying reasons for these changes.

Figure 20 EPN EHV Underground Cable Faults by Component



8.5.3 SPN EHV OHL and unknown faults

Figure 21 SPN EHV OHL Faults

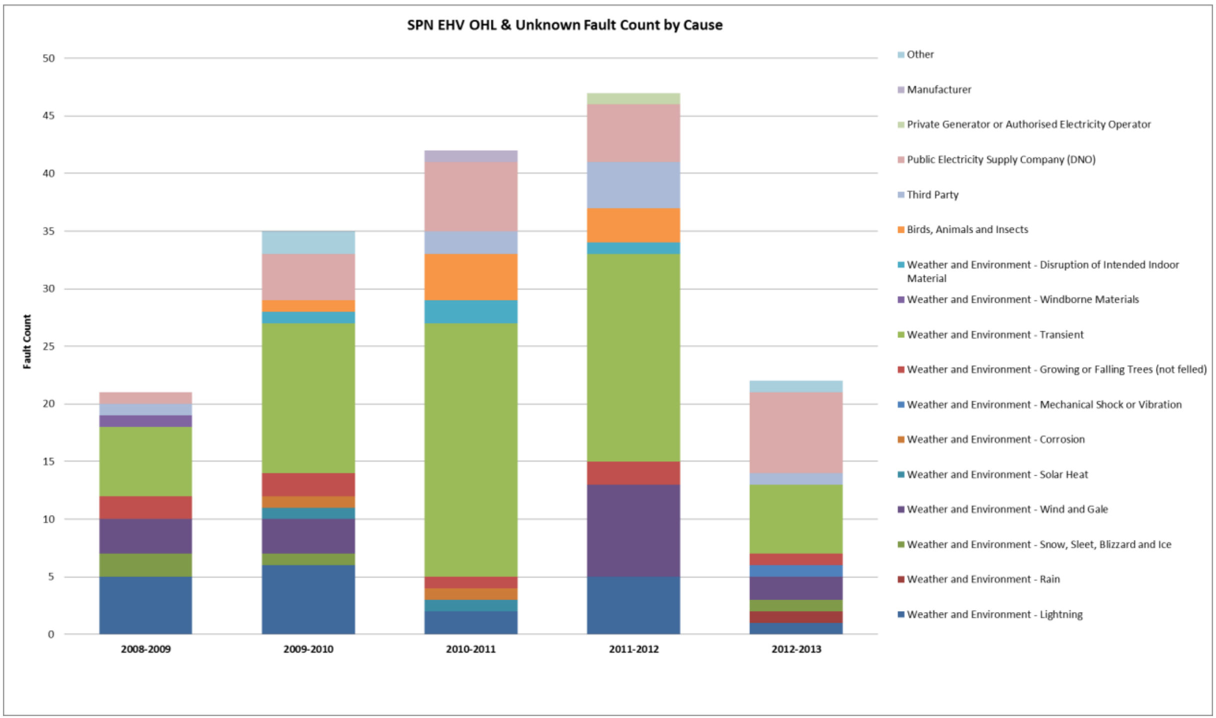
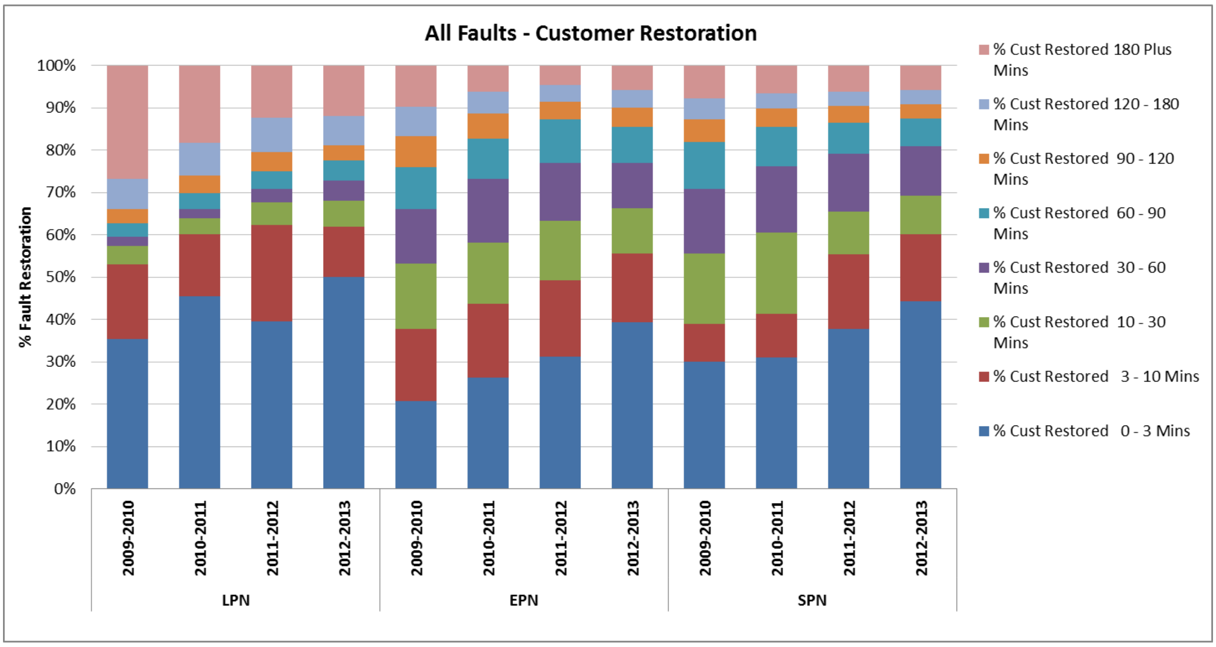


Figure 21 shows the increase in EHV overhead line and unknown faults by cause. Fault volumes have nearly doubled, with the principal causes being transient faults and wind and gale. The underlying cause is likely to be inadequate tree trimming.

8.6 Restoration duration

Speed of restoration from whatever voltage or fault cause is a priority for customers. In the percentage of customers restored after fault by time band is shown. Around 39% of customers interrupted in LPN and SPN and 31% in EPN are restored within 3 minutes due to automation or rapid remote control intervention. Due to differences in field response and repair, particularly of LV faults, at 1 hour 30% of LPN interrupted customers, 23% of EPN interrupted customers and 21% of SPN interrupted customers remain off supply. At 3 hours these figures are 12% LPN, 5% EPN and 6% SPN.

