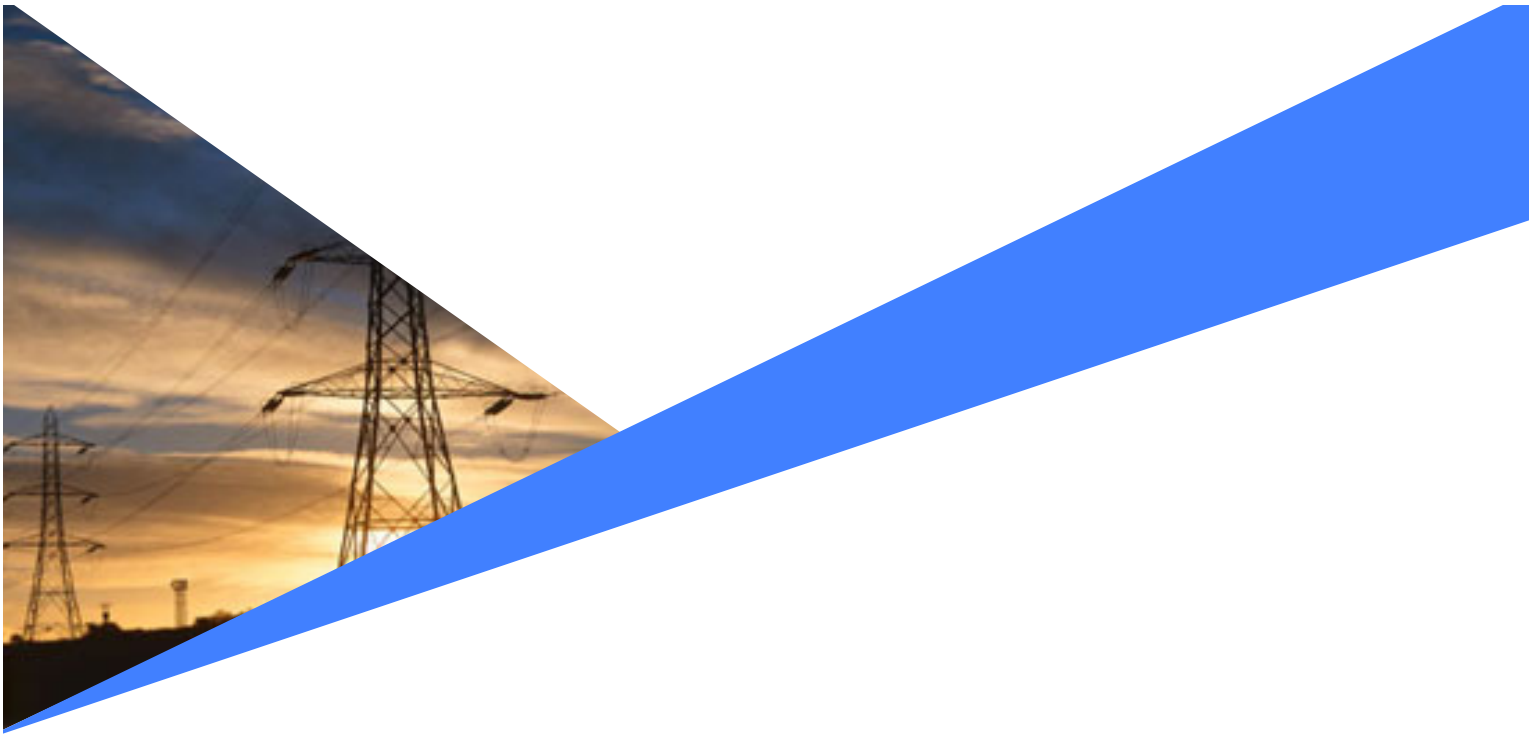

energypeople

Stage 2 Review of Distribution Network Operators' performance during the December 2013 storms

Report prepared by energypeople limited for Ofgem

July 2014

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1 Executive summary

Overview of the Christmas severe weather event and its impact

Over the Christmas 2013 holiday period high winds and heavy rainfall hit the United Kingdom causing widespread damage to electricity distribution networks across the country. As described in Section 5, the south of England was most severely affected. There had been prolonged heavy rain during the preceding weeks and in the period immediately before and during Christmas, the high winds and storm conditions persisted for longer periods in the south and south east than elsewhere.

Two electricity distribution companies, United Kingdom Power Networks (UKPN) in its South Eastern area (SPN) and Scottish and Southern Energy Power Distribution (SSEPD) in its Southern area (SSES) were affected more significantly than other companies' networks, each having almost 1100 incidents, affecting a quarter of a million customers on its network. Between them they had almost 16,000 customers affected for more than 48 hours and, in the worst case, some were without supply for six days.

Customers affected by the supply interruptions are reported to have had difficulty in contacting these two companies by telephone to report the situation and to get updates about when they could expect their supply of electricity to be restored. The focus of this report is on those two networks but, to give some context, it is important to consider the scale of the event they suffered compared with other areas of the country.

All other electricity areas were affected, but to a lesser extent. UKPN in its Eastern area with 850 incidents and Western Power Distribution (WPD) in the South West with 756 incidents were the next worst affected. UKPN in the east delivered a good performance in restoring all but 27 of its 88,000 affected customers in 48 hours and WPD achieved an impressive result in restoring all but 13 of its 58,000 affected customers in 24 hours.

The number of incidents on the networks immediately poses a different question; were the networks constructed to different standards or less well maintained? The evidence found during the review is that there is no significant difference between any of the companies in this respect. All companies build networks to the latest national standards in force at the time of construction and carry out routine inspections, follow up maintenance and tree clearance to similar standards (as explained in the report, the most critical being ENATS 43-8 and ETR-132).

The two companies adopt vegetation management policies that, as far as the ownership of the heavily tree populated areas will grant permissions to cut, optimise tree clearance around their overhead lines. There was evidence of significant effort being put into this with tree management programmes taking the work forward at a pace acceptable to stakeholders.

Key factors affecting performance over the Christmas period

A number of factors contributed to the differences between regional restoration performances during the Christmas 2013 event. These may be briefly and very simply summarised as follows:

Factors outside the DNOs' control:

- The severity and duration of the weather that affected them;
- The extent of tree coverage causing overhead line damage;
- The timing of the impact of the severe weather; and
- The delay in repairs caused by on-going bad weather.

Factors largely within the DNOs' control:

- Availability of overhead line staff to carry out repairs;
- Identification of multiple masked faults;
- Availability and deployment of generators to restore customers who had been longest without supply;
- Availability of call handling staff to talk to customers and telephony systems capability;
- Supporting the previous point, mutual dependencies between DNOs, which on this occasion did not appear to produce the support required at the right time; and
- Management of tree coverage, to ENATS 43-8 and ETR 132 within the limits of public acceptability.

There are of course other factors (the network configuration, network management systems, organisation, logistics and efficiency of resource deployment, etc) peculiar to each company, and in some cases each licensed area, which may affect restoration performance. However, in explaining the overall differences in performance we believe these were less relevant to this event.

Factors beyond the companies' control

The two worst affected areas were affected by a broadly similar set of the factors beyond their control. Both, particularly SPN, are in the areas of the country that are most heavily wooded; both encountered sodden ground conditions which could not support the weight of mature trees under such severe wind pressure for the duration to which they were exposed. The two faced a similar set of weather conditions to the rest of the south of the country but over a longer period. This resulted in more incidents, more severe travel restrictions and longer safety-related delays to repairs than at most other locations.

Both operate a tree clearance policy to national standard requirements, though with difficulty in obtaining permissions to

achieve the tree clearance expected by those standards and having to resort to expensive alternative solutions.

Both were affected by a weather pattern that had its most severe impact on 23 and 24 December, during the immediate lead up to the Christmas break. The number of incidents (Figure 10), shows that in the south west the peak activity was on 23 December, giving more time to address the impact of the event before Christmas; in SSES the activity started on the 23rd but continued at a high level into the 24th; while SPN and EPN were worst affected on the 24th. UKPN had previously responded to a weather warning for 18 December which did not materialise and then did not receive its warning of increased severity for 23rd and 24th until the morning of the 23rd. All of the evidence gathered points to a significantly different event being suffered in SPN and SSES than the rest of the country. These factors contributed to the longer restoration periods.

Factors largely within the companies' control

With regard to those factors generally within their control, the two most severely affected areas faced different situations but there were similarities. Each has a low ratio of overhead line staff to overhead line network relative to other companies (as shown in the analysis in section 8) and both are likely to be more dependent on imported resources than others. During the Christmas 2013 event, SSEPD suffered due to its comparatively high level of dependence on contractors for overhead line work in the south and their lack of availability over the period. This was combined with the inability to move internal resources from the north of Scotland, which was also under a severe weather warning.

SSEPD achieved an availability in the south of 31% of its combined direct and contract overhead line staff working over the emergency period, peaking at 40% on Christmas Eve, dropping to 21% on Christmas Day.

UKPN has a relatively low ratio of line staff to overhead line with 10% of the country's overhead line staff and 17% of the overhead network. It has a low dependence on contract labour in the south east but was unable to move its in-house resource from its eastern network, since this had also suffered an emergency event and staff were continuing to reconnect customers there following the storm damage in the east.

UKPN achieved an availability in its SPN area of 91% of its direct overhead line staff working over the emergency period, with 80% working on Christmas Day, the number increasing as EPN completed restoration and moved staff to SPN. SPN, which normally has only 30 contract line staff had up to 63 working by importing contract staff who normally work in EPN and accessing some via NEWSAC.

Under most circumstances the NEWSAC mutual aid consortium, to which all companies are a party, would provide additional resources from the less severely hit companies. On this occasion

NEWSAC did not produce the additional resource when it was most needed. There are two factors, which go some way to explaining this. Companies were almost all on severe weather alerts and, as a consequence, understandably wary about releasing their own staff in case they were needed. It was also the Christmas holiday period. Although there is a commitment to mutual aid, these factors help explain why there was no occasion when all of the theoretically available overhead line staff were used on repair work – both directly employed and contractors. The evidence is that over the critical Christmas period of 24 to 28 December when customers remained without supply, about half of the country's directly employed overhead line staff were used and 40% of the country's contractors.

Changes are being made to NEWSAC arising from the DECC initiated review which may improve its operation. However, it will remain the case that companies will need to be confident they can successfully manage events affecting their own customers before loaning resources to others.

The DECC work with companies is exploring the way forward and there may be some key trade-offs. In the face of a widespread severe weather event, either most companies must build additional resilience into their resourcing such that they can cope with the first 36 to 48 hours or so of very exceptional events (of the type experienced at Christmas 2013 in the south) with their own resources, make independent support arrangements or potentially a central organisation may be given the role of allocating scarce resources at a strategic level for the industry as a whole. The latter option is counter to the autonomy of the companies and the voluntary basis on which they have supported each other since before the industry was privatised in 1990.

Restoration of some customers will inevitably take longer. The need for physical repair; availability of the right staff and materials; safety and access issues; and the presence of 'masked' faults' add to the time taken. In these conditions temporary generation can be used effectively to restore supplies. Both the companies whose customers had the longer supply interruptions used temporary generation. However, both acknowledge they might have deployed it sooner and more effectively and both have put plans in place to review their approaches. This may have been a contributory factor in explaining the delay in restoring supplies to a small number of customers.

Dealing with customers

With regards to call handling, both companies are now operating on the STORM® computer integrated telephony platform for managing customer calls and messaging.

UKPN implemented its system following the October severe weather events and had it in place in December. Using this system it was able to provide information to call takers across its company offices and to its service provider. Using a mix of its own staff and service provider, UKPN was able to field a high number of call

taking staff in its offices (345 on Christmas Eve, 309 on Christmas day, in each case more than the rest of the country). Even with this number of staff, reported answer times become very high (over 9 minutes) and abandoned call rates escalated to 60% on Christmas Eve. This was for two main reasons; many of the incidents occurred overnight on 23/24 December resulting in a sharp peak in customer calls as people woke up without electricity, and a natural anxiety about supply restoration in time for Christmas Day.

SSEPD implemented STORM® in its Portsmouth call centre prior to December but not in its Perth call centre, where it was implemented in February 2014. The evidence is that, possibly as a result of this, the two call centres did not work effectively as a single unit leaving the 20 agents in Portsmouth unable to cope and the 10 in Perth unable to offer full support. On Christmas Eve the Portsmouth waiting time rose to almost 13 minutes with 80% abandonment for similar reasons to those which affected UKPN. SSEPD's normal back up service for call taking, its supply business call centres, was unavailable to take calls over the holiday period.

Telephony data quality

The detailed analysis of customer communication included in the report and appendices is based on data submitted to Ofgem. As noted at several points in the analysis, there is a concern over the consistency with which 'key measures' are recorded and hence the reliability of the data. There is clearly scope for different interpretations of the definitions used. Related concerns are the facilities in modern telephony systems to re-route calls, manage queues and waiting times; which can, in turn, affect consistency of reporting. Conclusions in this area must therefore be regarded as indicative and requiring further detailed study.

Assessing performance – qualitative as well as quantitative

The main body of the report focuses on quantitative data, using this to explain incident and restoration patterns, identifying differences in performance and explaining them. Section 10 reviews some qualitative factors – things DNOs have to 'get right' if they are to plan for, and then manage, a future severe weather event. This list of success factors, with a simple descriptor against each, provides a framework for the commentary on each company, which is included in the appendices.

Performance in responding to severe weather events in the future

For the longer term, the analysis in this study highlights the challenges in dealing with severe weather events. Improvements can be made and many are in hand, initiated by both the DECC review and the companies themselves acting independently. The reality is, however, that where large scale, geographically dispersed physical damage to the network occurs and weather conditions delay or slow down work, customers may be without supply for several hours and possibly days. The improvements underway will mitigate but not fundamentally change this reality. External stakeholders (for example the media and opinion formers) can play an important role in helping to manage customers' expectations.

When severe weather occurs in the future –the evidence suggests

that the bulk of customers (who were restored within 24 hours) should expect to see incremental improvements in the way these events are handled as companies learn and apply lessons from December 2013.

The worst served customers, such as the 16,000 who were off supply for more than 48 hours over Christmas 2013, could reasonably expect to see a significant improvement in two main respects, as companies (a) equip themselves to better manage the 'tail' of repairs to the network; and (b) improve their capability to inform and keep in touch with their customers.

How the report is structured

The report which follows is structured to provide a brief overview of the industry and its organisation; the approach and methodology adopted for this study; a review of weather events and forecasting and its significance; a summary of the phases of managing a severe weather event followed by an analysis of how companies performed during this event; an analysis of how the industry is resourced; together with a review of how successful companies are in communicating with their customers during emergency conditions. The final part identifies the most important factors companies must get right when managing a severe weather event; in the appendices, each company's actual response to the Christmas severe weather event is reviewed and evaluated. What follows presents energypeople's independent review and assessment of how the events were managed and related matters; it does not represent Ofgem's analysis, assessment or conclusions.

2 Introduction

2.1 Purpose

This report sets out the results of a study of the performance of Distribution Network Operators (DNOs) and their response to the damage caused by the series of storms over the winter of 2013/14 and, in particular, those which hit the UK during the Christmas week. Commissioned by Ofgem, the study was undertaken during the period 3 May to 20 June 2014 by energypeople limited.

This report presents an independent assessment of the matters covered; it does not report Ofgem's analysis or conclusions.

2.2 Overview of the storms

The winter of 2013/14 has been characterised by being the wettest and amongst the stormiest on record. There was a succession of severe weather events which disrupted electricity supplies, the most significant from a national perspective being the December storms which battered the south of the country on the 23/24 and 27/28 December, resulting in flooding and the loss of supplies to almost 1 million customers[1], some of whom were off supply for over five days.

DNOs found themselves on constant alert, holding resources in a state of readiness throughout most, if not all, of the winter – from the St Jude's Day storm on 28 October 2013 through to the conduct of this study during the spring of 2014.

To gain an overview and appreciate some dimensions of the weather events, view '10 key moments of the UK winter storms'[2].

2.3 Background to this study

This is the second study into these events commissioned by Ofgem. It should be read in conjunction with two already published reviews:

- December 2013 storms review – impact on electricity distribution customers. Ofgem March 2014. (Described in what follows as the Ofgem stage 1 review.)[3]; and
- Severe Weather – Christmas 2013. Department of Energy and Climate Change, March 2014. (Described in what follows as the DECC review.)[4].

Both these reviews were conducted in the aftermath of the December storms and deal with the same events. The reports have a different focus however.

The Ofgem stage 1 review provides a clear and detailed statistical review and analysis of the impact of the severe weather on the network, performance in restoring disrupted

[1] In addition to this, some 1.3 million customers were subject to an interruption for 3 minutes or less but were reconnected remotely by network automation.
[2] www.bbc.co.uk/news/uk-26170904
[3] www.ofgem.gov.uk/ofgem-publications/86460/finaldecember2013stormsreview.pdf
[4] www.gov.uk/government/uploads/system/uploads/attachment_data/file/287012/DECC_-_Festive_disruption_ review_-_Final__2_.pdf

supplies, and call handling. There is a detailed appendix for each of the six companies; the consolidated summary provides an overview of the industry's performance; a 'next steps' section sets out Ofgem's perspective on what will happen next. Companies duly responded to Ofgem on the content of the stage 1 review by 1 May 2004. The data included in the Ofgem analysis provides the foundation for much of the review and evaluation of performance included in this report.

The DECC review has a different focus. There is an emphasis on collaboration (including but not limited to the six DNOs, the ENA, the Energy Emergencies Executive Committee and DECC) and forging a consensus on what needs to be done to act on the lessons learned during the management of companies' responses to the event. The outcome of the DECC review was 26 recommendations and an agreed implementation plan, which defines each action, allocates responsibility for delivery and sets a completion date.

These recommendations are important in setting the agenda for sections of this study and the actions in hand have informed important aspects of the thinking reflected in this report.

There are two other pieces of investigatory work of direct relevance. The first is the appearance of five DNOs before the Energy and Climate Change Select Committee on 21 January 2014, during which leaders of the five DNOs most affected were questioned on their company's response to the storms. DNOs were asked to explain why there were delays in restoring power to thousands of customers who were cut off over the Christmas period; at its conclusion the Committee was highly critical.

The Committee 'were very dissatisfied with the way in which some of the network operators managed the disruption'[5], describing the companies as, among other things, 'complacent'[6]. Correspondence related to the Select Committee's hearing has also been studied[7]. Although not overly detailed on actual performance measures, the work of the Select Committee and its firm conclusions, together with the associated media coverage of events form an important backdrop to this study.