Figure 22 Customer fault restoration by time band – all voltages



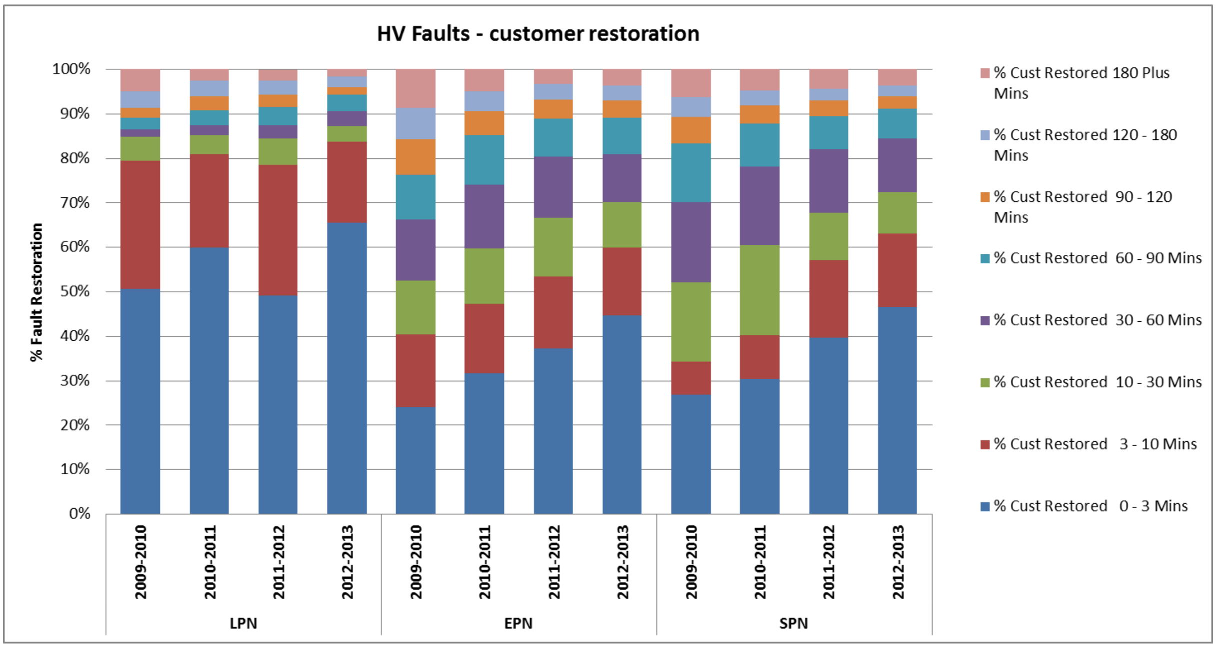
However, if we consider just the customers off longer than 3 minutes who count as a customer interruption and will have experienced a sustained interruption, 49% of these in LPN were off for over 1 hour during 2011/12 compared to 33% in EPN and SPN. At 3 hours 20% of LPN customers were still off compared to 7% in EPN and 10% in SPN. This may in part explain the low level of customer satisfaction recorded for LPN in Ofgem surveys.

A conundrum is that as increased automation restores a higher proportion of total customers in under 3 minutes, the proportion of remaining customers experiencing longer durations may increase. Therefore, if just customers experiencing sustained faults are surveyed their satisfaction may reduce whilst the satisfaction of the overall population will increase.

8.6.1 HV restoration

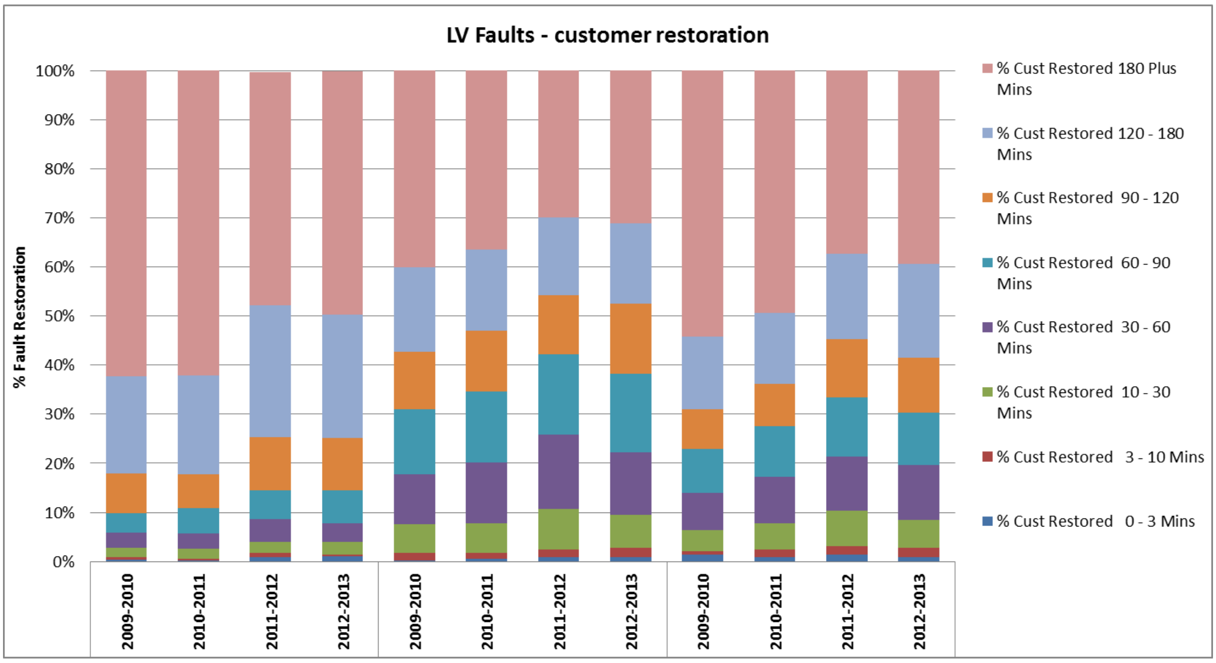
The impact of investments in automation and remote control can be seen (see Figure 23) in the increases in customers restored within the 0-3 minutes and 3-10 minutes time bands. LPN automation and remote control performance in 2011/12 has fallen back slightly due to problems associated with the network management system migration to PowerOn and holes in the network caused by unrepaired cable faults, coupled to high network loading, producing low availability of automation schemes in January and February 2012 and increases in customers affected

Figure 23 Customer fault restoration by time band – HV



8.6.2 LV restoration

Figure 24 Customer fault restoration by time band – LV



Whilst there have been improvements in speed of LV restoration (see Figure 24) the performance of SPN lags behind EPN and the performance in LPN is poor. Some benefits have accrued in LPN from the introduction of the DST (Distribution Supply Technicians) model in November 2011, and further improvements will result once the DSTs have been authorised to operate on the LV network.

8.7 Planned interruptions

Over the last year there has been a sharp increase in the number and duration of planned interruptions in EPN and LPN due to increased activity on defect reduction programmes, including link box replacements and trimming tree encroached overhead line spans. This is expected to improve towards the end of DPCR5 and should be more closely monitored during ED1 by identifying potential CI & CML impact of major and generic work programmes.

Table 5 Planned interruptions

DNO	Year	Count	CML Per CC	CI Per 100	CMLs Per CI
EPN	2009-2010	6231.00	6.50	18.83	289.86
	2010-2011	5882.00	5.89	15.01	254.89
	2011-2012	5420.00	5.26	15.11	287.05
	2012-2013	5796.00	5.02	14.24	283.68
LPN	2009-2010	834.00	1.24	2.74	220.15
	2010-2011	919.00	1.50	2.76	183.27
	2011-2012	1181.00	1.79	3.67	204.63
	2012-2013	875.00	1.44	2.71	188.45
SPN	2009-2010	3137.00	7.06	19.40	274.92
	2010-2011	3211.00	5.35	14.58	272.51
	2011-2012	2169.00	4.27	10.65	249.22
	2012-2013	2294.00	3.90	9.81	251.60

8.8 Key areas for improvement

8.8.1 EPN

In EPN, the majority of the fault count is at LV however these faults are of significantly lower impact in terms of CIs than EHV and HV. The main sources of CMLs are the HV and LV networks.

The primary focus in EPN is to reduce the CIs and CMLs occurring on the HV network whilst addressing the CIs on the EHV network and the CMLs on the LV network.

8.8.2 LPN

In LPN, the majority of the fault count is at LV, which account for the majority of the CMLs. The low numbers of CIs in LPN mean that the percentage split is not indicative of potential savings.

The primary focus in LPN is to reduce the CMLs occurring on the LV network whilst addressing the CIs on the HV network (Algorithmic Automation). CI reduction on the LV network will be considered a future initiative following trials of LV Automation.

8.8.3 SPN

In SPN, the majority of the fault count is at LV however these faults are of significantly lower impact in terms of CIs & CMLs than HV.

The primary focus in SPN is to reduce the CIs and CMLs occurring on the HV network whilst addressing the CMLs on the LV network.

9 Continuity of supply improvement strategy

9.1 Aims

The scope for major reliability improvement programmes following the step changes to be achieved during DPCR5 will be limited during ED1. Increased incentives rates may provide future business cases for discrete schemes however as the numbers of CIs and CMLs continue to decrease the potential benefit is diminishing.

Continuity of supply improvements should therefore be achieved by articulating the benefits to continuity of supply performance from the Network Asset Management Plan programmes and improvements to business operations and leveraging these to optimise these benefits. The Continuity of Supply Improvement Strategy aims to:

- Optimise NAMP programmes to improve network reliability
- Optimise the delivery of work programmes and projects to mitigate network risk
- Optimise operational response to restore supplies and repair the network through improved organisation and deployment of resources
- Improve asset information and processes to support the above

The actions necessary to achieve these aims are outlined below.

It should be noted that specific programmes targeting continuity of supply should be assessed individually against potential IIS savings/reward. It is not intended that the ED1 settlement should include allowance for continuity of supply related activities.

9.2 UKPNs Indicative ED1 IIS targets

Table 6 below summarises our actual performance over the current period (2010/11 and 2011/12) and our business target performance for the RIIO-ED1 period which commit us to deliver further improvements in relation to CIs and CMLs.

Table 6 Unplanned interruptions performance - current period performance and RIIO-ED1 targets

DNO	CI and CML's	DPCR5 average performance	UKPN forecast 2015-23 average performance	% reduction from DPCR5 average	UKPN forecast 2023 target performance
EPN	CIs	61.2	52.1	15%	51.1
	CMLs	44.8	36.5	19%	35.2
LPN	CIs	24.6	22.7	7%	22.5
	CMLs	32.9	30.3	8%	29.6
SPN	CIs	56.5	49.7	12%	49.0
	CMLs	44.2	35.9	19%	34.9

9.3 Indicative Ofgem ED1 IIS targets

As outlined in the Ofgem paper titled 'Strategy decision for the RIIO-ED1 electricity distribution price control Reliability and safety' published on 4th March 2013, the indicative IIS targets for ED1 are in Table 7below:

Table 7 ED1 IIS targets

ED1 Targets	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	
CI	EPN	70.6	69.6	69.2	68.9	68.5	68.2	67.9	67.5
	LPN	28.7	28.5	28.4	28.3	28.1	28	27.8	27.7
	SPN	68.9	67.8	66.8	65.8	65.5	65.2	64.8	64.5
CML	EPN	51.9	50.8	49.7	48.6	47.5	46.5	45.5	44.5
	LPN	40.5	39.9	39.3	38.7	38.2	37.6	37	36.5
	SPN	51	49.8	48.7	47.6	46.6	45.5	44.6	43.6

9.4 Asset information and process improvements

This section details areas where improvements in systems and processes will have a positive impact on Continuity of Supply. Savings in CIs and CMLs will result from efficiencies in work activities due to easy provision of data, interlinking of systems and development of best practice processes. Whilst these CI and CML improvements will be noticeable, it is inappropriate to quantify them at this stage.

9.4.1 Investment optimisation

The investment optimisation process shall be developed to quantify the CI and CML performance of networks, localities and asset populations with and without investment. This means that the unplanned CI and CML benefit from each work programme shall be assessed. The cost benefit of each programme can thus be assessed and the portfolio shaped to optimise the cost of risk management and performance. Models will need to be developed at asset and system level to enable fault rates to be estimated and CI and CML derived. At system level this could be by adding functionality to ENMAC/PowerOn to run models against the actual networks, or a simplified discrete module populated from Enmac, Ellipse and Netmap.

Also the impact of planned outages necessary to undertake the work programmes on both planned CI and CML (e.g. through customer shutdowns) and unplanned CI and CML (e.g. where a coincident fault results in a loss of supply that would not have occurred under normal running (N-1) or higher number of customers affected and delayed restoration due to abnormal running) should be calculated and projects and programmes designed to achieve an efficient balance between mitigation costs and CI/CML costs.

9.4.2 Network management and control system

During 2012 and 2013 it is planned to upgrade all networks to GE PowerOn version 5.4, which includes the provision of algorithmic automation through the APRS functionality. Algorithmic automation is planned for final rollout in Q2/Q3 2015. This intelligent automation system will target a decrease in HV related CIs and is described in more detail in Appendix A.3.

Following completion of the full GIS vector capture, network connectivity for PowerOn should be sourced via an interface from GIS to provide a single source of truth. This interface would also allow geographic display of traced circuits, analysis of network performance (including clustering) and network modelling. It would also improve the accuracy of the algorithmic automation system by allowing dynamic calculation of overload following network reconfiguration,

Load management functionality should be developed to enable dynamic network re-configuration of the HV and EHV networks to float load across the HV network interconnecting primary substations to optimise reliability, capacity and voltage profile.

The use of ENMAC mobile as part of an integrated field access solution should be considered.

Processes should be developed to analyse network performance data to identify latent or incipient faults and prioritise and implement mitigation.