The second is work commissioned by the Department of Trade and Industry, which then held the energy portfolio[8], into the resilience of the UK electricity transmission and distribution system to handle natural or man-made disasters in the summer of 2002 and, later, a review of how the sector coped in response to the severe weather event in the October of that year. The outcome was a number of changes to policy and standards dealing with, among other things, mutual aid, vegetation management and management practice during severe weather events.

Much has changed since 2002. Patterns of ownership and the nature and sophistication of regulation have developed at a pace. Whilst the basic technology of electricity

[5] Letter from the Chairman of the Energy and Climate Change Committee (Rt Hon Tim Yeo) to the Secretary of State, DECC (Rt Hon Ed Davey) 'Power Disruption due to severe weather in December 2013'. 6 February 2014.

[6] www.parliament.uk/business/committees/committees-a-z/commons-select/energy-and-climate-change-committee/news/sos-pwer-disruption-ev-session/

[7] www.parliament.uk/business/committees/committees-a-z/commons-select/energy-and-climate-change-committee/publications

[8] From 1970 to 2007. See 'October 2002 Power System Emergency Post Event Investigation' 16 December 2002 DTI

distribution with regard to overhead lines and associated plant and equipment has evolved but slowly, there have been significant advances in the monitoring and control, remote operation and automation of the distribution networks. The use of new technology to manage interaction with the customer has been transformational. Nonetheless, many of the fundamental issues remain the same: accuracy of weather forecasts and responding to them appropriately; efficiency of restoration by automation / remote tele-controlled operation; speed and accuracy with which damage and the extent of repairs required is assessed; mobilising and deploying the workforce and supporting resources; the efficiency with which customer 'contacts'[9] are handled, accuracy and timeliness of information is provided, including an estimated time of restoration; and the efficacy of support to the needy and vulnerable.

Where appropriate, reference is made to the findings of the 2002 study and the extent to which lessons have been learned.

[9] 'Contacts' is a convenient shorthand, since, although the focus in reports up to now has been on telephone calls, there is recognition in the industry that an increasing proportion of customer interactions will be through company websites, social media and alternatives to the conventional telephone call from the customers' premises to the companies.

3 Industry organisation and structure

3.1 Responsibilities of DNOs

DNOs are responsible for providing a system for the delivery of electricity from the transmission network (or in some cases generator), through to the customer. They must provide a reliable, accessible, economic, secure, safe and sustainable distribution system, in such a way that it facilitates competition in generation and supply and enables competition in connections to the network.

What a DNO is obliged to do is set out in the 1989 Electricity Act and a framework is provided by Regulation as it has evolved since then, the most important elements being included in licence conditions which govern the work of all network operators. DNOs are required to report on their costs and performance to the Regulator in accordance with Reporting Regulatory Instructions and Guidance (RIGs)[10], which have been developed to ensure that cost and performance data is collected on a consistent basis. The consequence of this is important as it enables inter-company comparisons to be made using data collected, consolidated and presented on the basis of common definitions and standards.

To summarise, an efficient, reliable and resilient distribution network is critical to delivering affordable, secure and sustainable electricity supplies now and into the future.

3.2 Industry structure

For the UK mainland, there are 14 licensed areas corresponding to the area electricity boards at the time the industry was privatised, owned by six companies as shown in Table 1 below[11].

Independent Distribution Network Operators (IDNOs) are licensed to develop, operate and maintain local electricity distribution networks. IDNO networks are directly connected to the DNO networks (or indirectly to the DNO via another IDNO). As new entrants, IDNOs are regulated in the same way as DNOs, though there are differences in their licence conditions. GTC, which owns and manages electricity distribution networks in the geographic areas of a number of DNOs, is one of the largest.

The Energy Networks Association (ENA) represents the 'wires and pipes' transmission and distribution network operators for gas and electricity in the UK and Ireland. Among its functions it performs three that are of direct and immediate relevance.

First, the ENA is responsible for maintaining the industry-developed and published Technical Specifications, Engineering Recommendations and Engineering Technical Reports, which provide a framework of standards by which networks are planned, built and maintained.

[10] Electricity Distribution Price Control Customer Service Reporting – Regulatory instructions and Guidance: version 2 (2012)

[11] A map showing the companies and their licensed areas can be found on the Energy Networks Association website. See www.energynetworks.org/info/faqs/electricity-distribution-map.html

Second, it facilitates meetings of the Emergency Planning Managers' Forum (EPMF) every two months. At these meetings matters of network resilience, emergency preparedness and response capability are reviewed[12].

Third, it facilitates meetings of participants in the industry's voluntary mutual aid arrangements – NEWSAC – an agreement by which companies 'loan' staff to others at times of system emergency, thereby helping to ensure that repairs are effected and supplies restored as quickly as possible.

Electricity North West Limited	
Northern Powergrid	Northern Powergrid (Northeast) Northern Powergrid (Yorkshire)
Scottish and Southern Energy	Southern Electric Power Distribution Scottish Hydro Electric Power Distribution
ScottishPower Energy Networks	SP Distribution SP Manweb
UK Power Networks	Eastern Power Networks London Power Networks South Eastern Power Networks
Western Power Distribution	Western Power Distribution (East Midlands) Western Power Distribution (West Midlands) Western Power Distribution (South Wales) Western Power Distribution (South West)

Table 1 Industry structure 2014

The reliability of the network has, by the most immediately relevant indicators, improved significantly. The last 20 years has seen reductions of the order of 30% in the number of interruptions (customer interruptions or CI) and their duration (customer minutes lost or CML)[13]. Stakeholder expectations of reliability and resilience have also increased, as evidenced by the reaction to the delays in restoration in the aftermath of the Christmas 2013 storms.

3.3 Responsibilities of Ofgem

Ofgem licences and regulates all companies that own, develop and maintain electricity distribution networks – the DNOs[14].

The basis of the framework is that customers fund the work of DNOs through the 'use of system charge', which is included as part of their electricity bills. Ofgem sets maximum allowed revenues that DNOs can recover through a price control mechanism[15]. This revenue is to enable the DNOs to provide, plan, build, reinforce and maintain an

[12] These take place following the national Energy Emergency Executive Committee (E3C). E3C comprises representatives from government, Ofgem and industry and its function is to prepare for emergencies by developing, maintaining and testing emergency planning arrangements. See the DECC guidance 'Preparing for and responding to energy emergencies' available at www.gov.uk/preparing-for-and-responding-to-energy-emergencies.

[13] Written evidence to the Energy and Climate Change Committee submitted by Ofgem on published 07 May 2014 (Reference NTC0027)

[14] This summary is an abbreviated version of that included in www.ofgem.gov.uk/ofgem-publications/86460/finaldecember2013stormsreview.pdf

[15] Summarised at www.ofgem.gov.uk/network-regulation-–-riio-model/riio-ed1-price-control

electricity distribution network that meets acceptable levels of reliability and security; meets high safety and technical standards; and is efficient and sustainable over the longer term. Revenue is linked to the achievement of performance targets against a number of network reliability targets designed to minimise disruptions. Guaranteed standards of performance (GSOP) require DNOs, under certain circumstances, to make a payment to individual customers if their supply is interrupted[16]. Under the current incentive-based regulatory regime network reliability has steadily improved. In this context it is important to note that DNOs are required to build, operate and maintain resilient networks and in the event of severe weather conditions have the capability to restore supplies quickly and efficiently.

The regulatory framework is evolving. For the forthcoming price review period from April 2015, changes to GSOP include reducing the length of time customers are off supply before a payment will be made under normal weather conditions (from 18 to 12 hours) and Ofgem is presently consulting about, firstly, whether payments should be automatic and, secondly, whether they should be increased[17].

Finally, it is important to note that, whilst regulatory reporting is centred on the 14 licensed areas, those companies which own more than one licensed area are increasingly managing and operating their businesses as integrated entities. A consequence is that whilst regulatory reporting is based on licensed areas, some analysis of preparation and response is best understood in terms of the company as a whole.

[16] See the Electricity (Standards of Performance) Regulations 2010. These are known as the Guaranteed Standards of Performance, often abbreviated to GSOP)

[17] 'Open letter consultation on potential changes to severe weather related Guaranteed Standards of Performance (GSOP) following the December 2013 storms'. Ofgem 31 March 2014. The Select Committee took a vigorous approach to this matter – see Letter from the Chairman of the Energy and Climate Change Committee (Rt Hon Tim Yeo) to the Secretary of State, DECC (Rt Hon Ed Davey) 'Power Disruption due to severe weather in December 2013'. 6 February 2014.

4 Approach and methodology

4.1 Approach

The main phases of the study are summarised in Figure 1 below.

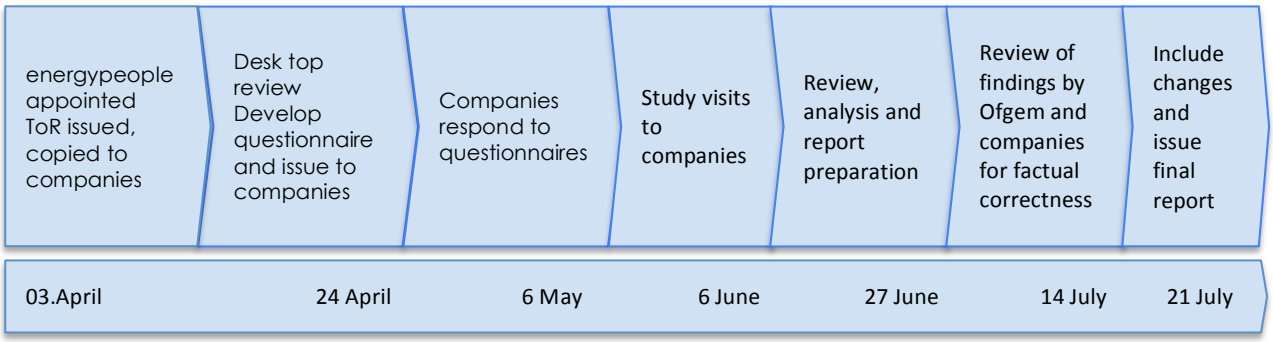


Figure 1 Timetable

As explained in the 'Background to this study' section above, the companies have already been subject to considerable scrutiny in relation to their handling of the December 2013 storms, with three publically available reviews of, and commentaries on, their performance – by DECC, Ofgem and the Energy and Climate Change Select Committee.

Following a review of the work already done and the insights provided by these three reviews, an information request was prepared, in the form of a questionnaire covering the key areas of performance and sent to the six companies. An array of quantitative data is already held by Ofgem; the questionnaire sought to supplement this but also generate qualitative responses on matters critical to an assessment of companies' preparedness and capacity to manage the December event. Some 70 questions were posed, grouped under the headings shown in Table 2.

Planning and preparedness ❑ In house plans and procedures ❑ Weather forecasts and response **Response and restoration** ❑ In what main ways was the licensed area affected? ❑ What was the restoration strategy? **Keeping customers informed** ❑ Organisation ❑ Systems and their resilience	❑ Resourcing ❑ Other means of keeping information flowing **Sustaining the response** **Review, evaluation and follow up action** ❑ In-house reviews ❑ Network condition and resilience ❑ Learning from others **Resourcing** ❑ Direct and contractor

Table 2 Company questionnaire – main themes

Companies responded promptly. The questionnaire then served as agendas for visits to each company. These visits involved discussion and document reviews - including visits to control and call-handling facilities and discussion with those in the company involved in planning and restoration activities.

4.2 Data sources

Under the conditions of its distribution licence(s), at the end of each regulatory reporting year[18], every DNO reports its annual Quality of Service (QoS) / Information Incentives Scheme (IIS) performance to Ofgem.

Ofgem's requirements for the submission of data and the accuracy to which it must be reported are contained in Ofgem's '*regulatory instructions and guidance*' (RIGs)[19]. By incident, this information includes the number (CI) and duration (CML) of customer interruptions disaggregated by voltage and other classifications (such as damage / non-damage), from which Ofgem is able to determine each DNO's progress against its incentivised targets.

It is from the DNOs' annual QoS interruptions performance reports, as submitted to Ofgem for regulatory reporting year 2013-14, that the quantitative data used in this Stage 2 review has been taken. In particular, the interruption start time; which is the time at which the DNO first became aware of the incident and, where customers' supplies are affected, the time that the majority of those customers experienced a loss of supply. In this context it is important to note that 'masked', or 'hidden', faults will generally be unknown to a DNO until the upstream infeeds have been restored, or attempts have been made to restore and the feeder has failed to re-energise due to a yet-unknown fault. By setting these start times in chronological order it is possible to gain an appreciation of the overall impact that the storms had upon the DNOs' networks.

Similarly, by analysing the times at which customers' supplies were restored, it is possible to gain an appreciation of the DNOs' responses to the situation and how long it took to restore supplies to all the affected customers.

The nature of a severe weather event and the characteristics of the restoration profile are discussed elsewhere in this report. Comparisons are drawn between the general case and the storms of December 2013 based on analysis of the DNOs' QoS reports to Ofgem.

This review also covers the important aspect of how the DNOs kept their customers informed; the messaging systems in use, the ramping-up of operations and the telephony systems and processes involved.

Under the requirements of Section 4 of Ofgem's 'customer service reporting RIGs'[20], DNOs are required to submit returns to Ofgem on their telephony reporting, including the speed of telephone response.

There are five separate key measures (KMs) within the RIGs, KM4 of which is entitled (the) '*mean time taken for response by an agent*'. Definitions in the RIGs determine what each DNO is expected to include for each of five KM measures. Both the Ofgem Stage 1 and the DECC post-storm reports indicate that ENWL appears to use a different definition of 'agent' to other DNOs. Furthermore, during the round of audit visits, several comments were made about how WPD's staff (and not a messaging capability) can

[18] Ofgem's regulatory reporting year runs from 01 April to 31 March in the following calendar year.

[19] 'Electricity Distribution Price Control Network Asset Data and Performance Reporting' – version 3 - Ofgem – 27 April 2012

[20] See Section 4 of Electricity Distribution Price Control Customer Service Reporting' – version 2 - Ofgem – 29 February 2012

answer an incoming call in the average time it reports. During the visit to WPD, it was confirmed that WPD's monitoring and measurement system for its traffic appears to be accurate in all significant respects.

The RIGs appear capable of different interpretations, there is a debate amongst companies about reporting practice and the conclusions drawn in this report are, as a consequence, qualified by a number of uncertainties. Recognising the broader significance of consistent and accurate reporting to the regulatory regime, it would be prudent for the definitions to be reviewed, with the objective of removing actual or perceived ambiguity.

4.3 Methodology

As discussed elsewhere in this report, when considering the nature of a severe weather event that affects more than one DNO, it is important to note that there are several variables which can influence the effect of the weather upon each DNO's area and its responses to the situation.

From regulatory reporting years 2002-03 to 2005-06, every single severe weather event was subject to a detailed audit. One of the requirements for exceptionality was that the number of HV incidents experienced in a twenty-four hour period exceeded 7 times a DNO's 'normal' daily average. As the industry became more familiar with the process, the approach changed to one where a higher threshold was agreed alongside an automated reporting process that obviated the need for individual audit visits. These principles were adopted and, at the beginning of the current distribution price review during DPCR5, the thresholds were adjusted to provide for several categories of severe weather events as shown in Appendix 1 of Ofgem's 'customer service reporting RIGs'[21].

The experience gained in auditing severe weather events indicated that, whilst it was possible to judge the performance of each individual DNO over time, it was difficult to benchmark one DNO's performance against any other with any confidence given the number of variables that affect how each DNO is impacted by the weather and each DNO's ability to restore supplies. These variables include but are not limited to:

- The type of weather (e.g. wind, gale, rain, icing, lightning); in what sequence, what combination;
- The nature of the weather forecasts each DNO received;
- Its precise impact upon the individual DNOs (e.g. over high ground only, any coastal affects, the strength of the wind, the strength of wind gusts, the number of lightning strikes);
- The duration of the severe weather over the area in question (how localised); and
- Seasonality, day, time of day and associated factors.

This wisdom gained from this analysis over many years has informed our approach. The impact is that there can be more confidence in the review of individual DNOs – their planning, preparedness, responsiveness, restoration strategy and delivery and their success in being available to their customers and keeping them informed – together with the general analysis of what worked well and what worked less well.

[21] Electricity Distribution Price Control Customer Service Reporting' – version 2 - Ofgem – 29 February 2012

Making direct comparisons between DNOs - beyond the analysis of basic quantitative measures - must be much more tentative and treated with caution.

4.4 Scope

This report has been prepared in such a way as to make it accessible to a wide readership. Inevitably, there is some industry-specific terminology but the most important terms are explained in footnotes or defined in the glossary.

The brief was to review and analyse company performance by licensed area, prompted in large part by the different restoration times reported by the two southern licensed areas, SSE South (SSES) and UKPN Southeast (SPN), during the December storms.

The scope was limited to the UK mainland, meaning the study of six companies and 14 licences under their ownership.

Most performance reporting relevant to this study arises from regulatory compliance, using data submitted to Ofgem by licensed area. However, as explained when discussing industry structure, increasingly those companies owning and operating more than one licensed area manage their businesses as a single entity. This is especially so in the areas of emergency planning; network monitoring, control and remote operation; customer contact and relationship management, and essential support functions such as IT, stores, logistics and transport. The degree of integration varies among companies but planned developments will accelerate this trend as new standards, systems and processes are introduced which are company, rather than licensed area, based. Reflecting this reality, the appendices are structured around the six companies and not the 14 licensed areas.

The brief was to concentrate exclusively on the DNOs and this focus is reflected throughout the study. We visited each DNO, adding in only the ENA and an IDNO with whom we held discussions on the key themes[22]. We do touch on the role and function of IDNOs at certain points where we believe they have the actual or potential to impact on overall industry resilience and responsiveness.

The scope is also narrow as it focuses on the Christmas storms and the performance of the DNOs in preparing for, and managing, the event. It does not, and does not purport to, provide a review and evaluation of the companies' many other functions, nor a generic assessment of a particular company or the companies as a whole.

It is important to acknowledge that there is a wide range of stakeholders, reaching well beyond those who have already studied and reported on this topic with a legitimate interest in the companies' performance. We hope that this study, along with those already published, will encourage further and more informed debate among the DNO community and industry observers; and inform those who have an interest in the companies' current performance and how this will improve into the future.

[22] We spoke to senior representatives at ENA and the largest IDNO GTC on the themes of the study but did not work through the full DNO questionnaire and agenda.

4.5 Acknowledgements

As appointed consultants, we were required to work to the terms of reference (ToR) set by Ofgem but conduct the study independently. We are grateful to the officers at Ofgem and those from the companies we have been dealing with for helping to safeguard this independence.