9.4.3 Smart metering

The roll-out of smart meters will provide network data that has not been previously available. This data must be properly collected and processed via an automated process to provide insight of the LV network operation, which the DNOs do not currently have visibility of. Provision of this data will highlight constrained areas of the network requiring reinforcement or reconfiguration, areas of the network experience voltage fluctuations due to domestic generation or early identification of LV faults allowing faster response reducing customer complaints. This will also demonstrate key areas for deployment of smart technologies for voltage and/or load management.

The introduction of last gasp technology will not only allow UKPN to respond more quickly to faults but will also allow identification of true LV faults against customer no supply calls. Currently, faults on customers' premises may require UK Power Networks staff to attend site unnecessarily following a no supply call. Smart meters will allow integrity checking of the DNO supply providing efficiency savings in deployment of staff. CitiPower in Melbourne, Australia have noticed a 30% increase in productivity following the rollout of over 600,000 smart meters.

9.4.4 SCADA and communications improvements

The overall requirements for field communications, fixed site non-operational voice and data, protection signalling, SCADA, and Smart Grid developments should be reviewed and an overall communications architecture and development roadmap evolved.

The initial target should be to provide more resilient communications for secondary control systems. This will result in improved operation of automation systems, which currently incur, on average, 4 failures per month due to communication links (5 in EPN, 2 in LPN and 4 in SPN). This equates to an estimated figure of approximately 0.13 CI per DNO, which isn't sufficient to warrant an investment case but is a useful secondary benefit.

New RTU designs should where economic be future proofed to facilitate SMART Grid development and a replacement programme established.

Refer to the UK Power Networks RTU, SCADA investment justification documents for more information.

9.4.5 Fault reporting data

Further controls should be introduced to ensure that fault data is accurately and consistently reported in full across all networks. This should include exception reporting on mandatory fields to ensure that erroneous data is not entered and monthly reconciliation of missing data/blank fields. There are currently differences in practice across the three DNOs and following merger of the control centres, step should be taken to ensure a common, consistent approach.

Tools to report on this data such as Qlikview shall be employed to improve visibility of fault data across the business and to ensure reporting consistency. Trials for this are already underway.

9.4.6 Geographic Information System

The vectorisation of Netmap for EPN and LPN has begun and is due to complete in 2016. This also includes rationalisation of software versions and a refresh of SPN data.

An improved GIS system will enable work on and performance of underground cable assets to be managed, networks to be modelled and network utilisation, design, reinforcement and extension optimised. Geospatial presentation of data from other systems should be developed to enable better planning of interventions and organisation of work (e.g. due to environmental modelling, identification of "hot spots" and packaging and dispatch of work).

Coupled with improved fault reporting data, clusters of fault could be marked on geographic plans to identify hotspots of deteriorating network for targeted investment.

9.4.7 Planning and design tools

Whilst a modern modelling tool (Digsilent) has been implemented for the EHV and 132kV networks, a range of legacy tools are used to analyse the HV and LV networks. These tools are not linked directly to the base network data and topology, requiring separate network models to be built and maintained. Extensive planning effort is required to analyse congested networks and the LPN interconnected networks in particular. This constrains ability to manage network design and loading and assess new connections within regulated timescales. Modern HV and LV planning tools linked to Netmap and PowerOn shall be implemented as part of the Business Transformation project to address these issues and provide capability to deal with the changing load flows that result from the low carbon transition. Provision of these tools is a pre-requisite for redevelopment of the central London networks.

9.4.8 Work planning and scheduling

Opportunities exist to improve labour productivity and reduce operational response times to restore or repair by both medium term resource planning and short term scheduling of internal and external crews. This could be achieved by implementing revised processes utilising existing SAP functionality (included as part of the Business Transformation Project)

9.4.9 Field access

Provision should be made for full two way communication of information including access to network information, management of work, logistics and HR functions. This should include knowledge based assistants and the capability to communicate images and measurements in real time.

9.5 LV network improvements

9.5.1 LV monitoring, remote control and automation

LV automation is being developed and trialled during DPCR5, however the costs of equipment are currently too high to justify wide scale implementation. Many of the benefits considered for LV automation are dependent on the ability to transfer load between feeders if a feeder becomes overloaded. However, there is likely to be limited opportunity to do this in highly loaded networks as other feeders may have little or no headroom.

Initially it is recommended that a mix of fixed and portable network monitoring be introduced to measure LV feeder loading at distribution substations. This, together with smart metering data and new modelling tools, would enable overloaded feeders to be identified and networks reconfigured, smart solutions applied or networks reinforced as necessary, preventing overload fuse operations and interconnected network sit downs.

Remote control facilities should be provided to all LV ACBs and Parasitic Load Tripping Units (PLTUs) on interconnected networks that are to be retained within Central London High Density Load Zone. This will entail replacement of many older ACBs as they are unlikely to be suitable for conversion to remote operation. Providing these facilities will enable rapid restoration of supply to blocks and large customers once HV supplies have been restored following an HV fault, avoiding network sit down and site attendance to reclose ACBs and restore PLTU connected customers.

An initial trial of LV automation will be implemented during DPCR5 (July 2013). This trial involves the rollout of fault sensing circuit breakers to 14 sites and installation of remote switching points in link boxes. The learning from this trial should be used to continue the development of LV Automation and a business case built against proposed CI and CML improvements for further rollout.

There are a few unquantifiable benefits of the LV automation system including: visibility of the network, active load management, reduction in load related outages and the ability to defer reinforcement by managing the network more closely. There is also a strong safety case behind the fault sensing circuit breakers, which will not close onto a fault. These benefits will form part of the business case following the learning from the trial.

9.5.2 LV network reinforcement

Better visibility of the LV network through load monitoring at distribution substations and analysis of Smart Meter data, as well as new efficient modelling tools, will enable pre-emptive reconfiguration and reinforcement of LV networks or identification of areas for trials of new smart solutions. Proven smart solutions shall be implemented on a wider scale.

Options for reinforcing the Central London High Density Load Zone are being considered and are detailed in the Central London Plan documentation. The main focus of the Central London Plan is to release capacity and reduce fault level whilst maintaining the current levels of continuity of supply afforded by the interconnected LV network.

9.5.3 LV asset condition

Tree related faults will be minimised through the tree cutting programmes in SPN and EPN and overall OHL fault rates maintained by maintenance and ABC refurbishment programmes.

Overall underground damage fault rates will be managed by on-going programmes to replace unreliable cable sections and poor condition link boxes. Improved diagnostic techniques should be developed to quantify condition and identify incipient failures of link boxes initially, but also cables and joints.

9.5.4 Operational response

During DPCR5 CIs on the LV system are being reduced by minimising the number of repeat faults (i.e. non damage faults with no determined cause that subsequently fault in the days following re-energisation of a circuit) and clearing the backlog of fault repairs. Fault restoration times have been reduced by effective use of fault location techniques, improvements in the end to end process and rigorous analysis of long duration incidents. The Distribution Supply Technician module was introduced in LPN. This focus will continue in ED1.

Enhancements to systems and field access, continuous improvement initiatives and changes to LPN operational practice for fault repairs will reduce the customers affected by faults and restoration times.

Rollout of LV inversion generation during DPCR5 will further improve LV restoration times by removing the requirement for multiple generator connections.

9.6 HV network improvements

9.6.1 HV monitoring, remote control and automation

During DPCR5 the density of remote control on the EPN and SPN networks is being increased to achieve a remote switching point every 350 – 400 customers and automation systems maximised on all networks through optimisation of automation scripts. This will be superseded in ED1 by the activation of algorithmic automation, which, coupled with the increased level of remote control, will minimise the number of customers affected for more than three minutes on every fault by automatically restoring the maximum possible number of customers. Also, quicker repair of HV faults and management of remote control defects will continue to increase the efficiency of automation and reduce customers affected by a fault.

There is a potential for substantial CI and CML savings following the rollout of algorithmic automation however, the system is currently under development and detailed trials have not been completed to provide accurate forecast improvements. A conservative estimate of CI and CML savings from the rollout of algorithmic automation in shown in Table 8 below:

Table 8 Algorithmic Automation Benefits

DNO	CI	CML
EPN	1.00	0.20
LPN	0.80	0.14
SPN	1.50	0.50

During ED1 no specific programmes are proposed to add remote control points but there will be organic enhancement of automation performance through new connections and planned reinforcement and replacement programmes as all switchgear for new and replacement purposes will be provided with remote control facilities.

9.6.2 HV network reinforcement

Adequate transfer capacity is required to enable automation schemes to operate. Headroom is also necessary to facilitate new connections. The provision of new modelling tools and monitoring of network loadings via PowerOn/ENMAC should be used to identify network loading issues and undertake targeted timely reinforcement. This will improve both the effectiveness of automation and speed of manual restoration through the availability of adequate switched alternative supplies.

Options for reinforcing the Central London High Density Load Zone are being considered and are summarised in the LPN Load Related Expenditure Narrative.

9.6.3 HV asset condition

Tree related faults will continue to be minimised through the tree cutting programmes in SPN and EPN and overall OHL fault rates maintained by maintenance and refurbishment programmes, with priorities assessed through the circuit performance process.

Overall underground fault rates will be managed by on-going programmes to replace unreliable cable sections and poor condition switchgear and transformers. The increasing volume of failures of transition cable joints may demand targeted remedial programmes, which will be highlighted by improved fault data linked to GIS mapping. Better techniques need to be developed to detect and locate incipient failures of cables, joints and terminations whilst circuits are in service to enable pre-emptive repairs to be targeted – the IFI programme has been investigating methods of incipient fault detection on overhead lines and the use of partial discharge mapping on cables should provide future insight into cable faults.

Following the recovery of backlogs during DPCR5, continuous improvement of maintenance practices will improve the reliability of plant and minimise the incidence of stuck circuit breakers and protection mal-operations.

9.6.4 EPN Auto-recloser & ASL expenditure and benefits

Extended deployment of pole mounted auto-reclosers (PMAR) and ASLs in EPN and SPN will improve the performance of overhead line networks. The PMAR / ASL operating combination is more effective at preventing interruptions due to non-damage, transient faults than a circuit breaker / expulsion fuse combination (a known issue with the time/current operating characteristic of fuses). Table 9 below shows the previous 3 year HV non-damage CI and CML contribution in EPN and SPN as a percentage of total CI and CML and highlights the opportunity for CI and CML savings from greater sectionalisation of the network during auto reclose time.

Table 9 Percentage of CI and CML caused by non-damage faults

HV Non-damage faults	EPN		SPN	
	%CI	%CML	%CI	%CML
2012-13	30%	25%	17%	15%
2011-12	18%	11%	11%	6%
2010-11	15%	9%	6%	4%
2009-10	25%	18%	11%	19%
Average	22%	16%	11%	11%

The required PMAR and ASL volumes is based on the determination of an optimum number of ASLs per PMAR and number of PMARs per customer on overhead line networks that produces a return on investment via IIS over the ED1 period.

High level analysis has concluded that a total of circa 450 reclosers could be installed in EPN at targeted locations to produce maximum benefit. This coupled with circa 2000 ASLs will provide estimated benefits of 1.6 CI and 1.55 CML at the end of ED1. In SPN there is less opportunity for deployment of auto reclosers however circa 800 ASLs could be used to provide estimated benefits of 0.4 CI and 0.3 CML.

In order to identify the target locations for installation of these devices a detailed network study is required. Since this is a very labour intensive and manual process, the high level figures have been used as an early indication of the viability of such a programme of work. The works should be treated as a generic work programme and not a bespoke project.

9.6.5 HV operational response

Improvements to the fault management process, including generator deployment, resource dispatch and contractor management, have reduced field response times during DPCR5. Recovery of maintenance backlogs under the Maintenance Improvement Project has reduced switchgear that is inoperable or subject to operational restriction.

Repair of outstanding defects and faults will maximise the availability of alternative network supplies.

The installation of additional remote control points in the DPCR5 QoS Programme and subsequent addition of Algorithmic Automation means that switchgear replacements and new connections will continue to reduce field staff involvement in initial restorations and allowing customers to be restored more quickly and staff to be deployed quicker to the affected site.

Enhancements to systems and field access and continuous improvement initiatives will further reduce restoration times.

9.7 EHV and 132kV networks improvements

During DPCR5 the following initiatives were taken to improve performance:

- Outstanding defects on auto-close and auto-isolation schemes were repaired
- Improved management of outages and quicker fault repair will reduce the time the network is a risk to a co-incident fault
- Rigorous pre-outage checks, including 24 hour pre-outage soak tests, were implemented within EPN to reduce losses due to human error and simultaneous trip
- Enhancement of maintenance practices, recovery of backlogs, validation of protection integrity, circuit breaker timing via SCADA and regular confidence switching
- Application of automation scripts to single transformer primary substation HV load transfer schemes to restore supplies in under 3 minutes, eliminating CI and CML
- Revision of the Depleted Earthing Policy to avoid switching out primary and grid substations where neutral earths are stolen if an alternative neutral earth can be provided by connection to an adjacent substation
- Introduction of the major network incidents investigation and review process to determine root causes, identify incipient failures and implement any necessary remedial action

Focus will be retained on these improvement areas within ED1, in addition to those described below.

9.7.1 EHV monitoring, remote control and automation

During DPCR5 primary substations in EPN with obsolete 11kV switchgear that is not equipped with remote control facilities will have secondary feeder circuit breakers installed to those circuits which benefit from automation, but transformer incomer and bus-section and bus-coupler circuit breakers will have no remote control added.

Priority shall be given to planned replacement of all non-remotely controllable switchboards during ED1. Where replacement during ED1 cannot be justified by condition or network reinforcement etc. incomer and, if appropriate bus-section and bus-coupler, circuit breakers also shall be converted where feasible to limited remote operation.

Opportunities to add remote control and automation to the 33kV ring networks in EPN shall be assessed and implemented where economic.