We have drawn extensively on a broad range of material relevant to this study and acknowledged sources wherever possible. If we have inadvertently quoted, used or otherwise referred to material that has not been appropriately acknowledged in the text, we are pleased to do so through this statement.

We acknowledge the help and cooperation afforded by the companies in responding to the questionnaire promptly and fully; making available those who managed 'day to day' during the severe weather of December when we visited; and to others for contributing both their ideas and time. This generosity has enabled the study to be completed within the timetable.

We are also grateful for the help given by those who reviewed an early draft of this document but confirm that the responsibility for any errors or omissions which remain rests with the authors.

It is important to say that we observed a sense of commitment and enthusiasm to improve the service to electricity customers among all those that we spoke to during the visits and in subsequent exchanges. There is openness and willingness to learn among those operating the 14 licensed networks and a preparedness to pass on good practice where there is the technology, systems or ways of working that offer the potential for cost reduction or service improvement. Dealing with the storms during the winter of 2013/14 and following up the DECC-sponsored initiatives have served to confirm this. Whilst the six companies are commercial entities with their own strategic ambitions and financial and regulatory pressures, in our estimation there remains a commitment to work together for the good of all electricity customers.

Despite the difficulties which this report reveals, we endorse without hesitation the conclusion of the Ofgem stage 1 review which says:

> [we] '*recognise the tireless efforts of the operational staff across all DNOs in restoring supplies to nearly one million customers. That this was achieved with no fatalities or serious injury to members of the public or DNO employees is testament to their dedication and professionalism*[23].'

[23] Similar sentiments were expressed in the DECC review; see especially pages 5 and 7.

5 Weather and forecasting

5.1 The winter of 2013/14

The winter of 2013/14 was characterised by extreme weather conditions[24]. Whilst the focus of the stage 1 review was on the most severe conditions, which occurred over the Christmas week, from the autumn of 2013 onwards there was a succession of extreme weather events beginning in October 2013, continuing until February 2014.

On 28 October 2013 a storm battered the southern part of the UK and caused widespread disruption. The winds were strongest in the south, east and East Anglia, with the Met Office reporting gusts of 99mph on the Isle of Wight. This became known as the St Jude's Day storm and caused four fatalities, felled trees and disrupted travel.

The storm on 4 and 5 December 2013 was a significant event. The strongest winds occurred in the north moving south through the midlands and East Anglia. A major North Sea storm surge event took place that coincided with one of the highest tides of the year and threatened much of the east coast in a similar manner to the 1953 event.

Through a combination of factors the heavy rain and strong winds of the 23 and 24 December brought widespread disruption and this episode was immediately followed by heavy rain and strong winds on 27 and 28 with heavy rain again on 29 and 30 December 2013.

On 23 December, the strongest winds occurred with gusts in excess of 70 mph over parts of south west England and west Wales during the morning, and gusts over 60 mph locally further east. During the night of 23 December the strongest winds were concentrated over southern England with gusts of 60 to 70 mph over several hours, only easing by the end of the night. Through 24 December, the strongest winds occurred mostly over the north west and Scotland.

> '*When compared to the rapidly moving [St Jude's Day storm] the fronts and strong wind zone in this storm was much slower to clear … inland gusts in excess of 50 mph persisted for many hours*'.

Gale force winds frequently exceeded 100 mph: with a recorded high of 109 mph at Aberdaron; affected much of Scotland and Western Wales and exposed coasts of the south and south west again on the night of 26 December.

There was a series of subsequent weather events. High winds and sporadic lightning storms on 25 January across England and Wales; strong winds during 4, 5 and 6 February which affected primarily the south and south west coasts; and the severe weather

[24] This summary is based on the data included in the Met Office and NERC Centre for Ecology and Hydrology study *The Recent Storms and Floods in the UK* (2014) and *Weather Review of Winter 2013/4* by MeteoGroup (2014). The quotes used in this section are from these studies.

A helpful and brief overview can be found in the Met Office article 'Winter storms, December 2013 to January 2014'. This provides, among other things, maps showing wind speeds (maximum gusts) for each of the significant events. See www.metoffice.gov.uk/climate/uk/interesting/2013-decwind

The MeteoGroup study is helpful in this context as it gives wind speeds (maximum wind gusts and hours where gusts exceeded a certain wind speed) by company, which enables the more detailed impact analysis which follows later. For consistency, wind speeds are quoted in mph; some source documents provide wind speed in knots and others kph.

event of 12 to 14 February. For this latter 'Valentine's' event, the MeteoGroup analysis catches the essence:

> '*… the strongest winds occurred to the south and south east of the storm's centre … in this case across north Wales and north west England, bringing one of the most significant wind events to affect this area in decades*.'

Most models which attempt to predict the impact of weather on network performance point to the importance of wind speed – both gusts and sustained periods of high winds - as the primary cause of damage to electricity distribution networks. However, the winter of 2013/14 has not just been about high winds and storm conditions. There have been lightning events and the winter has been characterised by exceptionally heavy rainfall and consequential flooding, especially in the south and south west. Quotes from the Met Office and MeteoGroup reviews speak for themselves:

> '*December and January were exceptionally wet. For England and Wales this was one of, if not the most, exceptional periods of winter rainfall in at least 248 years*.'

> '*Overall winter 2013/4 was the wettest winter quarter (defined as the months of December, January and February) in a record dating back to 1766.*'

> '*In a series from 1883, flow rates on the River Thames remained exceptionally high for longer than in any previous flood episode. Correspondingly, floodplain inundations were extensive and protracted*.'

The impact of this exceptional rainfall may be described as secondary but it was significant, especially in the south, south east and south west. There were examples of networks having to be de-energised for safety reasons and reconnection delayed because of flooding[25]; saturated ground conditions which made trees more vulnerable to falling / uprooting in storm conditions and adversely affected the stability of overhead line structures. There are many and varied examples of this, some examples of which are shown below. Significant also is the impact these conditions had on limiting the mobility of repair teams and others critical to efficient restoration – those involved in scouting, deploying mobile generation and logistical and customer welfare support. Flood defences around substations and associated plant stood up well however.

In summary this winter has been characterised by exceptional conditions. There has been a succession of storms, several of which have been intense and slow moving. As the MeteoGroup put it succinctly:

> '*Whilst there is no one measure of storminess, the frequency, intensity and low latitude tracks of the areas of low pressure is, in our opinion, exceptional*.'

It was also the wettest on record, especially in the south, south west, Wales and the midlands, exceeding all previous records.

[25] The village of Yalding in Kent (SPN's area of UKPN) had to be isolated for public safety because of flooding. Overall UKPN reports that 17,829 of its customers were affected by safety and flood-related incidents.

A consequence was that DNOs found themselves on constant alert, holding resources in a state of readiness throughout most if not all of the winter – from the St Jude's Day storm through to the time of the study visits during May.

5.2 Forecasting

There are two main providers of weather forecasting to DNOs; the Met Office and MeteoGroup. There is agreement between them on the analysis of the winter 2013/14 events. Other bodies issue weather warnings, including most notably DEFRA, though its guidance draws on essentially the same forecasting data.

On the efficacy with which the events under review were forecast, there were differences and these are referred to in the individual company analyses. Most notably UKPN make the point that the earliest forecast they worked to for 23 December did not cause them concern – at a time when others were in the early stages of their emergency procedures[26].

The DECC review is likely to have a positive outcome in that DNOs will have earlier pre-event exchanges under the terms of a revised NEWSAC protocol. The weather forecasting workshop will lead to enhancements to processes in several modest but potentially important ways: sharing early warnings and greater use of long range weather forecasts.

This will enable forecast information from different sources to be exchanged and reviewed by companies before the expected event. Early exchange should expose any differences which can be explored, resolved and factored into planning, preparation and, where appropriate, mobilisation[27]. The forecast of winter weather patterns will be established as an annual feature of the autumn meetings, which discuss winter preparedness[28]. Some DNOs have already revised their practices and changes are referred to in the individual company appendices.

Effort is underway to improve the accuracy and reliability of models designed to predict the impact of adverse weather on network performance and provide forecasts of resources required to achieve target restoration times. DNOs vary in their enthusiasm for these, given the many variables which affect the outcome. All agree that for the foreseeable future, any model predictions must be accompanied by the application of operational expertise and experience of managing incidents, supported by thorough planning and preparation. To paraphrase how one DNO expressed it:

> *… each specific major event has its own, unique set of circumstances … weather pattern, timing, scale and type of damage, geographic coverage … impact on the overall infrastructure … and other pressure the network is under…*

The Met Office study points to the importance of understanding future weather patterns, a theme which is taken up by the DECC review[29]. There remains a

[26] The detailed sequence of events is set out in the UK specific appendix.

[27] See recommendations R1 (Sharing resource and contractor management strategies) and especially R5 (NEWSAC). This latter recommendation is that the NEWSAC Aid Protocol should be reviewed, a process which is continuing at the time this study was prepared.

[28] See recommendation F1.

[29] See section 2 'What is the likelihood of similar periods of severe weather occurring in the future' which reviews briefly climate changes projections from UKCP09 and IPCC Fifth Assessment Report.

considerable degree of uncertainty in predictions about the frequency, intensity and trajectory of storms but the general prognosis is reasonably clear.

Severe storms have always affected the UK and will continue to do so and, whilst the impact and origin of climate change remain a source of contention, the balance of argument suggests the incidence of severe storms will not lessen and may indeed increase.

The country may also see generally wetter winters with a greater proportion of rain falling as heavy events, meaning that, going forward, it would thus be unwise to treat the conditions experienced during 2013/14 as 'exceptional'. In the light of what happened during the winter of 2013/14, customers and their advocates will expect the industry to progressively improve the resilience of electricity distribution networks and their capacity to recover from severe weather incidents. Although outside the scope of this review, the long term impact for the industry, and specifically for electricity network assets, has already been studied under the auspices of the Energy Networks Association[30].

Two points may be made by way of summary:

First, as will be seen, DNOs were affected differently by the storms and one measure of 'storminess' on its own does not capture the impact adequately; it is a combination of wind speed and gusts, duration of the event; and associated factors such as ground conditions and flooding.

Second, the weather patterns have been well described and analysed by the Met Office and MeteoGroup; and, by a number of their key measures, the winter of 2013/14 was exceptional. However, the evidence on likely future weather patterns suggests that the storm events experienced this year may be more frequent into the future.

[30] *Electricity Networks Climate Change Adaptation Report* Electricity Networks Association Reference: ER1 (2011). See especially in this context sections 5.1 which deals with overhead line risks and 5.2 which considers increased rates of vegetation growth.

6 Weather-related distribution network emergencies

6.1 Response to a weather-related electricity distribution network event

To fully understand the issues and challenges associated with restoring customers' electricity supplies following a severe weather-related event it is important to consider the various inter-linked elements of the situation, including:

- What short term preparations can be made, assuming longer term strategic plans are already in place;
- The impact of the weather on the distribution network(s);
- The means by which customers' supplies can be restored;
- The impact of the weather on access to incidents / damage sites to assess the situation (scouting and making-safe);
- The impact of the weather on access to incidents / damage sites to carry-out repairs;
- The support that can be provided to customers during extended periods without supply; and
- Importantly, the means of communicating with customers during this period.

Evidence indicates that all DNOs have in place well developed and rehearsed plans covering all aspects of their responses to a severe weather emergency situation. These include strategic issues of resilience and preparedness as well as those matters that can only be implemented shortly before, or immediately at, the point at which a severe weather impacts the DNO's area.

6.2 Longer term emergency plans and preparedness

Longer term preparations and plans include matters such as ensuring stocks of repair materials are available at strategic locations; availability of suitable transport and logistics for the likely conditions, such as snow and floods; and designated emergency roles for staff. These items and others are planned outside the emergency period and routinely checked during the periods between emergencies.

All distribution companies' (along with transmission's) emergency plans were reviewed under the Department for Trade and Industry's network resilience review carried out in February 2002[31]. This 2002 review was commissioned by the DTI. The need for the reviews was based on a growing concern that the electricity distribution sector had reduced staffing levels, was taking risks with its maintenance and taking a much shorter term view of network resilience, possibly due to the regulatory pressure it faced; than had been the case under nationalised ownership.

In all companies the emergency plans were found to be fit for purpose and it was considered likely that the industry was better organised, better equipped with technological support and more responsive than it could have been under its former ownership. In October 2002 this resilience was tested by a severe weather event in

[31] 'Resilience of the Transmission and Distribution Networks' 2002 DTI

which one or two companies did not perform well and the DTI commissioned a further review to test the assertion that companies were, on the whole, better prepared than before. This second review in 2002 confirmed the view that, in general, the distribution companies were better placed to deal with the impact of a severe weather event than they had previously been, as evidenced by the performance of some, while those that failed to perform well were actually not implementing their own maintenance standards - particularly in terms of tree clearance.

Since 2002 there has been a further regrouping of distribution licensed area, ownership and emergency plans have evolved taking into account best practice and further significant improvements in technology. Examples are the use of network automation for higher percentage "first hour" restoration and network intelligence processing, through to the use of text messaging and social media for providing information to customers.

Based on their management philosophies and experience of what works best in their areas, the six ownership DNOs have evolved different approaches in their plans.

At one extreme, the approach is to do nothing different in terms of incident response from routine operations other than to rapidly escalate the scale of operations to do 'more of the same' by diverting the whole of its team to emergency response and repairs. Accountable managers have the delegated authority to stop planned work, divert teams to different locations, deploy generators and do whatever is required to restore customers' supplies without seeking approval. This approach appears to be very effective.

At the other end of the scale is a more formal process of setting up central emergency 'committees' or groups of senior staff to make strategic decisions such as the suspension of day work and movement of teams to focus on repairs, calling on NEWSAC, and agreeing Government / media updates. There remains a degree of delegated authority to regional operational units to allocate incidents for repair to appropriate resources but strategic responses are retained by executive teams. This form of governance conforms to good 'command' practice and ensures resources are allocated efficiently. This approach tends to be modelled on the 'gold-silver-bronze' structure used by the emergency services. Others use a variation of the two approaches.

A key enabler that allows any of these organisational approaches to function is the use of technology in ensuring that everyone active in an emergency response role has timely access to vastly improved information regarding the event and restoration progress than was available in 2002. The same information is also instantly available to the people delegated to respond to Government / media enquiries but who may not be directly classified as 'active' in the sense of responding to the emergency.

The sector has generally responded very well to deploying the latest advances in technology, some inevitably ahead of others due to timing of replacement systems compared with technological advances and ownership. The drivers behind DNOs organising themselves as they do include:

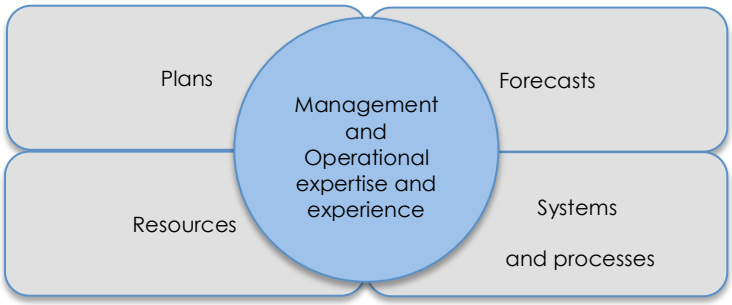
- The hands-on operational experience of the decision makers;
- The geography and travel distances between their licensed areas;
- The numbers and locations of their skilled staff; and
- Their overall management philosophy.

Both approaches can work effectively. The less formalised and regimented approach to escalation has a greater dependency on a team understanding with clear leadership and delegation and may be considered more vulnerable to adverse impact from changes to ownership or leadership. The command type governance regime ensures a strategic overview of priorities and resource allocation but may be characterised by lack of pace and flexibility at local level. Key ingredients to any approach are the experience of the lead people and the availability of information.

Whatever their particular approach, all DNOs link into the local emergency services' command organisations operating in their geographic areas.

6.3 Short term preparations

Weather forecasting is improving and, though there are notable exceptions, is generally becoming more accurate in its predictions. The forecasts, in terms of predicted wind speed and direction, damaging gusts, predictions of flooding, lightning activity and temperature generally give distribution network operators a very good indication of the types of problem that will be encountered along with an indication of the severity of the anticipated damage to their distribution infrastructures. Clearly though, weather forecasts cannot predict the locations of individual network incidents or which of a DNO's customers' supplies will be affected. Some DNOs have developed models to predict the probable number of incidents they will suffer at each voltage level. Others have less confidence in the value of this approach.



In response to weather forecasts the distribution companies can, and generally do, put all of their staff on alert, increase out-of-hours standby cover and increase staff levels in key roles. However, they still have to wait until the weather pattern arrives and incidents start to occur before they can begin to gather intelligence and plan detailed restoration tactics against their well-rehearsed plans, procedures and / or approaches they have in place. Prompt response to weather alerts and implementation of plans by experienced people are key to managing the event.

6.4 Assessing the impact

A severe weather-related emergency event on a distribution network is not a single major incident, such as those that may have to be addressed by the blue light emergency services, but hundreds, potentially thousands, of smaller individual incidents occurring at, or very close to, the same time.

After automatic and remote-controlled tele-switching has happened it therefore becomes a very significant logistical exercise in gathering data, identifying issues and mobilising "the right resources with the right equipment and materials to the right location at the right time" before repairs can be started.

This is generally prioritised on restoring the maximum number of customers in the shortest time in a still-evolving situation. Against that priority, identifying individual customers, particularly those with special needs from the PSR register, who are still without supply while major repairs are on-going, remains an issue to address throughout the event.

The impact on the distribution network will depend upon a number of factors, some within the control of the network operator, others not so. Those within the network operator's control are essentially related to the type of construction standards and maintenance condition of the overhead line networks along with protection from damage from external sources - primarily tree-related damage. Those outside their control are all directly or indirectly weather-related. This is not just immediate temperature, wind speed and direction but also the period of exposure, seasonal conditions and the combination of weather patterns over extended periods; such as the exceptional rainfall and frequent periods of high wind speeds during the winter of 2013/2014.

6.5 Examples of faults encountered

The scale of the damage caused by the storms of December 2013 can be gauged from the typical photographs taken by DNOs' staff in the south of the country as they worked to restore their customers' supplies. The strength of the wind uprooted trees where the sodden ground provided insufficient 'holding' for the trees' root systems. In one incident for example, the up-turned root ball unearthed a high voltage underground cable, causing it to fail.

Figure 2 Roads made impassable by falling trees

Figure 3 Building collapse onto adjacent substation

Figure 4 Overturned tree with root ball

The following photographs depict incidents where trees outside of a DNO's cut swathe have been blown over and damaged the DNO's overhead line system.