9.7.2 EHV asset condition

Improvements in asset condition assessment, improved quality of maintenance and targeted refurbishment and replacement programmes should enable fault volumes to be reduced. Particular emphasis should be paid to switchgear and underground cables in EPN.

9.7.3 EHV protection replacement and enhancements

Hand reset tripping relays within EPN should be replaced with self or remote resetting types. Programmes should be introduced for planned replacement of digital relays to avoid reliability issue due to component deterioration.

9.7.4 Load management and reinforcement

Additional monitoring will be required given the continued increase in distributed generation connections. This data can be coupled with smart systems for voltage control and load management. Learning from the Flexible Plug and Play LCNF project will provide a useful start point for future network management initiatives.

9.7.5 Outage risk management

The risk of unplanned outages should be controlled by quicker fault repairs and the frequency and duration of planned outages reduced by changes to project design and construction and maintenance working practices.

9.8 Planned interruptions

The arrangements introduced during DPCR5 to coordinate required maintenance, connections and capital programme HV outages to minimise required shutdowns should be monitored and enforced.

Mobile generation and live line working should continue to be used where economic to reduce planned interruptions.

9.9 Worst served customers

For DPCR5, a Worst Served Customer is defined as:

"A Customer experiencing on average at least five higher voltage interruptions over a three year period, i.e. 15 or more over three years with an additional requirement for a minimum of three higher voltage interruptions in each year"

In ED1, this definition is being altered such that a customer experiencing 12 or more higher voltage interruptions in a three year period is defined as worst served. Table 10 below shows the differences in volumes of worst served customers over the last two years with the different definitions applied:

Table 10 Worst Served Customers DPCR5 Definition Vs. ED1 Definition

DNO	2011/2012		2012/2013	
	DPCR5 Definition	ED1 Definition	DPCR5 Definition	ED1 Definition
EPN	3,234	9,951	3,747	11,750
LPN	0	0	0	0
SPN	1,644	3,842	2,249	11,258

The investment in additional HV remote control during DPCR5 should reduce the numbers of customers consistently having 4 or more sustained unplanned interruptions in a year. However, further investment may be required to modify the network to mitigate poor service to small clusters of customers. During DPCR5 a Worst Served Customer procedure has been implemented to analyse fault data annually following publication of WSC numbers and create an action log to improve the service to these affected customers. Schemes range from undergrounding of overhead lines and diversions of circuits to improved monitoring and network configuration. There will be opportunities for the installation of smart technologies such as energy storage as these technologies mature and provide cost effective solutions.

9.10 Assumptions

The DPCR5 Quality of Supply Programme is delivered and planned performance improvements are achieved.

Work programmes will maintain existing levels of network reliability except where improvements are targeted in this Strategy.

9.11 Risks

The following major business risks have been identified which have the potential to adversely continuity of supply.

Fault rates

Fault rates vary from year to year, predominantly due to the effects of weather. Whilst the contribution of exceptional events is excluded from the regulatory performance calculation, sustained lower level increases are not. The associated benefits are therefore sensitive to these variations and a series of high fault rate years would adversely impact both CI and CML performance.

Reporting accuracy

Reporting errors may be discovered which when corrected significantly the change the current performance baseline from which improvements have been calculated, either requiring greater or lesser improvement to achieve CI and CML targets.

Insufficient resource

A lack of sufficient development resources will delay the delivery of improvements and hence benefits from the Programme. Insufficient or inadequately skilled operational resources could result in planned reductions in response times and hence CMLs not being achieved or extended duration of network holes impacting both CI and CML performance.

Industrial action

This would have a similar impact to the risk from insufficient resources.

Major operational restriction / type defect / prohibition

A major operational restriction, type defect or HSE prohibition could result in increased numbers of customers being affected by an incident due to dead switching, suspension of normal working practices etc., leading to higher CIs and CMLs.

Short Interruptions

Ofgem could reduce the time of a short interruption from 3 minutes to 1 minute (in line with the IEC definition), reducing the time for automation to operate and hence the CIs that existing automation can avoid.

Ofgem may introduce incentives to reduce short interruptions. Dependent on the strength of the incentive this may require a range of initiatives including revised network designs that have not yet been considered.

Quality of work

Latent defects in the quality of installation and commissioning and poor assurance practices may lead to premature failure or mal-operation of assets.

Climate change

Increased volatility of weather may increase the frequency of storms and hot weather, raising network risk.

Low carbon changes

Incentives to install solar power and heat pumps could result in clustering of installations

Algorithmic Automation

Issues with performance or acceptability of Algorithmic Automation would significantly reduce the improvement to CI performance for all networks planned during DPCR5. This may be mitigated in part by increasing the complexity of existing automation scripts to include more automatic sectionalising points.

Telecommunications

Reduced reliability and availability of third party provided telecommunications (particularly cellular radio) would reduce the performance of automation schemes.

9.12 Dependencies

The delivery of quality of supply improvements is dependent on the following:

- The IFI programme – for delivering improvements in diagnostic testing of LV link boxes, LV and HV cables and accessories, LV automation and tree management initiatives
- IT transformation programme - for delivering improvements to ENMAC, Ellipse, Netmap, work management, mobile access and modelling tools
- Achievement of all necessary planned asset work programmes
- Provision of reliable communication services by third party providers
- The roll out of smart meters for LV network visibility

10 References

- Expectations of DNOs and willingness to pay for improvements in service – Accent final report July 2008
- Electricity Distribution Final Proposals – Incentives and obligations – Ofgem December 2009
- Network Performance Strategy – Draft December 2009
- Quality of Supply – Achieving a step change in performance (Presentation to EMT 2nd March 2011)
- Quality of Supply Programme Initiation Document – version 2.0 June 2011
- DPCR5 Quality of Supply Strategy – version 1.1
- Central London Area Strategy – Draft April 2012

11 Appendices

A.1 DPCR5 QoS programme improvement initiatives

This appendix summarises the initiatives deployed to improve performance during DPCR5.

A.1.1 HV remote control & automation

HV Remote Control Project – EPN and SPN

The HV Remote Control Project is a finite project that applies to EPN and SPN and aims to reduce the number of CIs and CMLs incurred on the HV networks in these Regions in line with the mission.

The project involves the provision of additional remote control points at regular customer intervals on the HV network. This will reduce restoration time and hence CMLs by replacing manual operations with remote switching operations and enable additional CMLs and CIs to be eliminated through the use of algorithmic automation.

Analysis has shown that for a return on investment of 2.5 years remote control points should be installed at intervals of 350 customers in EPN and 400 customers in SPN.

The benefits from the HV retrofit programme are dependent on a number of other initiatives such as the repair of SCS defects – the HV model uses a 90% success rate on HV remote control commands.

Feeders that require large investment for minimal benefit have been excluded from the programme.