In each case it should be noted that the weight of the fallen timber is considerable and the strain on the aerial conductors is high. Therefore the safe removal of the tree and the releasing of the tension in the conductors must be carried-out in a safe manner by people who have the requisite skills. In summary – this is not simply a matter of putting a chainsaw through the partially suspended tree trunk - the safe removal of the fallen tree from the DNO's equipment is not a straight-forward matter. Hence, whilst it is not possible to be precise about the time to repair the damage, an indication is provided as to its likely duration.

For each of the following situations, an assessment is made of the likely time it took for the DNO to be made aware of the incident, the number of customer supplies the incident would have interrupted, the time it might take to complete repairs and what the DNO could have done to mitigate against the incident occurring.

Case 1 - Tree fallen through an open-wire LV overhead line

Figure 5 Tree through overhead line

This incident has been caused by a tree falling from a garden into an open-wire low voltage overhead line, breaking the four conductors and the under-running telephone wire. The pole in the foreground has been pulled-over by the impact but appears to be sound and capable of being up-righted unless there is damage at the point where it has pivoted about the footpath and would therefore need changing.

DNO discovery/awareness time

Given that the damaged overhead line runs along a roadway and across the frontages of houses, the DNO would be alerted to the incident by telephone calls (or other media) from its customers, providing they were not solely reliant upon the damaged telephone wire. It is expected that the DNO would know about this incident within 10 minutes.

Impact on customers

Dependent upon the type and size of properties, a low voltage overhead line of this type would supply between 50 and 150 customers. In this case the number is estimated to be towards the lower end of the scale as the properties are large and detached.

Repair time

The tree is resting on the ground and is not suspended by the overhead line conductors. Its girth is considerable and therefore requires a powerful chainsaw with a long chain bar to cut it into sections so that it can be safely removed. The time to clear the tree is estimated at being between 2 and 3 hours once the appropriately equipped people have arrived on site.

After the tree is cleared and its weight removed from the broken conductors, the leaning pole can attended to. To prevent injury to people and further damage it would be supported and the tension released from the conductors on the non-damaged span. If sound, the pole can then be up-righted and the infill around its base re-compacted. If damaged, it would be removed and a new pole installed.

Re-placing the broken conductors and re-tensioning the non-damaged ones needs care to ensure the forces on each side of the pole are balanced. It is estimated that the above repair work might take in the order of 4 to 5 hours to complete.

Possible mitigation

The replacement of the open-wire overhead line with aerial bundled conductor (ABC) would not have prevented the incident but, with appropriately fitted 'weak-links', the pole may not have been forced out of plumb and the conductors may not have been damaged. Thus, once the tree had been cleared, the work to repair the DNO's system would only take an estimated 2 hours.

The fallen tree was situated in a garden and not on the public highway. There is therefore no legal right of way or wayleave under which the DNO could have reasonably entered the private garden to lop or fell the tree as it was outside the cut swathe of the low voltage overhead line.

Case 2 - Tree suspended by an open-wire LV overhead line

Figure 6 Tree suspended by open-wire LV overhead line

This incident has also been caused by a tree falling from a garden into an open-wire low voltage overhead line. This time the tree had broken one conductor and its weight is suspended by the three non-broken conductors.

The wood poles are intact and the principal safety concern would be how to remove the tree without the conductors whipping-back once the weight of the tree has been removed.

DNO discovery/awareness time

Similar to the previous case, given that the damaged overhead line runs along a roadway and across the frontages of houses, the DNO would be alerted to the incident by telephone calls from its customers, it is again expected that the DNO would know about this incident within 10 minutes.

Impact on customers

As previously, a low voltage overhead line of this type would supply between 50 and 150 customers. In this case the number is estimated to be towards the middle of the scale as the properties are a mixture of smaller cottages interspersed with larger, detached houses.

Repair time

The tree is supported by the overhead line conductors and its safe removal requires careful planning; the safest way would be to support its weight and thus relieve the

tension in the three overhead conductors so that they can be safely lowered to ground level.

The tree can then be lowered to ground level, cut into sections and removed, following which the overhead line conductors can be replaced.

It is estimated that the total time to remove the tree and restore supplies would be in the order of 3 hours once the appropriately equipped and skilled people arrive on site.

Possible mitigation

The replacement of the open-wire overhead line with aerial bundled conductor (ABC) would not have prevented the incident but, with appropriately fitted 'weak-links'; the overhead conductors may not have been damaged. Thus, once the tree had been cleared, the work to repair the DNO's system would only take an estimated 1.5 hours.

As before, the fallen tree was situated in a garden and not on the public highway. There is therefore no legal right of way or wayleave under which the DNO could have reasonably entered the private garden to lop or fell the tree as it was outside the cut swathe of the low voltage overhead line.

Case 3 - Tree brought down an ABC LV overhead line

Figure 7 Tree brought down an ABC LV overhead line

This incident has been caused by a tree, which has brought down a low voltage "aerial bundled conductor" (ABC) overhead line. The conductors appear to be intact. It is unclear if any wood poles were damaged.

If the conductors are intact it is probable that no customers lost supplies as a result of the tree falling. That said, however, it would be necessary for the DNO to de-energise the line to enable the tree to be safely sawn into pieces and removed.

DNO discovery/awareness time

If supplies were lost due to overhead line connections being damaged, it is again expected that the DNO would hear from its customers within 10 minutes.

If no supplies were lost as a result of this incident it is most likely that it would be discovered by the first person to use the lane after the tree fell and this may take several hours.

Impact on customers

ABC is used as a direct replacement for open-wire low voltage overhead lines and is therefore capable of supplying up to approximately 150 customers. Given the rural nature of this setting, it is likely that no more than 50 customers would be supplied via the grounded line.

Repair time

This is a substantial tree and its clearance is expected to take between 2 and 3 hours, during which time, if it was not already, the ABC would be de-energised for safety. Assuming no damage to wood poles, once the tree is cleared, the ABC can be re-hung, re-terminated and re-energised within 2 hours. If any wood poles need changing then the repair time would be consequently longer.

Possible mitigation

The DNO has recognised the possibility of damage to its overhead line from the vegetation along the lane and, apart from the need for a safety shutdown to clear the fallen tree, the use of ABC conductor has already mitigated against incidents of this type affecting customers' supplies.

Whist it is not clear if any wood poles were damaged in this incident, the use of 'weak-links' by which the ABC is suspended could help mitigate against wood pole damage in locations where it is safe to install them.

Case 4 - Tree brought down a high-voltage overhead line

Figure 8 Tree brought down an HV overhead line

In this incident, a tree has fallen into an open-wire high-voltage overhead line and is partially suspended on the intact conductors. The conductors are clear of the ground and may have remained energised or been re-energised through the operation of auto-reclosing switchgear. There is considerable strain on the conductors but the wood poles at each end of the affected span are intact and upright. The position of the tree relative to the conductors suggests that it fell vertically downwards onto the line as opposed to falling sideways into it.

The left-hand insulator spindle on the wood pole beyond the tree has been bent sideways during the incident. The principal safety concern would again be how to remove the tree without the conductors whipping-back once the weight of the tree has been removed.

DNO discovery/awareness time

If supplies were lost it is expected that the DNO would be made aware of the fact within 10 minutes by its customers or instantaneously if an item of tele-controlled high-voltage operates to clear the incident from the DNO's system.

If supplies were not lost, it is most likely that it would be discovered by the farmer whose field the DNO's overhead line traverses.

Impact on customers

HV overhead lines of this configuration are generally used to supply small groups of houses or small farms in rural areas. Thus the number of customers affected by this incident would likely be in the region between 1 and about 10.

Repair time

This tree is partially suspended on the overhead line conductors and its weight is placing considerable strain on them. The safest way to remove the strain in the conductors is to gradually lower them in a controlled way from the nearest pole that is safe to climb. This would only begin once the line is proved dead, earths applied and a permit for work issued.

Once the conductors are on the ground the tree can be cut into pieces and removed, the bent insulator spindle replaced, the conductors re-strung, the permit for work cancelled, the earths removed and the overhead line re-energised. It is estimated that the total time to remove the tree and restore supplies would be in excess of 3 hours.

Possible mitigation

In this case, the DNO's overhead line is situated along the headland of a field. The falling tree was located outside of the field boundary in land potentially under a different ownership to that on which the DNO's line stands. Hence the DNO would have no wayleave with that landowner and no legal agreement to lop or fell trees thereon.

The replacement of the open-wire overhead line with insulated conductor (BLX) would not have prevented the incident. Whilst the concept of 'weak-links' in BLX systems is untried, the introduction of such in this case would have permitted the BLX to fall to the ground and reduce the time it would take to render it safe to remove the tree, possibly halving the repair time.

6.6 Intelligence gathering and restoration by switching

All DNOs have SCADA (Supervisory Control and Data Acquisition) systems monitoring their higher voltage networks (6.6 / 11kV and above), also enabling remote control of key network devices. They are all, to a greater or lesser extent, working on automation and remote control[32] of their distribution networks such that many supply interruptions are detected and a proportion of customers restored, often within three minutes, significantly reducing the number of customers waiting for network repairs to take place.

[32] Remote switching from control centres must be carried out with due regard to the safety of public and staff. Companies each have their own policies to address this.

These tools are the key means of the high percentage of customers (51% nationally in the Christmas 2013 storms, for example) restored to supply within one hour of interruption. This first hour restoration performance is the result of the prudent application of allowable capital expenditure and is a key differentiator from the performance the companies were able to deliver a decade ago. This level of automation is supported by manual operations at locations where first response teams can physically travel to site and carry-out field switching operations. To enhance this first hour performance significantly further will require investment at levels that may be seen as unjustifiable to bill-paying customers. The performance of the sector is considered to be good with marginal improvement still expected in its first hour response.

After the first hour, the next stage of customer supply restoration depends upon further levels of manual switching in the field to isolate damaged sections of network (requiring repair) and reconnecting supplies by alternative, manually switchable means. By focussing on network intelligence drawn from monitoring devices, incoming customer calls and proactive calls to identified customers, this switching can be prioritised to restore the maximum numbers of customers quickly.

This group of restoration stages is achieved by the DNO's own resources. Figure 9 overlays those restoration stages on the actual profile of customers without supply over Christmas 2013.

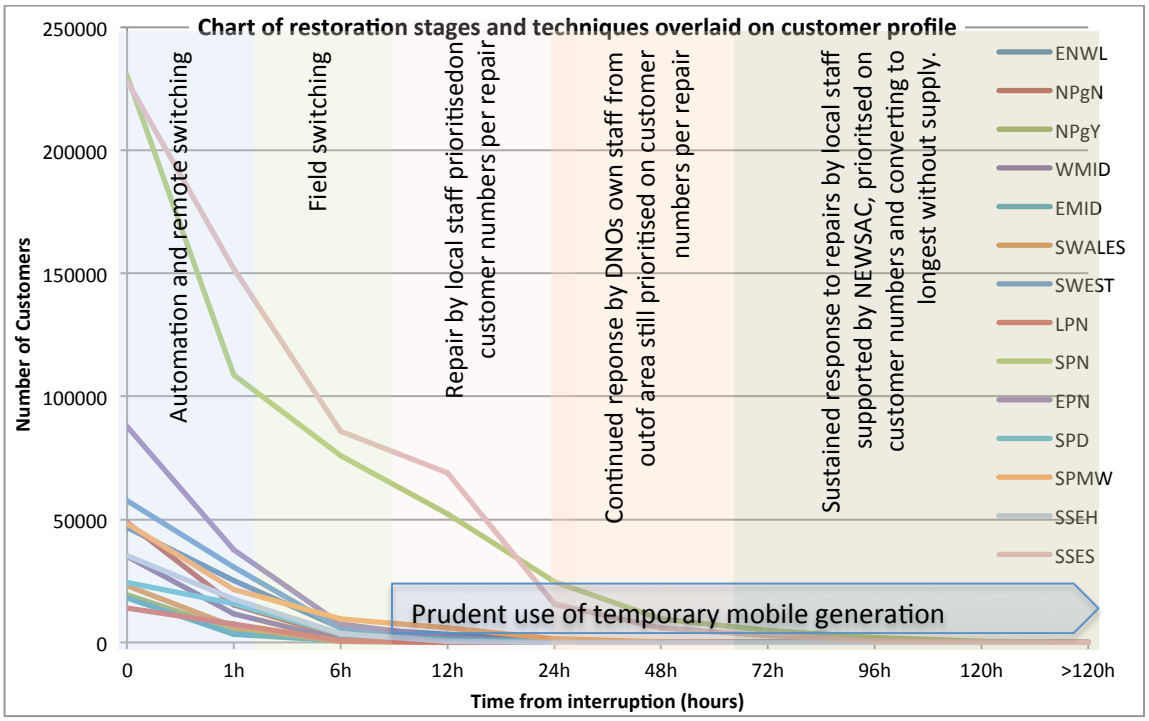


Figure 9 Restoration phases and techniques

6.7 Ongoing restoration by repair

Individual incidents requiring physical repair on distribution networks may range from major high voltage network damage through to single premise connections that have become detached. Whilst the number of customers affected is generally higher with incidents on the 11kV system compared with incidents on low voltage systems (for the purpose of discussion assuming that at 33kV and above there is duplication to at least

an (n-1) level such that a first circuit outage does not cause customer supply interruptions) there is no direct correlation between type of incident, number of customers affected and repair time.

Following the restoration of maximum customer numbers by automation and switching to alternative sources of supply, customer restoration is then continued by dealing with field repairs; generally prioritised on maximum customer numbers per repair. The large number and widely dispersed locations of Priority Services Register (PSR) customers means that adopting the 'maximum number' approach is also highly likely to address the maximum number of those with special needs, though there remains the need to monitor and address individual cases, which all companies have processes to deal with.

After an initial (undefined, but based on progress) period of prioritising repairs by customer numbers restored, focus has to turn to addressing those customers longest without supply and will start to include different techniques including local mobile generation.

A very significant issue regarding customers longest without supply is the feature of "nested" or "masked" faults. This is the situation where there is more than one incident that impacts on an individual customer's, or small group of customers' supplies. If the second and subsequent fault(s) are on a low voltage, unmonitored, section of network the DNO will only become aware of their existence through proactive contact with customers by, voice call back, text message or social media when the first fault has been repaired, or through early scouting activities.

It is considered best practice to be proactive following fault repairs and deploy scouting teams from the onset of the emergency to gather this data, which is essential for 'managing the tail' – the relatively small proportion of customers whose supplies are not restored by the first round of repairs.

Some DNOs have, to a greater or lesser extent, made use of Power Outage Detectors (PODs) over the last decade as a reliable source of network information. Essentially these devices, installed at strategic locations on the network, detect a supply failure and generate a message to the DNO, via a landline, to inform it of the failure. They also send a return to service message by the same means when supply is restored. This is invaluable information regarding feeder extremities for the DNO. These devices had issues, partly associated with customers' acceptance, partly through inadvertent disconnection and erroneous messages. The cost of installing them as an additional device in all premises would be prohibitive.

There is an expectation that when smart metering becomes the norm in the country this role will be a feature of the meters. This is subject to the functionality which had been included in the specification to allow DNOs to 'ping' the meter to check the status, working as intended.

The repair activity continues as long as there are customers without supply. It also continues beyond the last customer restoration for the purposes of making permanent any temporary repairs that were necessary, and for restoring network resilience through repairs to alternative circuits where damage-related incidents did not interrupt customers' supplies. Site repairs require skilled overhead line staff for safe and effective completion. The safety aspect has to be given highest priority and, as well as electrical safety which is always paramount, the weather conditions including high wind speeds and lightning activity have to be taken into account.

Staff Group	Response Time
DNO's own locally-based staff	Immediate
DNO's staff from an adjacent licensed area	4 to 8 hours
DNO's staff from a remote licensed area	12 to 18 hours
Staff mobilised under NEWSAC	24 to 48 hours
Contractors' staff	Immediate to 48 hours depending upon contract terms, the location of the people and the time of year (e.g. public holidays)

Table 3 Response phases

Overhead line staff may be locally based, employed by the DNO but based in a different location, employed by a different DNO or employed by a contractor to one of the DNOs. Mobilisation time for each group of staff may be significantly different but may be categorised under the general broad headings shown above. It should be noted that staff travelling for several hours in commercial vehicles, require a period of rest before they can safely be put to work on repairs, particularly where hard physical effort is required at height. This essential is included in the above time broad bands.

7 Response to the December 2013 storms

7.1 Overview of incidents and restoration

In section 5 the weather patterns during December 2013, and the entire 2013/14 winter were discussed in some detail. In this section we review the impact of the weather on the distribution networks across Great Britain. The persistent severe weather in December caused a high level of system activity throughout the month. Some companies were at, or very close to, their exceptional weather event thresholds for 50% of the month.

During the underlying busy month there were two peaks of weather-related activity on distribution networks. The first, peaking on 5 and 6 December was essentially a north of England and Scotland event, with SPD and SSEH suffering at least twice as many incidents as any other licensed area. Though not in the north, EPN and WPD (EMID) were the next most badly affected.

This event, starting on 5 December was handled by the Scottish companies calling in resources from their sister companies in England supported by resources mobilised through NEWSAC. This storm hit a peak of incidents on 5 December but had subsided by 6 December.

Figure 10 shows the abnormally high network activity through the month of December with the two major peaks of incidents, which correspond to the peak wind speeds and locations. It is also apparent that the duration of the first severe weather peak on 5 and 6 December was shorter than the second, which started on 23 December.

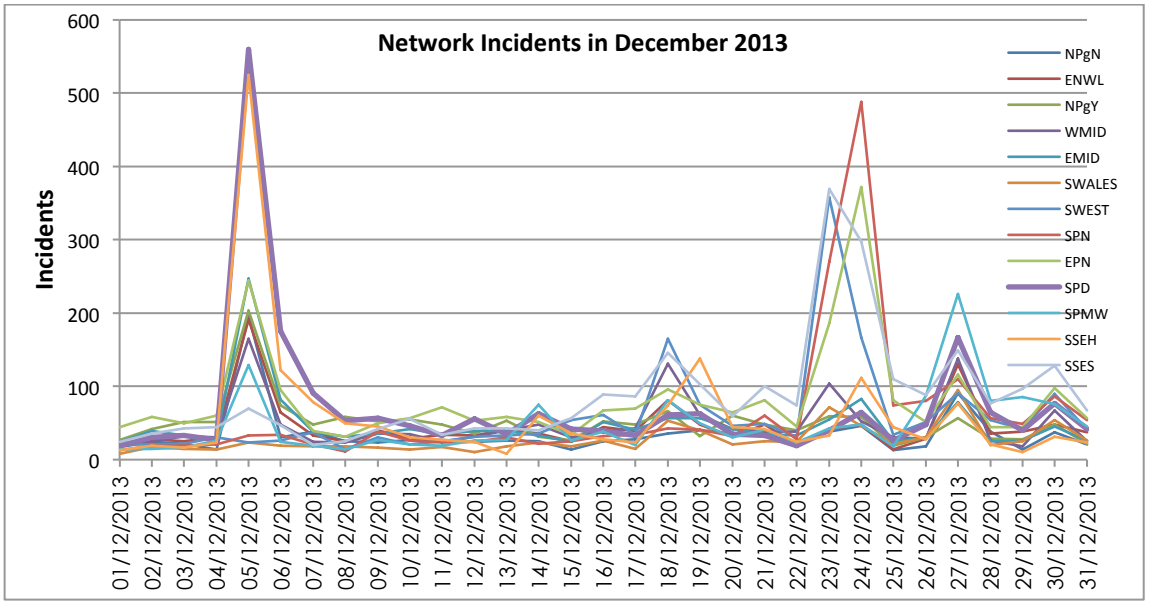


Figure 10 Chart showing incident pattern - December 2013

The second event, which attracted much more attention because of the location of its damage and the season, is itself best considered as two distinct events purely on a magnitude basis.

This event, which was very much more focused in the south of England resulted from a weather pattern that first caused damage to networks on 23 December and moved

west to east across the south of the country causing major damage on the networks of WPD (South West Licence – 756 incidents by 28 December) and SSEPD (SSES Licence – 1091 incidents by 28 December). The peak of activity on these networks occurred on 23 December, beginning to subside on 24 December when it moved across the territory of UKPN causing major damage peaking late on 24 December (EPN - 850 incidents and SPN Licences – 1079 incidents by 28 December).

It is also noticeable that this peak of activity over the Christmas period itself had a major peak on the first pass of the weather pattern, on 23 and 24 December and a second, lesser peak three to four days later, when more of the country was affected on 27 an 28 December. Christmas Day and Boxing Day were relatively less active in terms of new incidents occurring on the southern networks though by no means quiet and repairs were on-going from the pre- Christmas incidents.

The four southern licensed areas each had more than three times the number of incidents in the 48 hours of 23/24 December than any other licensed area.

Table 4 shows the total number of incidents suffered by the 4 licences over the Christmas period and the rate at which they were repaired.

Licence	Incidents 23 to 28 December	Repaired in 24 hours	Repaired in 48 hours	Repaired in 72 hours	Repaired in 96 hours	Repaired in 120 hours	Repaired in 144 hours
WPD (SWest)	756	740	749	750	751	753	756
SSES	1091	669	803	903	990	1045	1091
SPN	1079	351	499	639	788	925	1079
EPN	850	761	822	827	837	839	850
Note: not all of the incidents in the table above at the tail end of the event affected customers.							

Table 4 Incident repair rate

WPD (SWest) had received advance weather warnings from the MeteoGroup and was able to mobilise staff from its two midlands licensed areas to the south west in readiness. As a result, WPD's staff were in place, ready to start repair work when the storm arrived and as soon as it became safe to do so. There were some delays to climbing for repair work as with other DNOs. WPD suffered 47% of its incidents in the six day event on 23 December. The scale of WPD's operation with four DNOs, only one of which was severely affected gave it the opportunity to take this action. However, it also has to be recognised that with the highest ratio of linesmen to length of line in the country, a very high proportion of whom are directly employed, they have provided themselves with a high degree of resilience and diversity. In business as usual terms, there has been a noticeable improvement in CI and CML in both the East and West Midlands licensed areas since WPD took ownership.

In the event, WPD had fewer system incidents, which peaked 24 hours earlier than SPN, had people in the right place to start work and was able to get the vast majority of its affected customers back on supply before Christmas Day.

SSES had also received advance warning of the severe weather but was also under a weather warning for its Scotland licensed area such that it was unable to make any immediate transfers of staff in ether direction. Transferring staff between these two areas is a significant decision to make with the risk of severe weather at both locations. Even

though there is no NEWSAC involvement in such a decision, from the time a decision is made and teams have travelled, rested and started to be effective on repair work an elapsed time of 24 hours may be expected. SSE normally has slightly more overhead line staff working in its southern licensed area than WPD does in the south west, but over 50% of them are contract staff and some had travelled home for the Christmas period so were unavailable. SSES reported some difficulty in getting contract staff back into area due to travel arrangements, particularly from Ireland, but did manage to get some back to work with 48 hours notice. They also attribute some difficulty in mobilising directly employed staff on the actual public holidays to their terms and conditions of employment, though the precise impact of this is difficult to quantify. Even with these disadvantages, SSES was able to restore over 60% of its system incidents within the first 24 hours. Like WPD, the main impact of the storms was on 23 December when 34% of its incidents over the six day period occurred.

UKPN had received advance weather warning from the Met Office for 18 December that was subsequently stood down on 20 December when the predicted weather did not arrive. Through 21 and 22 December, UKPN received progressively worsening forecasts from the Met Office, leading to UKPN invoking the NEWSAC agreement when the severe weather was forecast to impact both its EPN and SPN licensed areas. On the morning of 23 December the forecast worsened still, by which time the weather pattern had already begun to impact the networks.

UKPN's two licences with overhead linesmen are adjacent, with a relatively short travel distance to transfer staff, but both licences were subject to severe weather warnings making an advance decision to move staff difficult. As described above, the weather warning did not give timely notice of the event; though arguably the impending weather pattern could have been expected from network activity in their western neighbours and from the national media.

UKPN's two licensed areas suffered the main impact of the severe weather some 24 hours later than WPD South West and SSES, in the late afternoon of Christmas Eve, giving less time to restore customers' supplies before the critical public holidays of Christmas Day and Boxing Day. This no doubt contributed to some of the mobilisation issues encountered[33].

In November 2010, UKPN took over a somewhat neglected network in terms of maintenance (in particular tree clearance in the EPN area) from EdF Energy. The UKPN licensed areas were among the poorest performers in terms of CI and CML nationally and, similar to the improvement WPD has made in the midlands, UKPN has achieved an improvement in CI and CML. UKPN has recognised, and been working on, the need to increase its numbers of overhead line staff by both direct employment and increased numbers of contractors and is in a period of recruitment. However, in spite of this, in December 2013 it still had the lowest ratio of linesmen to length of overhead line. Almost one third of UKPN's linesmen are contract staff working predominantly on the EPN network (which is almost three times as large as that of SPN).

Other than the four networks discussed, the rest of the country was not affected in nearly the same way and, whilst there were cases of customers being without electricity

[33] Although not studied in detail, the anecdotal evidence suggests this does not seem to have been linked to terms and conditions acting as a disincentive to staff turning out. UKPN was offering sizeable payments to those who made themselves available to work. The payment details are available but not disclosed in this report.

across the country, this was at a lower level and those companies were generally able to cope to restore electricity customers with their own resources.

Figure 11 shows the impact of the faults on customers (numbers still without supply at key milestones after interruption) and how the two licences, SPN and SSES, had significantly more customers affected. Nevertheless they still had one-hour and twenty-four-hour restoration performance comparable with what has become the industry norm, due to (a) investment in system automation and remote control, which was complemented by (b) mobilisation of field switching resource. The first hour profile for WPD (SWest) and EPN is equally impressive, but starting from a lower number of customers affected.

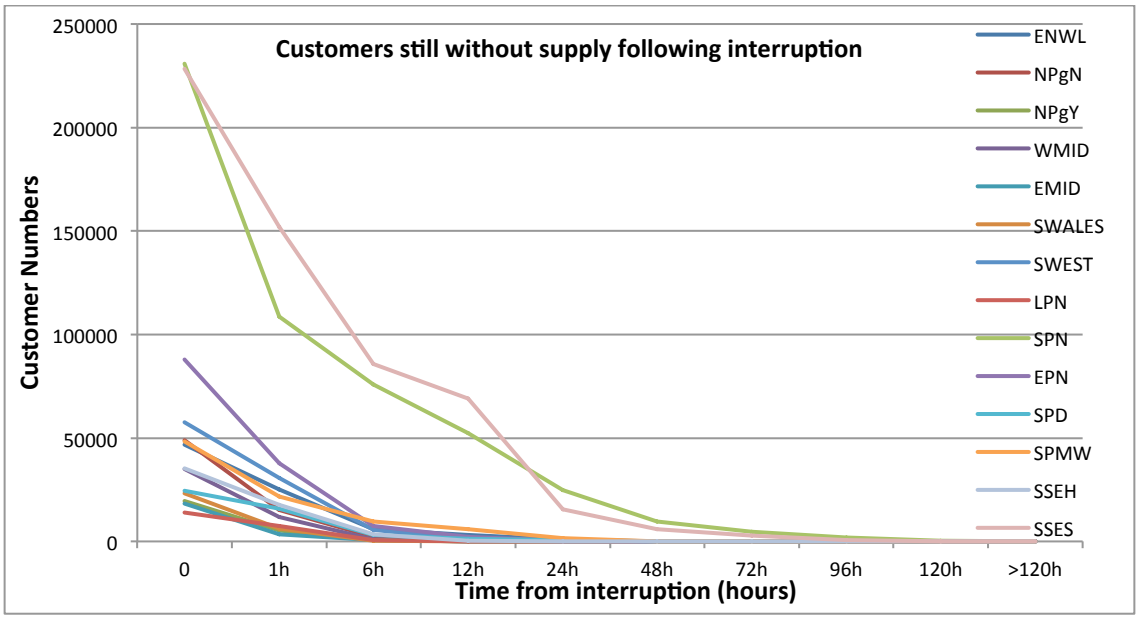


Figure 11 Customers without supply (hours after interruption - non linear scale)

The graph in Figure 11 has a non-linear scale over the first 24 hours to show the distinct stages of restoration. On a linear scale as shown as a national position in the Figure 12, the impact of the early restoration is even more dramatic and demonstrates the impressive performance of all companies through prudent investment in automation and remote control facilities. As a result of this investment, customers supplied by all companies are far better served in an emergency event than they could have been a decade ago.

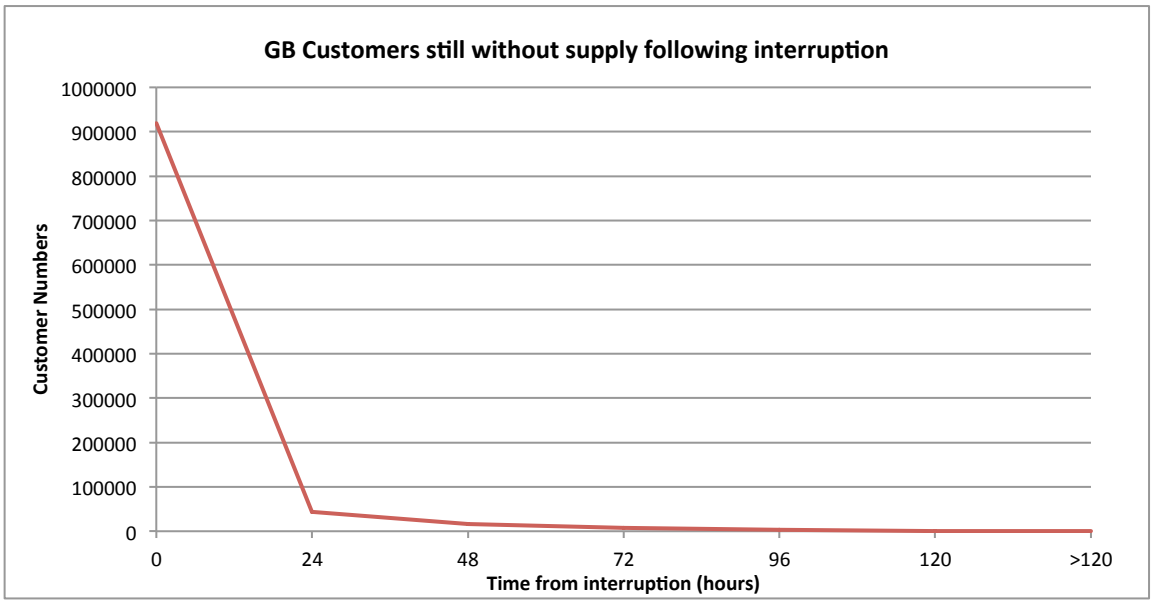


Figure 12 Customers without supply (hours after interruption - linear scale)

It is worth looking further at the incident rate and restoration profile of the four most severely affected licences, WPD (SWest), SSEPD (SSES) and UKPN (EPN and SPN).

Figure 13 shows clearly the impact of the moving weather pattern from west to east, with WPD (SWest) and SSES suffering most incidents on 23 December, with a gradually declining rate, while SPN and EPN both started on the 23rd, picked up significantly to suffer more incidents on Christmas Eve, and then a sharper decline to Christmas Day. All four however were still suffering more incidents than elsewhere in the country. A warning of lightning activity on the morning of 25 December hampered SPN's repair activity until the danger had passed.

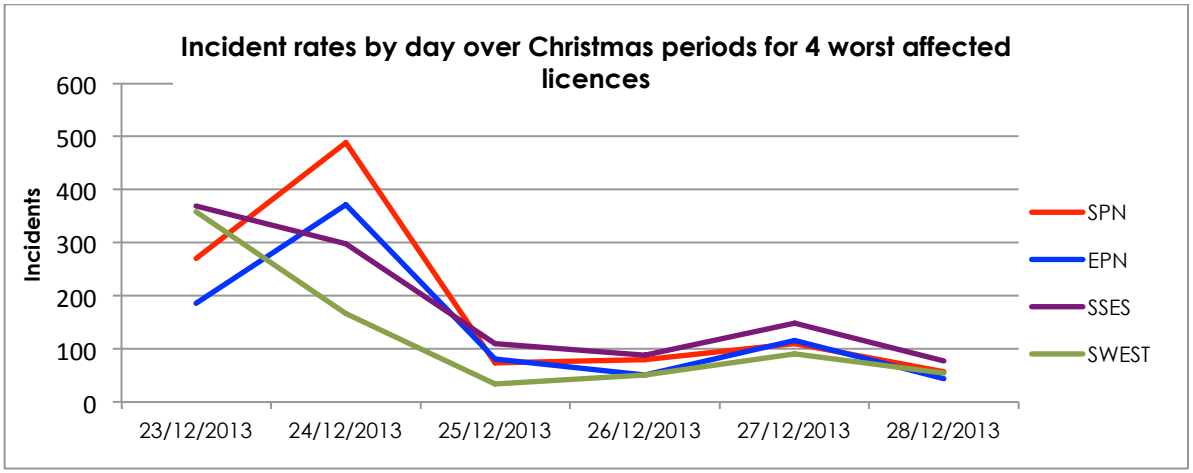


Figure 13 Incident rates by day - four worst affected licensed areas

Furthermore, all four of these DNOs were affected again on 27 December but this event hit most severely in Scotland, West and North Wales and the north of England. That said, in the case of SSES, SPN and EPN, there was still work going on to repair the incidents that occurred late on Christmas Eve and through the two-day national holiday.

This profile of incidents and restoration provokes two key questions. First, what was the underlying cause of so many network incidents? Second, why were there extended restoration times in some areas compared with others?

7.2 Number of Incidents

The high number of incidents suggests either a difference in network condition compared with the rest of the country, and therefore ability to withstand the weather conditions, or a different set of weather and environmental conditions.

In this review we have looked at network construction standards and approaches to maintenance and there is no evidence to suggest that any of the companies are not constructing to recognised industry standards, including ENATS 43-30 for low voltage lines and, in particular, ENATS 43-40 covering 11kV lines, which are the network elements that have the most dramatic impact on number of customer interruptions. Nationally, there remain some legacy derogations to planning standards, where the costs of alternative supplies cannot be justified but none are understood to exist on the four networks in question.

The main cause of system incidents, which are partly outside the control of the DNOs is trees and vegetation growing through, or adjacent to, overhead lines. In the EPN area in 2002, for example, the network, then run by the former 24seven had very severe tree-related problems. Partly prompted by the 2002 review, the ENA produces, and reviews in conjunction with the DNOs, two standards relating to tree clearance; ENATS 43-8, which inter-alia relates to maintaining safe clearances from trees and targets a 3m clearance for lines below 33kV; and ETR 132, which addresses a risk-based approach to achieving falling distance clearance for trees close to overhead lines. ETR 136, a Good Practice Guide, accompanies ETR 132.

There is evidence that all companies are taking tree and vegetation management seriously and carrying a regular ENATS 43-8 standard of maintenance cut around their lines to minimise impact from tree-related incidents caused by transient contact with lines or branches and twigs blowing onto lines. Even maintaining this standard is increasingly difficult to achieve due to landowners not wishing to grant permission for tree clearance, particularly around low voltage lines close to houses. All companies are also implementing ETR 132 which attempts to achieve, over several years, falling distance clearance for trees near overhead lines and, as a result, requires wide swathes of tree-free area near overhead lines. This is not at all easy to achieve and companies are having to find ways to compromise by re-routing overhead lines when rebuilds or refurbishments are carried out.

Anecdotal evidence from at least one DNO is that there were no system incidents, on circuits where clearance to ETR 132 had been achieved. Acceleration of ETR 132, however difficult to achieve, is likely to be a significant factor in preventing similar tree-related incidents. It requires public cooperation in granting tree clearance permissions and the acceptance by all stakeholders that overhead lines, to be reliable, must remain clear of the risk of falling trees.

There is wide acceptance that the often suggested undergrounding of all lines is not a viable option.

Evidence gathered under this review suggests that there are no underlying reasons in terms of construction and maintenance techniques within the control of DNOs that account for such a difference in performance between networks. Indeed, looking at

the worst affected networks over Christmas 2013, WPD (SWest) is owned and operated by a company which also holds three other licences and operates them as a single entity, applying the same policies across its four licensed areas.

SSES is owned by SSEPD, which also holds the SSEH licence (which may have been expected to be more severely affected based on its sparse exposed network with legacy planning standards derogations).

UKPN holds three licences; all of which were affected (the LPN licensed area was slightly affected) but of the other two, SPN was much more significantly affected than EPN.

The conclusion is that there were critical difference in the weather and environmental conditions that account for the difference in incident numbers compared with the rest of the country. Table 5 provides some qualitative information that, when taken in combination, captures the severity of the weather event in the south of England.