Primary Remote Control – EPN Only:

- There are approximately 300 source circuit breakers in EPN that are not remote controlled (all source circuit breakers in LPN and SPN are remote controlled). The performance model assumes that source circuit breakers are remote controlled. Options for remote controlling source circuit breakers include retrofit where applicable (not all switchgear types have an available retrofit), installation of spring release coils to allow 1 shot remote reclose, primary switchgear change or additional secondary switchgear installation. The cost of each option varies significantly such that the cost outweighs the expected benefit in a number of cases.
- Further analysis is required to adjust the benefit from the HV model in cases where source circuit breaker remote control is not viable.

Optimised automation

There are a number of existing remote control sites on all three HV networks that could make up part of an automation script with no further investment required. Until Algorithmic Automation is employed on the HV networks, hard coded scripts are used, which nominate section and normal open points. There are many types of script used with different number of section points. Analysis has shown that some feeders that currently have no automation could have scripts written with up to two section points. Also, feeders with existing automation and one section point could be upgraded to two section points using existing remote control on the feeder.

The benefits of this initiative are included in the remote control model run, which maximises the number of section points on a feeder following the completion of the retrofit programme until Algorithmic Automation becomes available.

All three areas hold a number of existing remote control sites in which the telecontrol has not been commissioned. The equipment is installed on site and requires half a day's work to commission the telecontrol. The backlog of commissioning will be completed by Network Operations and monitored by the QoS Programme.

The benefits of this initiative are included in the remote control model run since the planning analysis for the retrofit programme will take these sites into account.

End to end automation management processes

The process for the management of SCS (Telecontrol) defects is vastly different between regions and a backlog exists in all three.

A process to complete the backlog and harmonise the continuing repair of defects will be produced to ensure that remote controlled devices operate at the maximum possible efficiency.

The benefit from this initiative is tied into all model runs except response improvement since the model uses a defined value for remote control efficiency in benefit calculations.

Single transformer primary automation

There a number of single transformer circuit primary substations, mostly in EPN, but some in SPN, which rely on load transfer by 11kV switching to restore supplies in the event of loss of the incoming transformer circuit. Automation schemes will be applied to the 11kV switching points concerned to enable supplies to be restored in under 3 minutes.

Algorithmic automation

Algorithmic Automation is an advanced automation system capable of using any remote controlled device on the HV network as a section point and will replace existing automation scripts. This will significantly reduce CIs and reduce CMLs for customers normally restored remotely.

This system relies on the upgrade of the existing ENMAC systems on all three networks to version 5.2. For more information on Algorithmic Automation refer to the Gate B document for project number NB_IF00_11-0001.

The benefits from algorithmic automation are shown based on existing levels of automation and also following the completion of the retrofit programme.

All costs for the Algorithmic Automation project are included in the tables in this document although it is envisaged that 75% of cost will be funded via the Innovation Funding Incentive (IFI) mechanism.

A.1.2 Operational delivery and planning

Improved restoration performance

Operational response performance will be analysed to determine best practice, improvement areas. Actions plans will be developed to control and implemented agreed solutions.

DST Model within LPN and SPN

First response within LPN is currently undertaken by metering staff From EDF Energy and rostered UK Power Networks' staff. EDF Energy staff have limited competency and are only able to replace cut out fuses, resulting in delays and hand offs where the cause is a network or service fault. Overall first response is slow. It is proposed to recruit and mobilise a DST first response team based on the EPN model.

The SPN Troubleman model will be enhanced to achieve the performance levels of the EPN DST model.

Generation deployment

Arrangements will be negotiated with generator hire contractors to station generators across regions and reduce abort fees to reduce deployment time through reduced travel and earlier ordering.

Training will be undertaken to authorise staff to synchronise generators thereby avoid interruptions for planned shutdowns.

Implementation of inversion generation

Mobile HV step up transformers with associated protection will be purchased and deployed to enable islanded HV overhead networks to be supplied without the necessity to connect multiple LV generators.

Fault management process

The Fault Management Process will be revised to tighten restoration targets and escalation procedures, thereby reducing restoration time and follow up repair duration.

The delay before commencing remote switching within SPN will be removed, bringing its procedures into line with other networks.

Excavation contractor review

Arrangements will be reviewed and practices revised if necessary to reduce restoration time by ensuring required availability and performance.

A.1.3 Repair critical faults and defects

Repair of network faults and network defects

Target durations for repairing outstanding faults will be reduced, and backlogs recovered by the end of 2011.

Defect data will be cleansed and critical defects prioritised for rectification by March 2012.

The procedures for management of repeat LV faults will be reviewed and re-implemented with target of no more than 3 repeat interruptions.

Fault management refresher training packages will be developed and delivered to fault response staff.

Network performance reporting

Rationalised regulatory and business reporting.

EPN and LPN fault reporting will be migrated to ENMAC IFR system, thereby establishing a common reporting platform for all networks and eliminating errors in transcribing data to FRS.

The quality of fault reporting will be reviewed and training and additional assurance implemented as necessary to improve the accuracy and consistency.

An integrated automated reporting system will be developed to provide readily accessible operational management reports and strategic asset management information.

Incident analysis and fault avoidance

A process will be introduced to review data for each major incident data to identify any protection mal-operation or incipient equipment failure and instigate further investigation and corrective action.

Responsibilities and procedures for monitoring and analysing asset fault performance and determining required early interventions will be further developed and formalised as part of the Asset Risk Management enhancement.

A major network Incident investigation and review process has been introduced to determine the root causes of 132kV and 33kV network failures (including operational response) and instigate necessary remedial actions. This process will be developed further.

HV circuit performance

The Fault Analysis tool will be refined to provide up to date operational reports. A management process will be developed and implemented across Asset Management and Network Operations to monitor circuits and performance and instigate appropriate operational or investment responses.

Protection integrity

A methodology will be developed to review protection settings at all sites and validate these against current standards. Delivery of updated settings to sites as required.

A.1.4 Manage network risk

Outage optimisation process

Assessment and quantification of construction outage risk at planning stage and incorporation of proportionate mitigation within design.

Revised EHV / 132kV pre-outage check procedure

Existing procedures have been reviewed and improvements are being implemented to minimise avoidable unplanned interruptions during planned outage conditions.

Improved HV outage management

A process will be developed to minimise risk from planned outages on the HV networks through better coordination of work, limiting duration controls and optimising mitigation.

A.1.5 Continuous improvement and quick wins

Network performance action teams

A Network Performance Action Team (NPAT) was established in each Region which meets weekly to monitor and drive restoration and fault repair performance against agreed targets.

Continuous improvement of fault management and customer service daily call

Fault management performance is analysed daily and managers required to explain exceptions and required corrective actions at a daily morning call. Matters covered include.