Licence	Incidents 23 to 28 December	Max wind gust speed mph	Duration of wind speeds >60mph	Ground Conditions	Tree cover[34]
WPD (SWest)	756	85	28	Floods	Heavy
SSES	1091	95	25	Floods	Heavy
SPN	1079	80	25	Floods	Heavy
EPN	850	80	18	Wet	Medium

Table 5 Summary of factors affecting the scale of the event

WPD (SWest) and EPN have relatively less tree cover than SPN in particular, and parts of SSES. The nature of incidents occurring was that whole mature trees were uprooted by the sustained high winds because the root structures in the saturated ground were unable to support the wind pressure on the trees and whole trees overturned. Had ETR 132 been started earlier and been achievable in the south of England the impact of whole trees falling on lines might have been lessened. Timing and rate of implementation of ETR 132 is an issue. However, the key issue remains whether ETR 132 will ever be fully achievable in these locations (or indeed anywhere in the country).

It is understood that the ENA is currently considering an ETR 132 review to look at its applicability in certain areas and its chances of succeeding in providing tree-clear overhead lines. The predictable issues do arise, landowners not willing to give tree clearance permissions, trees standing within falling distance but across a boundary, sometimes across a road on a different landowner's property.

[34] The most recent and accessible reference point is an Ofgem determination from 2002, arising the impact of the 2002 storms. The analysis relates Forestry Commission data on woodland cover for England in 1998 and Wales in 1997 to the storm impact. Forestry Commission regions do not match DNO boundaries but the data enables broad generalisations regarding the size of woodland, woodland cover, number of live trees over 5m outside woodland and density of live trees over 5m outside woodland. Two conclusions are of relevance. First, the South, South East and South West of England, and Wales are the areas with the highest woodland density; the East of England and the East and West Midlands each have a lower than average density. Second, the South West, West Midlands and Wales have the highest number of trees outside woodland areas. The particularly wooded area South of the Thames increases in density towards the East.

With the densely tree populated south east of England SPN and the eastern parts of SSES suffered many more major tree-related incidents than either WPD (SWest) or EPN. As well as increasing the number of incidents, these falling trees also caused significant delays in staff getting to site, with consequential increases in travel and repair times.

7.3 Extended restoration times

In spite of the impact on the networks WPD (SWest), through the effective deployment of staff, restored supplies to all but 13 of its 57,695 affected customers within 24 hours. Those 13 went over the 24 hours by 19 minutes. WPD was able to mobilise and relocate staff early prior to the impact of the weather, aided by the weather hitting slightly further ahead of the Christmas break.

EPN, which had been unable to relocate staff either to or from its sister licence area SPN due to high incidents in the south east, restored supplies to all but 26 of its customers in 48 hours. Those 26 customers are understood to have been unable to be reconnected due to the co-existing effects of the east coast floods.

There were significantly extended restoration times in the remaining two of the four networks being considered, with customers in both SSES and SPN without electricity for more than 120 hours.

Availability of overhead line staff was without doubt a contributory factor, as acknowledged by both companies. UKPN requested assistance from NEWSAC on Sunday 22 December, the first company to invoke NEWSAC over the Christmas period. No staff were available via NEWSAC until 26 December when NPg released 21 linesmen to assist SPN with its repairs.

The tables below shows the overhead line staff numbers that were reported as active in restoring customers supplies over the period 23-29 December.

	Overhead Line staff working on repairs (including contractors)						
Licence	**23/12**	**24/12**	**25/12**	**26/12**	**27/12**	**28/12**	**29/12**
WPD (SWest)	372	436	194	233	281	105	105
SSES	164	194	128	220	175	247	269
SPN	91	99	91	145	162	176	170
EPN	182	178	114	51	88	39	18

Table 6 Overhead line staff working on repairs

	Overhead Line staff imported via NEWSAC						
Licence	**23/12**	**24/12**	**25/12**	**26/12**	**27/12**	**28/12**	**29/12**
WPD (SWest)	0	0	0	0	0	0	0
SSES	0	0	0	0	0	0	0
SPN	0	0	0	21	21	21	21
EPN	0	0	0	0	0	0	0

Data source: ENA

Table 7 Staff deployed through NEWSAC

Safety Delays

There were on-going high wind speeds for several hours in the south east of England making it unsafe for staff to work at heights, thus delaying repairs being carried out; although ground work, such as clearing trees from fallen lines and making fallen wires safe, did go ahead. Preparatory work also happened where access was possible.

UKPN also received a severe weather alert for lightning activity on Christmas Day, further delaying repairs for safety reasons until the risk had subsided.

Travel

The weather in the south east caused extensive damage through bringing down mature trees and damage to buildings. Frequently, where trees came down and brought down overhead lines they also fell across roads blocking access for repairs to the damage they had caused, along with many others that fell across roads without hitting overhead lines. This was accompanied in places by flooding such that overall travel was severely impeded.

Overhead line staff who were at work found themselves clearing trees before they were able to start repairs and restore customers' supplies.

Repair Duration and type of construction

Similar to the increased travel times, repair durations were also extended by the need to clear trees before repairs could be carried out. In the worst cases repairs involved replacing broken poles and reconductoring several spans of overhead line. The types of construction, all to current standards, also have an impact on repair times. On 11kV networks; and even more significant on low voltage networks; BLX covered conductor and aerial bundled conductor (ABC) respectively have been used extensively to overcome the transient incidents and supply interruptions caused by trees growing through lines, coming into contact with lines and broken branches and twigs blowing on to lines.

These types of construction allow a much reduced clearance from the line to be acceptable and, in villages and gardens where tree cutting is difficult to achieve, have been a great success in reducing CI and CML in moderate to strong weather patterns. However, they are unable to withstand whole tress falling on them and, when this happens; they either break, or withstand the weights and another weak point in the network breaks. In some cases this can result in broken poles, leaning poles infringing safety clearances or, with such wet ground, uprooted poles.

Though proven to be capable of withstanding most wind-blown debris and the impact of smaller trees, when BLX or ABC is brought down by the type of mature trees uprooted during the December storm, it is a much more difficult task to repair. In the case of ABC it is invariably running through trees that have to be cleared, the repair itself requires special tools and is more extensive and time consuming than a similar task on the traditional open-wire overhead line. Repairing BLX conductors can take similarly extended periods.

Duplicate and masked faults

A feature of all weather-related emergencies is the possible occurrence of duplicate incidents on the same circuit, incidents on alternative switchable circuits or incidents in series between the supply and the customer. For example, an 11kV main feeder incident, an incident on an 11kV spur fed from that circuit, a low voltage network fault from a transformer on that spur and finally individual premise service connection incidents on the low voltage network supplied by that transformer. Whilst this may sound improbable, over the Christmas period there were a significant number of instances where multiple incidents had to be repaired before customers' supplies were reconnected. The chances of this multiple incident situation increases dramatically in areas with dense tree populations as exist in much of the south of England.

As already acknowledged in this report overhead line resource availability was an issue, it would appear in this event not to have been significantly relieved by requests for support from NEWSAC. However, due to the factors just described in the south of England, reduction in repair time should not be expected to have a linear relationship with staff numbers alone, be they skilled overhead linesmen or the people scouting ahead of them; all were affected by the impassable roads and the duration of the severe weather.

8 Resourcing and mutual aid

8.1 Mutual aid 2013/14

The industry has a long tradition of mutual assistance during emergencies, the basis of which is inherited from its public sector roots. Post privatisation a new set of commercial arrangements between companies was developed, with two mutual aid consortia being formed – first came NoSAC (covering licensed areas to the north and south) based on the premise that weather-related emergencies seldom affected both north and south at the same time making more likely the mobility of resource, followed later by WESAC (covering the west and east) – to facilitate the fast and coordinated movement of resources between companies at times of emergency with donor and host obligations and commercial terms agreed and understood in advance.

The two mutual aid consortia were later merged into one countrywide arrangement, which now also includes Northern Ireland, Electricity Supply Board and Manx Electricity. At the time the fourteen electricity distribution licences in Great Britain and one in Northern Ireland, were under different ownership, with all but one (London Electricity) having significant overhead line networks and overhead line staff. This placed London Electricity in a good position to act as an impartial co-ordinator in an overhead line related (by far the most common) emergency.

In reviewing how effectively the mutual aid arrangements operated in December 2013, there are some important points to note.

NEWSAC is used and increasingly so. There were more invocations during the two years to the end of 2013 than in any other equivalent period since it was formed. The extent of the transfers during the winter is shown in an appendix.

NEWSAC is a voluntary arrangement, hence making available resources to others (how many, what type and when) is, ultimately, at the discretion of the donor DNOs. Allocation of available support is decided by the NEWSAC chair based on an assessment of the national situation. Under this regime, it is the potential donor's assessment - and not that of the DNO under stress or an independent arbiter - that determines the release of resources.

The arrangement as it operated up to and including the winter of 2013/14 was essentially reactive; it was invoked when the magnitude of the storm and its potential was evident or becoming evident[35]. A consequence was that resources loaned to DNOs under stress were valuable but only able to make an impact on the restoration 'tail'.

Some DNOs, while positive about improving standards, expressed concern that Ofgem's proposal to tighten the application of the supply restoration incentive could have an impact on companies releasing staff to support others and thereby adversely affect how NEWSAC works. DNOs will have to consider this in developing their emergency plans.

[35] The initial NEWSAC call for the Christmas event was held at 15.00 hours on 23 December. The first wave of the storm had hit WPD areas early on the 23rd, and UKPN's SPN from midday. We are grateful to UKPN and the ENA for providing the detailed step by step schedule of NEWSAC actions. For a more detailed review, please refer to the appendices for each company.

The extent to which DNOs make use of contractors is changing. There has been a steady trend since privatisation of making increasing use of contractors for the construction and maintenance of distribution networks. The evidence suggests that this trend has levelled off with some DNOs in-sourcing certain engineering work and others in the process of reviewing their resourcing options[36]. It nonetheless remains the case that contractors are a significant resource, making up some 29% of the country's overhead line workforce.

The 2002 Review had a perspective on this when noting that then companies were 'fishing in the same pool' when it came to calling on contractors for support during times of stress. Things have moved on since then. DNOs report that they now typically have in place commercial contract terms which seek to maximise availability of certain categorises of contract staff – terms include provision for standby, general availability out of normal hours and ensuring that the DNO has first call on the contractor's staff it regularly uses. Nonetheless, there remain residual issues of the type discussed over a decade ago. First, the nature of the contracting market is that many of the major players will work for more than one DNO meaning that there remains scope, at the margin, for tension in the allocation of resources. Second, a characteristic of the contract workforce is that a proportion of staff will not be local to their host DNO[37]. Many are mobile. This means that some will not be in the locality of their host DNO during weekends and holidays, especially national holidays, making mobilisation less certain and slower during these times.

A more formal 'NEWSAC for contractors' offers the potential to maximise the use of this resource and deploy it as early as possible during an emergency.

In summary it was said of NEWSAC in 2002 that:

> '*… though essential, the current arrangements are therefore more effective as a settlements system than as a means of guaranteeing the efficient allocation of resources according to some overall assessment of industry or national need*[38] .'

Although there have been improvements in information flows and the mechanics of how NEWSAC functions over time, in our view this assessment remained essentially true for the winter of 2013/14.

8.2 Current developments and the future

It is important to review some of the obvious consequences of what is happening as a result of learning lessons from the winter of 2013/14. NEWSAC - with the improvements likely to emerge from the DECC review - will work more effectively[39].

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[36] Examples of the different approaches can be found in the company specific appendices. WPD in-sourced some contractors shortly after their acquisition of two midlands licensed areas.

[37] That this remains an issue is reflected in the DECC review and resulting action – see R1 'Network Operators will review their contracting arrangements and their dependence on them to ensure the rapid availability of adequate resources to deliver resilience particularly over extended holiday periods'.

[38] See 'October 2002 Power System Emergency Post Event Investigation' 16 December 2002 DTI.

[39] The DECC review has prompted action on this already. See R1 'Network Operators will hold a workshop to share their resource and contractor management strategies'.

Invoking NEWSAC during the initial escalation phase will enable the early exchange of views; the triangulation of forecasts and the likely impact of adverse weather on the network; and the sharing of information on resource capacity (staff and contractors) and possible availability. However, it may be difficult to square the way in which NEWSAC is set up to function with the DECC recommendation that there is a need for criteria around 'strategic prioritisation' to be clear. Under the current structure it will remain a priority for each DNO to be confident of restoring its own customers before it contemplates releasing resources to others.

Among the DNOs we spoke to, there are two main perspectives on the future of NEWSAC. One is that NEWSAC works about as well as it can be expected to work in that it facilitates resource sharing when companies have confidence about their own situation. In the opinion of some it needs a thorough review and perhaps external co-ordination. In this view refinements, along the lines of those arising from the DECC initiative, may help but the fundamental structure of the industry and the commercial autonomy of companies means that aid was, and should remain, a voluntary and mutual arrangement.

An alternative perspective is that NEWSAC should evolve to become an arrangement that facilitates the strategic allocation of resources during times of national or regional emergency conditions, possibly involving a body external to the DNO community acting as an arbitrator. Agreeing this as an objective would be problematic in itself; delivering it would require a change of commercial relationships among companies that is beyond the scope of this study.

As noted above, a variation is that NEWSAC should develop into a co-ordinator of contract and well as employee resources.

8.3 Resourcing – overhead line staff

One of the factors that has to be taken into account in considering the future efficacy of responsiveness is the changing ownership structure of the licensed distribution networks.

The sector has evolved from a structure in which 14 licences were each held by an autonomous company, to the situation where six companies hold all licences. This significantly affects the ability of some companies to move overhead line teams, authorised staff and other resources within companies – i.e. without reference to NEWSAC. This has two potential impacts during emergency conditions; the availability of staff to move out of their 'normal' territory, and the timing at which they may be released from their home DNO.

The current situation regarding overhead line staff[40] is considered below. An analysis, based on information as reported by companies during this study, of who employs overhead line staff is set out in the tables below.

[40] There are other potential bottlenecks but overhead line staff (whether employed or contractors) are generally regarded as the most critical part of the restoration process.

Overhead line staff by employment type	
Contractors	29%
WPD directly employed	42%
Other DNOs directly employed	29%

Table 8 Overhead line staff – summary

The more detailed analysis in the table below shows that some companies have significantly greater capacity to move staff in response to adverse weather than others. In the most extreme case, WPD now employs 59% of the industry's directly employed overhead line contract staff and 7.6% of contract labour.

(a) DNO	(b) Licence	(c) km OHL	(d) Direct OHL staff	(e) Contract OHL staff	(f) km OHL / line staff	(g) % of OHL staff controlled	(h) % of OHL owned
ENWL	ENWL	12918	111	113	57.7	5	5
NPg	NPgN	14837	186	191	74.8	8.	10
	NPgY	13361					
SPEN	SPD	18752	83	195	95.6	13	14
	SPMW	20350	114	184			
SSE	SSEH	31399	290	28	62.9	20	21
	SSES	27250	264	350			
UKPN	EPN	34196	189	140	100.9	10.	17
	LPN	22	0	0			
	SPN	12485	104	30			
WPD	EMID	21943	1943	88	45.3	44	33.
	SWALES	18049					
	SWEST	28156					
	WMID	23951					

Notes to the table. (c) is taken from the DNOs' returns to Ofgem. (d) is taken from DNO replies to the questionnaire. (f) is the total resource, both direct staff and contractors relative to the network. (g) is a measure of access to resources without recourse to NEWSAC, assuming that DNOs can, by virtue of their contract terms, immediately call on all their contractors' overhead line staff. (The reasonableness of this assumption is contentious as reviewed in the text.)

Table 9 Overhead line staff - analysis

The data in the table, when viewed alongside the map of the industry which shows how the DNOs are configured geographically, gives a broad indication of DNOs' resilience

and access to critical resources in the face of the 'typical' severe weather event which affects regions / areas differentially (in terms of timing and impact)[41].

The time to mobilise resources under NEWSAC compared with the likely customer supply restoration profile in a weather-related emergency is a significant consideration for a licensee and for the NEWSAC co-ordinator. An early response offers the potential to deliver benefits in restoration time, though the extent to which it can be realised is not always certain. There are risks – of incurring costs and creating later delays as a result of moving resources in the wrong direction and, as a consequence, delaying overall restoration time.

The profile of a weather-related emergency is discussed in more detail above. In general terms the severe weather has its impact on networks over a relatively short time span of perhaps a few hours[42]. This is followed by a period of intelligence gathering from network monitoring systems and customer contact to establish with greater precision the extent of the loss of supplies.

In a very short period of time following cessation of the severe weather DNOs will have a high degree of certainty on the number of their customers who have been affected, though much less certainty about the number of individual incidents that require on site repairs. Equally, they will be unaware of those customers who are affected by more than one incident and where repairs may have to be sequential. The early hours of the emergency event will be focussed on working on two parallel activities:

- Restoring supply to those customers where this can be achieved by automatic means or remote switching; and
- Gathering intelligence from damage reports, scouting and other reconnaissance, on repair requirements.

This will then provide DNOs with a best estimate of the workload they face in repairing damage, the likely restoration periods using their own resources, and whether NEWSAC resources, where available, can be mobilised to be effective in shortening overall repair and hence customer restoration times.

It is therefore unlikely, unless mobilised in advance of the event - with mobilisation based solely on weather warnings - that NEWSAC resources will become at all effective within the first 24 hours and probably not very effective within 36 to 48 hours of the first supply interruptions.

The result is that for restoration of all customers to be achieved in 24 hours, the companies must have arrangements in place to deal with an emergency situation independent of NEWSAC, and with limited reliance on NEWSAC to achieve a 48 hour complete restoration. For damage so extensive that repairs are on-going beyond 48 hours, additional resources via NEWSAC offer the potential to play a valuable role as the enabler of safe, sustainable continuity of repair work.

[41] This quantifies the comment in the DECC review that some DNOs are better placed to move and flex resources. See para 2.4.

[42] As revealed in earlier reports – DECC and Ofgem stage 1 – and reviewed in more detail above, the winter 2013/2014 was an exception in this respect in that the severe weather was sustained over a period of some hours over the south during the 23/24 December.

There is evidence that DNOs are making use of the workforce renewal facility and are recruiting (apprentices, graduates and other methods of improving the skill and competence of their people) and through this sustain their workforce over the longer term[43]. However, the resource available via NEWSAC is bounded by the total skilled overhead line resource in DNOs and the contractors used by DNOs. The size of this resource pool is ultimately determined by the volume of work available (via the regulated income) to keep those resources efficiently occupied during non-emergency periods.