- 18 Hour Failures
- >8 Hour Incidents
- HV faults exceeding CI and/or CML threshold
- 1st hour restoration performance
- Excessive HV Repeats
- Excessive LV Repeats
- Media Review (Mondays only)
- Repair Duration Non-Compliance (Thursday only)
- Automation Performance Review (Friday only)
- Weather and resource escalation

A.1.6 18 hour action plan

An Action Plan was developed and implemented at the start of 2011 to eliminate over 18 hour failures. This included removing restrictions on overnight working, improved dispatch and earlier and more robust escalation of slow restoration incidents.

Table 11 Step change programme action areas

Ref	Action Area	Description & Means of Delivery
1.0	QoS Steering Group	Set up and establish monthly QoS Steering Group.
2.0	Network Performance Actions Teams (NPATs)	Set up and establish weekly NPATs. Formulate a standard agenda for all Regions and Areas.
3.0	Visibility of Network Performance (Dashboard)	Create Network Performance "dashboard" showing granular network performance by area i.e. CIs, CMLs, % restoration, over 18 hour failure.
4.0	Automation & RTU Commissioning	Understand switchgear / RTU replacement programme. Agree schemes that can be delivered in this year then monitor performance against target. Agree 'end to end' process owners.
5.0	Key Switchers (Manual Restoration)	Implement key switcher initiative across EPN areas and re-invigorate in the SPN area (out of normal working hours) to improve HV fault response.
6.0	Daily Switching Roster (Manual Restoration)	Implement daily switcher roster across all regions to improve HV fault response. To include operational staff from other Directorates.
7.0	Phone 'Pinging'	Trial and implement phone 'pinging' to evaluate the use of such technology to support faster identification of resource to improve HF fault response.
8.0	Establish DST 1st Stage Restoration Model in SPN	Implement rapid response model to faults in SPN area.

Ref	Action Area	Description & Means of Delivery
9.0	Review Business Case for DST Model in London	Undertake review of DST business case in light of QoS exposure.
10.0	Operational Policy (Unlock Network Restrictions & Constraints)	Identify key issues affecting restoration performance i.e. ROD, OR's - List pressing issues (SMT owned), discuss at NPATs, Process for engagement throughout Network Operations.
11.0	Ensure Robust Standby Rosters (EPN (S) Specifically	Ownership of robust rosters by areas. Ensure appropriately authorised staff are on the roster to carry out the work they will be expected to undertake.
12.0	Generator Policy	Review policy and implement any changes, including temporary restoration versus permanent repair and arrangements for connecting generators live.
13.0	Communication	Develop an awareness bulletin of QoS Operational Recovery Plan and details of Dashboard.
14.0	Network Holes	Significant reduction in the number of holes in the network helping to avoid the impact of 'islanded networks'.
15.0	Planned Interruptions	Establish process to prevent contractors undertaking shutdowns without using LV backfeeds where available. Implement process for 'rationing' of CI/CMLs for Planned Interruptions.
16a	SPN E2E Fault process review	Deliver outcome of Networks 1st SPN end to end faults review.
16b		Implement "Early Dispatch" in SPN area from Fore Hamlet.
17.0	HV Fault Response Incentive Scheme (SPN Region)	Implement Incentive Scheme to encourage rapid response to HV faults in SPN Region
18.0	Protection Review	Undertake a review of protection settings at a sample of Grid & Primary S/Ss.
19.0	Tree Management	Monthly report from each region (EPN (N), EPN (S) & SPN) on Tree Cutting programme performance by voltage and hot spot areas of concern.
		Tree cutting prioritised on circuits with highest tree related faults
20.0	Analysis of impact of operational response improvement	Undertake analysis to show the impact of improved operational response i.e. moving from 65% 1st hour HV response to 75% 1st hour HV response will deliver 'x' CML benefit. Monitor CI/CML trend.

A.2 LV monitoring and automation

A.2.1 IFI Project

UK Power Networks and TE Connectivity have been working in collaboration as part of an Innovation Funding Incentive project, to develop a new solid-state switching technology for use on the LV distribution network. The devices developed in this project retrofit to existing LV plant, and the system allows remote switching, re-configuration and automated fault restoration on the LV network.

Single phase fault break / fault make circuit breakers retrofit in place of the existing LV distribution board fuses, and load break / fault make switches replace solid links in link boxes. In addition the system has the ability to provide visibility of the LV network down to link-box level; real time communications and built in sensors allow extensive load monitoring data to be gathered.

A.2.2 Tier 2 project

A tier 1 project has been proposed which will fully populate strategically selected areas (approximately 60 secondary substations) within the LPN LV network with LV Remote Control & Automation devices with the aim to:

Quantify the improvement to quality of supply possible when using LV Automation to create a self-healing LV Network.

Pro-actively manage the LV network to reduce loading issues and reduce load related customer interruptions and increase LV network performance.

Evaluate the potential benefits provided by highly granular LV visibility, and remote control of the LV network configuration.

Investigate how greater understanding, visibility and smart management of a flexible LV network can help facilitate the predicted increase in domestic distributed generation, penetration of electric vehicles and a move to other low carbon technologies.

Use the unprecedented visibility of the LV network available to validate current LV modelling.

A.3 HV automation

A.3.1 Existing automation

UK Power Networks uses a hard coded script system for automation of the fault detection, isolation and restoration process. This system replicates the actions that a control engineer would take and performs the actions much quicker allowing supplies to be restored to healthy sections of the circuit within 3 minutes. While this system has been successful in reducing the CIs and CMLs from faults, it has some drawbacks:

Each feeder requires an individual script based on a number of generic script templates (9 templates in EPN & SPN, 6 Templates in LPN).

During abnormal running conditions, the automation must be disabled, risking CIs and CMLs.

The trigger can only come from the source circuit breaker.

The remote switching points which can be used to split the feeder (known as Automatic Sectionalising Points or ASPs) are limited (2 in EPN & SPN or 4 zones in LPN).

Every time a feeder is run in an abnormal condition (for example a faulted feeder, a moved open point or a faulty RTU) the automation has to be disabled. This puts a substantial amount of CI and CMLs at risk. In addition, should the allocated remote control point not be available (for example the Normal Open Point fails to close, or has a communication failure) the automation sequence is aborted, incurring CIs and CMLs.

A.3.2 Algorithmic automation

An alternative system to the hard coded automation system is an algorithmic automation system. This system works by having a ‘global’ automation engine. The way this system reacts to a fault is:

1. Circuit breaker trips (source or along the feeder) and feeder goes dead up to the Normal Open Point (NOP)
2. The Automation engine is triggered, and locates the fault using fault passage indicators
3. The Automation engine traces from the tripped breaker location outwards locating any remote control points
4. The engine isolates the faulted section using any R/C switch available
5. Healthy sections are restored using any R/C switches available

This system will take advantage of the increasing number of R/C switches available on the networks. The original system cannot do this as it is limited to 2 Automatic Section Points (ASPs) in EPN and SPN or 4 zones in LPN.

In addition, because the algorithmic automation system can be triggered from any circuit breaker, the 11 kV transformer circuit breakers will be able to trigger ‘loss of primary’.