In responding to a call via NEWSAC to release resources, it remains the case that a donor DNO has to strike a balance between responding to a call for help from a company under pressure and meeting its own obligations. These include its licence obligation '*to develop and maintain an efficient, co-ordinated and economical system of electricity distribution*' while also taking into account other obligations including guaranteed standards of service, the health and safety of its staff working during severe weather conditions, and the needs of its own priority customers.

The evidence is that while DNOs rightly and reasonably address their obligations to their own customers as a matter of priority, there remains a willingness – and indeed enthusiasm - to maintain the tradition of mutual assistance during emergencies.

Over the longer term there are now other developments to consider, such as the role of IDNOs. Small but growing, IDNOs have a technically capable workforce which should be utilised to the full at times of network stress. Thus one of the largest IDNOs, GTC, is a subscribing member of the ENA, serves a substantial customer base which it expects to grow to 300,000 during the next few years and employs some 600 staff.

GTC has contacted the NEWSAC co-ordinator[44] with a view to entering into an arrangement for resource sharing. Although there may be commercial tensions to overcome, the inclusion of all sector participants is important to ensuring the maximum availability of resources during emergency conditions.

8.4 Resourcing – comparisons

A key theme in the DECC report is the criticality of the number and availability of overhead line staff during emergency conditions. Comparing the number of overhead line staff to km of overhead line in each licensed area shows those companies that are well resourced compared to those that are less so, and the relative dependence on contractors.

Such analysis is of course partial and must be treated with care. Although critical, the availability of overhead line staff is but one measure of how well a company is prepared and then able to response to emergency conditions. Numbers of overhead line staff will be influenced by factors such as the size of the capital programme. Numbers of contractors will, at least at the margin, be subject to uncertainty (as the nature of the business is that most firms will be working or have ambitions to work for more than one DNO, so there is a risk of double counting). Overhead line staff are not a homogeneous group. Some may be all-rounders, while others may have more limited

[43] The most comprehensive analysis of the workforce requirements of the industry – the six DNOs and their principal 'Tier 1' contractors - was prepared for Ofgem (for RIIO-ED1) by the National Skills Academy in 2013 entitled 'A report to Ofgem on the workforce requirements of DNOs during RIIO-ED1 and RIIO-ED2'.

[44] This role is currently carried out by UKPN; ENAs role is described as facilitation.

competency – being limited to working at a particular voltage or being involved in construction only.

This indicator also needs to be considered alongside other resources, which are important, together with the indices of efficiency and the qualitative assessment of preparedness and response included in the appendices to this study. The contribution of non-overhead line resource trained to carry out specific activities in emergency conditions to support the critical overhead line resource is not to be under estimated. Even with all the necessary qualifications however, the analysis should prompt a review by those companies that are less well resourced in terms of overhead line staff.

Finally, the general question has been asked about whether the industry as a whole is short of overhead line staff. There are two main aspects to this. First, the charts below aggregates the data submitted by companies and enables the utilisation to be considered day by day, as the severe weather event unfolded. It shows that, even during the peak mobilisation on the 24 December, there was some – albeit limited - unused capacity available, of the order of 19%[45]. There has been an undercurrent of criticism that not all staff responded to the call to work and, as noted, there were differences between companies in their success in mobilising staff. However, on Christmas Eve, 71% of those overhead line staff available worked[46].

[45] The detail of this chart needs to be read carefully since for two DNOs the staff are aggregated for the company, whereas for others reporting is by licence area.

[46] This measure is crude, since some staff will have been unavailable for unavoidable reasons, such as illness. In one sense this makes the figure more impressive in terms of those used; in another sense it suggests that the industry was nearer its capacity than the headline figures indicate.

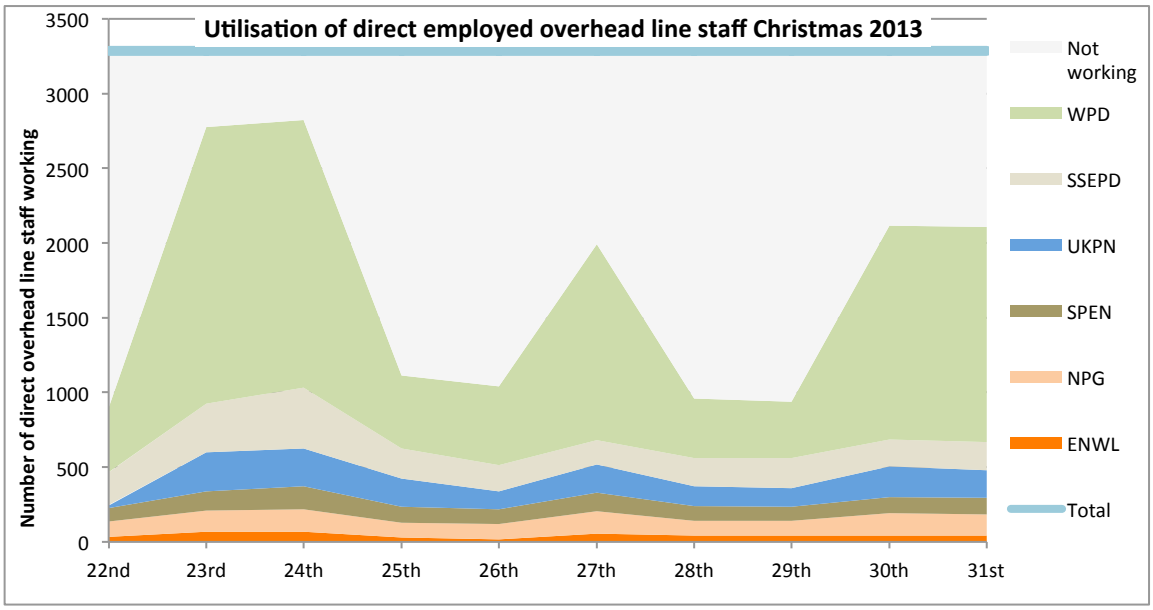

Figure 14 Utilisation of direct overhead line staff

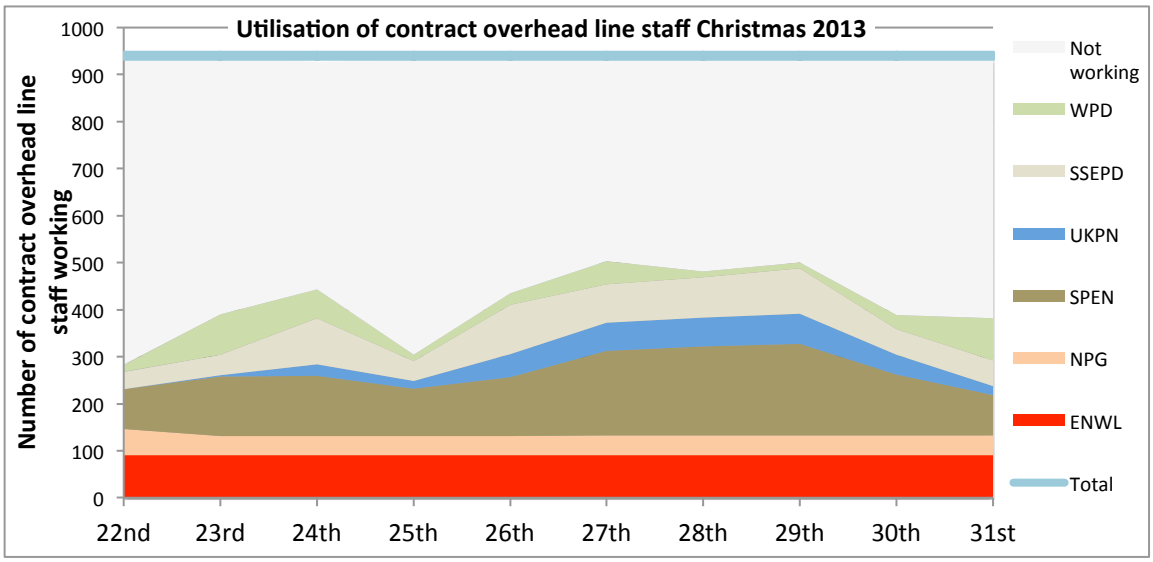

Figure 15 Utilisation of contract overhead line staff

It should be noted that the numbers NPg and ENWL quoted for contractors are 'available' as opposed to 'utilised'. In any case, the position on utilisation of contractors is much less clear-cut because of the already discussed likelihood of some double counting in the returns. From the evidence available, the peak utilisation of contractors was on 27 December, when about half the (theoretically) available contractors were used.

The second issue is to consider what the situation might be if the other DNOs were resourced at the level of the company that performed best in managing the Christmas event. If the ratio of overhead staff (directly applied and contractors) to km of line of WPD for this event were applied to other DNOs, the national availability of overhead line staff would increase by over one third. This has longer term cost implications beyond the scope of this review.

9 Contact with Customers

9.1 Overview

Keeping customers informed during an emergency, when customers have lost supply, is a priority for all DNOs. Customers need to be reassured that the DNO is aware of their situation and is actively working to restore supplies. The key means of contact remains the telephone, supported by the growing usage of websites, SMS and social media. Digital technology enables the integration of the key systems and information sources and provides the necessary information to all operational and business functions in a unified way. The key requirement at the outset of each customer call is to obtain details of the location where the loss of supply is being reported. If the customer is calling from the premise affected some call details[47] can be recognised by the telephony system and automatically linked to a database, which holds records[48] of the installed meter and its network connection point. Using this information any information regarding the loss may instantly be made available. Where this is not possible the customer can opt to manually enter the necessary details through an interactive voice response (IVR) system[49] .

All DNOs' call Advisors are trained in the use of the companies' trouble call incident management systems and always have the system available 'on-line'. This integrated approach enables the call Advisor to provide information on the situation to the customer and to enter new information that the customer may report. The integrated systems instantly make new information available to those managing the restoration of supplies. This approach also establishes a common information platform which is used by the DNO's messaging system, interactive features on its website, and for providing real-time responses through the various social media channels.

The degree of integration varies between DNOs, as do the processes and technologies in acquiring, collating and formatting information from the various sources. This is especially the case with information from field staff, which, when entered in the DNO's system becomes readily available to the customer-facing and system operation teams.

9.2 Acquiring information

For network incidents on the higher voltage systems, the first indication of a loss of supply situation generally originates from the control centre system control and data acquisition (SCADA), which alerts the control engineers to an incident. There are cases on unmonitored sections of high voltage network (such as those only affecting a spur line) and generally all those at low voltage where there is dependence upon customers calling to tell the DNO of the supply failure. Network automation then restores supplies to as much of the network (and as many customers) as possible, following which control engineers will take the necessary actions to restore those parts of the network that can be safely undertaken by remote control switching. Simultaneously, dispatchers will be locating and directing field staff to optimum switching points to undertake manual switching to safely restore supply to as many customers as possible.

[47] If permitted the telephone number using the calling line Identification (CLI) service supplied by the service provider

[48] MPAN (Mete Point Administration Number)

[49] IVR technology enables a computer to interact with the spoken word and keypad DTMF tones.

As soon as the first interruptions occur, the DNO's contact centre will start to receive calls from customers notifying them of the loss of supply. Depending on the type and time of day, the number of incoming calls will rise rapidly exceeding by many times those received during a normal working day. This sudden peak of calls following a single incident will demand support to call takers through adequate messaging systems and will be much more pronounced in multiple incident situations. However, messaging systems cannot provide the necessary information to all customers and under the preparation for an emergency, the contact centre would increase staffing levels to handle the huge increase in calls and to ensure the appropriate information messages are prepared and updated on a regular basis.

An indication of the number of calls received during the Christmas period severe weather event (23 to 28 December) is provided in the charts below.

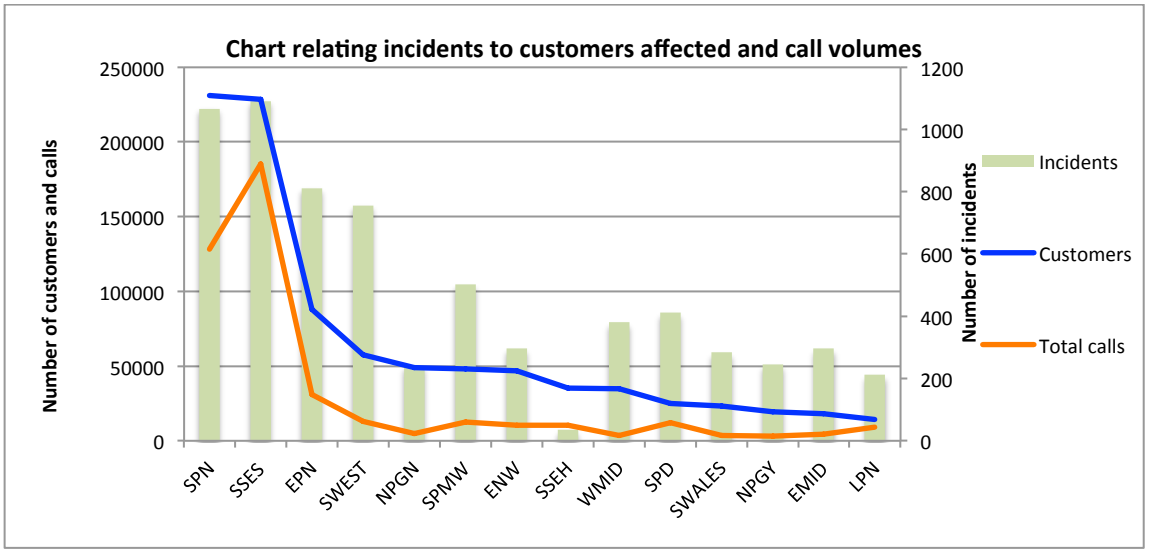

Figure 16: Chart of customers and call volumes

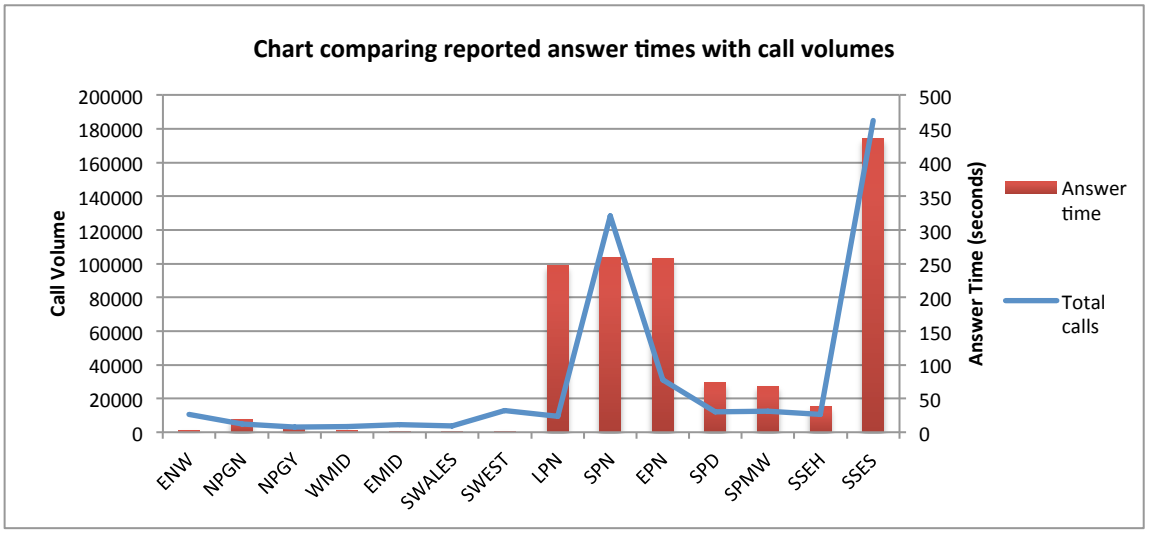

Figure 17: Chart of call volumes and answer times

The chart above requires explanation as it raises again the concern that average answer time (KM4) may not be measured in a consistent way. It is also of interest to note

that the three DNOs with the longer answer times were using, or part using, the STORM® telephony system. It is understood that STORM® has features for managing queue lengths and call routing that may, for this purpose, give output measures specific to the way the organisation is using STORM®, and may not be directly comparable.

One of those DNOs (SPEN, with the SPD and SPMW telephone numbers) was less badly impacted by the Christmas storms, but still appeared to have longer answer times than DNOs that were similarly impacted. SPEN's no 'force disconnect' policy, reported as being endorsed by its customers, is likely to have had a material effect on customers' willingness to accept extended waiting times.

The other two users of STORM®, UKPN (LPN, EPN and SPN licences) and SSEPD (SSEH and SSES licences) each had a severely impacted licensed area and customers suffered very long answer times. All DNOs report that they operate either a single or a virtual customer contact centre, such that calls to any of their published numbers overflow to any available agent in their organisations to level workload and minimise response times. In SSEPD, where STORM® had been installed in SSES in October 2013, but was not installed in SSEH until February 2014, the mutual support feature between the two call centres appears to have been less effective.

There also seems to be uncertainty among DNOs over the intent of what KM4 should measure. It appears that some measure just a fixed call set-up time, which is a system processing time; others measure ringing time after the call has been routed; and others the combination. The slight variances in configuration of systems may also result in different measures being declared. If it is to be used as a comparator among DNOs, the definition of KM4 needs clarification. It may be that with a whole new basket of media channels available, a response measure for customer satisfaction across the range of channels would be more appropriate.

In the early stages of an event, when the extent of the damage has not been fully assessed and the number, nature and location of incidents remains unknown, the information contained within the DNOs' pre-recorded messages will of necessity be of a general nature, informing customers of the emergency and reassuring them that all appropriate actions are being taken to restore supplies. However, through the controlled remote and manual switching on the power networks, a large percentage of supplies are restored to customers in a relatively short time (over the Christmas period over 50% in the first hour). The challenge remains to restore supplies to the remaining customers and to update the messaging systems with appropriate messages, particularly honest, best estimates of expected restoration time to enable customers to make plans for dealing with their own situations.

When contacting the DNO, customers provide details, which enable the call adviser to identify the network serving the customer. This information is used internally by those who are (a) able to send out teams to locate the damage, ensure public safety and send back information to the centre with an update on estimated repair times for passing onto customers: and (b) to call on additional staff to complete repairs if required. This new information direct from site is used to update the customer messages with location-specific information for those who are still without supply; in the case of an extended outage due to extensive on-site repair work, the information remains relevant. In some cases mobile phones are used to take photographs of damage sites to pass out on social media channels to make customers aware of the full extent of the damage.

9.3 Systems and their resilience

The telephony systems have the facility to automatically distribute customer calls; either directly or through the IVR system; to advisors who are generally located in the contact centre(s). The use of IVR facilitates callers reporting a loss of supply from a different location, or those using landlines or mobile phones with call line identifier (CLI) information not previously registered in the DNOs' systems.

The IVR systems offer customers options to suit their call requirement that may then be resolved by routing the call to an advisor or by using a pre-recorded general or location specific voice message.

During an emergency, customers who call in to notify a supply failure have the option to hold for an advisor after hearing voice messages, which provide information relating to their location. If the message satisfies the customer needs, the customer will clear-down the call and thereby reduce the number of calls potentially queuing for an advisor.

Generally, the contact centres will have sufficient capacity to handle the business as usual (BAU) call volumes with the facility to accommodate additional advisors in the event of a system emergency resulting in widespread supply failures. With the availability of broadband connections, contact centre facilities can be accessed by remotely located staff who have been trained to take and record customer calls. This can be at a different work location or even at home, greatly extending the availability of call-handling advisors and enabling a much speedier ramp-up when the need arises. WPD provides its trained staff with the necessary facilities to enable them to take customer calls from their homes; other DNOs are at the stage of planning or trialling their systems for home working.

The Computer telephony integration (CTI) systems and supporting communications networks are designed to high levels of availability and resilience through duplication and redundancy of equipment, communication connections and power supplies.

9.4 Resourcing

During BAU call- advisor staffing levels are matched to expected daily call volumes. The call handling management system provides real-time information on the call volume, advisor availability, the number of calls queuing to be answered and any associated waiting times. This information enables the advisors to be matched to manage the queuing and waiting times to acceptable levels.

Having a sufficient number of advisors available to answer customer calls within an acceptable waiting period [50] is a basic requirement in providing effective voice communications to customers. Answering calls within this period is used as a service target, providing a measure of performance. Contact centre staffing decisions will be based on historical data to create call volume forecasts with necessary staffing numbers to meet the service target. Challenging situations arise when forecasts based on previous events fail to meet expectations, normally associated with the underestimation of call volumes occurring over relatively short periods of time or an event which requires advisors to spend longer periods talking with customers.

[50] The waiting period can be adjusted to meet particular circumstances

DNOs maximise the accessibility of their call handling systems by training staff from other parts of the business and ensuring they have regular opportunities to gain experience as advisors. This increases the pool of advisors and broadens staff knowledge of the implications of a major emergency situation. Other DNOs have focused on trained staff dedicated to the role of an advisor with access to additional suitably trained resources as and when needed from other sources (e.g. a third party or their group's supply business).

It is normal practice across the DNO community, to increase staff levels and place additional staff on stand-by to provide support to the contact centre over a long Bank Holiday, especially over the Christmas period. With the threat of storm damage, staffing levels are further increased to the maximum required to cope with an emergency. This process is included in all DNOs' system emergency plans.

Monitoring the weather forecasts and responding to severe weather warnings enables the numbers of advisors to be increased to match the expected higher call volumes which will be generated during the first hours of the emergency, and also for the bulk of the restoration period.

Other forms of communication and media have been recognised as effective means of maintaining customer contact and providing restoration information. These channels have already found to be effective and are thought to become more so with likely demographic changes. Their increased use will result in the reduction in telephone call volumes, reductions in queue lengths and reduction in any waiting times along with improved customer perception and information.

All DNOs have either introduced or are trialling:

- More options for customers to request a call-back;
- The use of websites to provide interactive supply interruption maps linked to restoration status and with the facility to report incidents; and
- The use of social media, such as Facebook and Twitter.

9.5 Keeping Customers Informed

Keeping customers informed effectively can only be achieved by the timely provision of accurately updated information. This is dependent upon the use of sophisticated technology which can handle calls, combine many sources of data and simultaneously connect multiple incoming calls to messaging systems. It further depends upon the application of a robust process, handled by skilled and competent staff, who really understand and believe that what they are doing matters to the customer.

Technology

DNOs all have a long-standing commitment to restoring power supplies to their customers in a safe and timely manner and recognise advanced CTI as an essential tool for providing customer contact. Although there are common components and features, in each CTI system there are variations in capacity, configuration and associated processes, which makes direct peer-to-peer assessment problematic. What is common to all is an output from the CTI systems and processes; keeping customers informed by providing supply restoration information in a timely, meaningful and accurate manner with the CTI being the means for delivery.

Call handling and messaging processes

DNOs have shown that their contact centres are resourced by a team of well trained and competent advisors with high levels of call handling skills, competencies and service knowledge, working to defined procedures and processes. Each DNO has shown the training programmes that they have in place for maintaining and increasing the number of trained and practised staff. In most cases additional advisers are primarily sourced internally from other parts of the DNO's business. Other DNOs, who use third party contact centres (either from an agency or in one case from it group's supply business) for all or part of their call handling process, monitor and ensure that the training given is to the standard required.

Having this pool of staff available as described is one key to providing an effective response to customer calls; the other is the ability to rapidly ramp-up the pool size from BAU levels to emergency levels when events occur. This is essential if the DNO is to match the rapid increase in calls. The effective use of IVR messaging is likely to remain essential during the immediate peak, whatever staff levels are in place, and will, to a large extent, reduce the number of customers who wish to talk to an advisor, as will the growing use of DNOs' websites. However, there remains anecdotal evidence that a relatively large proportion of customers still want to talk 'personally' with an advisor to notify the company and to be given information relating to their particular situation.

DNOs recognise that a key role of the contact centre manager is addressing this issue; having staff to handle the messaging system (IVR), staff to maintain the website, staff to interface in real time with social media and, importantly, advisors available to answer customer calls. Although there is a demand for calls to be answered by an advisor, there will be a number of customers who find that the messaging service is acceptable and sufficiently informative.

An effective indicator in providing customers with information via advisors is to ensure that customer calls are answered within an "acceptable" period of time. Providing the number of advisors to achieve this throughout an emergency event, and especially in the initial period when there is a high volume of calls coming in over a short period of time, is challenging.

9.6 Assessment process

The approach to assessing DNO call taking performance has limitations, there are different systems in use and, even for those DNOs who use the same systems and service providers, there may be some significant differences in the way the systems are arranged and operated. Applying simple ratios may also have limitations, as the circumstances under which one or both occur may be very different. Where applicable such limitations are highlighted.

Where appropriate graphical representations of measures have been given to show the association; each is accompanied with a brief explanation and comment on the contribution they make towards the effectiveness of one or both of the key components, advisor staffing and messaging. The outcomes from this process for each DNO are included in the specific appendices.

To review how effective each DNO is at keeping customers informed through messaging and call handling, data has been obtained from the DNOs' monthly performance report of key measures, as listed in Table 10. A small number of additional measures have been provided by each DNO, either in their responses to Ofgem's Stage

2 storm enquiry questions, or obtained directly. These are listed Table 11. Related measures have been represented in an association, in some cases expressed as a ratio or shown as a daily or hourly rate. The list of 'associations' which will be applied to each DNO is shown in Table 12.

Key Measure	Definition[51]
KM1	Total calls on the specified lines
KM2	Total calls answered by an automated message providing fault details (excluding an IVR/group announcement providing details of alternative contact telephone numbers if the call is not a power-loss call)
KM3	Total calls answered by an agent
KM4	Mean time taken for response by an agent
KM5	Total number of unsuccessful calls, comprising: a) Total calls not reaching the specified lines b) Total calls terminated by the DNO during the IVR/group announcement c) Total calls not allowed into the queue or flushed from the queue d) Total calls abandoned by the customer in the queue

Table 10 Definitions of key measures for the monthly performance report

There appears to be an issue with the interpretation of some of the definitions of KMs, especially KM4 '*Mean time taken for response by an agent*' and KM3 '*Total calls answered by an agent*' - what constitutes an agent? Unless advisors (agents) are immediately available to directly answer an inbound customer call, all calls will be 'answered' by the IVR system which then gives the caller the choice to report a dangerous or emergency situation - normally option 1, which places callers into the queue to be answered by an advisor, in some cases receiving a priority placing n the queue.

In addition, most DNOs' IVR systems offer the customer waiting in the queue the option to register for a call-back enabling them to terminate their call. This request can also be made via a fault page on the DNO's website.

When an advisor becomes free an outbound call is made to the customer; the occurrence of this call is included in the KM3 calculation. In numerical terms it is very difficult to reconcile KM1 - the call volumes entering the system - with KM3 those answered by advisors, KM2, those answered by the IVR system, and KM5, the number of unsuccessful calls, excluding KM5a, those not reaching the specified lines.

[51] As in the Electricity Distribution Price Control Customer Service reporting – Regulatory Instructions and Guidance Version 2

	Measure
M1	Number of Advisors available to answer calls
M2	Number of lines / connections available for individual inbound customer calls
M3	Number of initial and update messages posted per day
M4	Number of power related website hits per day

Table 11 Measures supplied by the DNO

	Association	Comment
A1	Abandonment Rate	The ratio of the number of calls abandoned by the customer whilst waiting to be answered by an advisor to the total number of calls waiting in the same queue
A2	Advisor call loading	The average number of calls answered by an advisor

Table 12 Associations

There is an important note regarding the appendices. The detailed analysis for each DNO is based on the interpretation of the KM definitions and the point in the system at which the companies take their measurements. The configurations of the different telephony systems allow for measurements to be taken at different points, leaving the possibility of inconsistency. Inter company comparisons should therefore be treated with caution.

10 Performance

At the heart of this review has been a quantitative analysis of companies' success in restoring customers after the impact of the Christmas storms, which has identified the key factors influencing the effectiveness of their responses. It is also important to consider qualitative factors.

Table 13 shows factors which DNOs have to 'get right' if they are to plan for, and then manage, a severe weather event. They are distilled from the discussion of a typical emergency situation in section 6. The list is not exhaustive. It does however give structure to the commentary on each company in the appendices, which are presented as a separate, accompanying document. There may be insufficient data to permit a rating but it enables strengths, weaknesses and areas for further review to be identified.

Ref	Activity	Description of Good Performance
SF1	Emergency plans and advance preparation	❑ Robust plans and/or well understood escalation processes from 'business as usual' levels of activity. ❑ Plans well rehearsed or simulated to respond to multi-incident severe weather events. ❑ Scope to include all aspects of emergency management from first response to weather warnings, advance mobilisation of resources, escalation of telephony and messaging, adequacy of resource, clarity of authority, information systems, through to use of generators and welfare for PSR customers. ❑ Review, evaluate and learn from previous events, others.
SF2	Weather forecasts, prediction of impact and resource requirements	❑ Robust weather forecasting with alerts of weather patterns that are likely to cause damage to distribution networks. ❑ Alerts communicated widely within the organisation so that all staff responsible for initiating any aspect of the DNO's emergency response is aware. ❑ Early estimation of impact of event in terms of resource requirements, likely affected areas and overall restoration times, requirements for external resource, in particular NEWSAC.
SF3	Early reaction and mobilisation	❑ Clarity of authority for mobilising, transferring staff, approving additional (potentially abortive) expenditure, cancelling planned work, based on key trigger points and/or experience. ❑ Reacting to weather forecasts to have skilled field staff close to the right (predicted) locations able to respond to the impact of the weather as soon as it is safe to do so after the incidents have occurred.

Ref	Activity	Description of Good Performance
SF4	System automation to restore bulk customer numbers	❑ Use technology to automatically reconnect supplies to maximum numbers of customers after isolating damaged sections of network and provide better internal information on damage location.
SF5	Telephone response & answering service.	❑ Ensure functional telephone messaging service, with adequate capacity. ❑ Provide trained staff to answer telephones supported by suitable systems. ❑ Rigorous stress testing regime and contingency plans for under performance/failure.
SF6	Gathering field information	❑ In support of information gathered from automatic systems and incoming telephone calls, have an effective means to mobilise field scouting staff to gather information on precise locations of damage, whether more customers can be reconnected through manual filed operations, identify materials, special equipment and team sizes needed to carry out repairs and where appropriate make safe by isolation or stand by to ensure public safety. ❑ The use of helicopters to patrol higher-voltage feeders.
SF7	Processing Information	❑ Ensure that information systems, including call taking, network management and resource dispatch are fit for purpose, robust and adequately stress tested for emergency situation customer call and system management volumes.
SF8	Rapid dispatch of switching resource to site	❑ Prioritised dispatch of field switching resources to optimum network locations further enabling maximum customer numbers are restored quickly, following the automation phase.
SF9	Ensure adequate resources in terms of people, transport materials	❑ Ensure plans (as described in SF1) are implemented by establishing resource availability for key roles, locations in field, dependence on external aid given the changing industry structure and patterns of ownership.

Ref	Activity	Description of Good Performance
SF10	Adequate overhead line staff	❑ Ultimately, restoration of supply will depend upon adequate numbers of skilled, trained, equipped overhead line staff able to safely carry out repairs under adverse conditions. ❑ Timely activation of NEWSAC or future equivalent. ❑ Review NEWSAC scope and structure and other options.
SF11	Management of repairs	❑ Through incoming calls, company network monitoring systems and information systems (see above) identify number of incidents, customers affected, geographic locations and use this to prioritise repairs. Rigorous testing regime and contingency plans for under performance or system failure. ❑ Respond to vulnerable customer issues.
SF12	Manage the event tail	❑ The large numbers of customers, in the order of 50% in first hour, 95% in first day are reconnected by prioritising on customer numbers. ❑ At key points (depending on scale of event and customer numbers but at latest from the 24 hour mark) consider changing priority to longest without supply and make decision on ongoing priorities. This is recognised as a difficult balance in a still evolving event.
SF13	Use of mobile Generation	❑ Ensure availability of generators of all sizes to deal with cases where supply restoration is critical for special needs or delayed restoration by network repair. ❑ Where network configuration or access for repairs dictate - use HV generation. ❑ Generation may be effective whether in-house or through robust contract arrangements with service providers.
SF14	Use of all media channels to communicate with customers	❑ Use all forms of media to communicate to different customer groups, within an overall communications strategy. ❑ Use trouble call management systems as unique information base to ensure consistency of outgoing information via call agents, automatic and personally recorded messages on IVR systems, websites, text messages, Facebook, Twitter and other social media.

Ref	Activity	Description of Good Performance
SF15	Provide realistic estimates of repair duration and informing customers	❑ Provide customers with honest and reasonable expectations of the restoration time, updated at a known frequency, in their particular location.
SF16	Provide feedback to customers with regular updates	❑ Ensure that information is processed and updated, and that customer messages are regularly and appropriately updated. ❑ Work with customer groups and all other stakeholders including local media and established local contacts to present information, updates and expectations and awareness of impact on distribution networks. ❑ Maintain stakeholder liasion, updating and reporting.
SF17	Local presence and community contacts	❑ In extended emergencies of greater than 48 hours create local information centres in community halls and other locations to engage face to face with customers, parish councils and other local communicators. ❑ Support agency arrangements mobilised.
S18	Provide adequate welfare facilities to PSR customers from start of event and to all customers who are without supply for more than 48 hours	❑ Early contact with all PSR customers who lose supply. ❑ Regular contact with PSR customers without supply throughout the event, ensuring special needs are being met effectively. ❑ Hot food facilities either by local provision or reimbursement for meals purchased by customers. ❑ Other facilities such as alternative accommodation provision after a defined period (48 hours) without supply.

Table 13 Description of success factors

11 Glossary

The table below provides a glossary of the abbreviations, acronyms and short forms used in this report. Electricity distribution and the associated regulatory framework is rich in this respect and where a more technical term is used which is not adequately described below, reference can be made to one of the several detailed glossaries provided by Ofgem or the more generic ENA glossary of industry terms.

When sources are quoted, these are generally available via the web and the web location is given as a footnote on the first reference to the source.

Acronym or abbreviation	Description
ABC	Aerial bundled conductors (cables) as used for LV mains and services
BAU	Business as usual
CLI	Call line identification (identifier)
CI	Customer interruptions (a standard measure of network reliability)
CML	Customer minutes lost (a standard measure of network reliability)
DECC	Department of Energy and Climate Change
DECC Review	Report entitled *Severe Weather - Christmas 2013* published in March 2014
DEFRA	Department for Environment, Food and Rural Affairs
DNO	Distribution Network Operator
DPCR5	The price control which set the outputs the 14 licence holders are required to deliver and the associated revenues they are allowed to collect for the period to 31 March 2015
DTI	Department for Trade and Industry (the Government Department which held the energy portfolio from 1970 to 2007)
DTI Review	Report entitled October 2002 Power System Emergency Post Event Investigation published 16 December 2002 DTI
DTMF	Dual tone multi frequency (in relation to telephone systems)
E3C	Energy Emergency Executive Committee (which comprises representatives from government, Ofgem and industry; a key function is to ensure preparedness for emergencies)
EMID	East Midlands, one of WPD's licensed areas
ENWL	Electricity Northwest Limited, one of the six companies that operate electricity networks. It operates one licensed area
ENA	Energy Networks Association

Acronym or abbreviation	Description
EPN	Eastern Power Networks, one of UKPN's licensed areas
ESQCR	Electricity Safety, Quality and Continuity Regulations. For more detail see www.hse.gov.uk/electricity/index
ETR	Estimated Time for Restoration (Also, depending on context, Engineering Technical Reports, as produced by the Energy Networks Association)
Gemserv	The organisation that manages the Master Registration Agreement (MRA) governing the electricity customer switching arrangements
GSOP	Guaranteed Standards of Performance, as explained in the Electricity (Standards of Performance) Regulations 2010. Sometimes shortened to GS
GTC	An independent utility infrastructure provider and, importantly in this context, a substantial IDNO
IDNO	Independent Distribution Network Operator
IIS	Interruptions incentive scheme (one of the Ofgem incentive schemes, reports from which provide data on supply interruptions). See also RIGs
IPCC	Intergovernmental Panel on Climate Change, specifically the Fifth Assessment Report (often referred to as AR5)
IVR	Interactive voice response system (included in telephone systems to facilitate efficient call routing, enable targeted messaging, etc)
KM	Key measures (as defined in the Reporting Regulatory Instructions and Guidance issued by Ofgem)
LOS	Loss of supply, or loss of service as the context
LPN	London Power Networks, one of UKPN's licensed areas
LRF	Local Resilience Forum (multi-agency partnerships in which DNOs participate as category 2 responders). For more detail, see 'Emergencies - preparation, response and recovery' on www.gov.uk
NEWSAC	North East West South Aid Consortium (the industry agreement which governs the 'loan' of staff from/to companies during system emergencies). This replaced NoSAC (covering licensed areas to the north and south) followed by WESAC (covering the west and east)
NPg	Northern Powergrid Holdings Company, one of the six companies. It operates two licensed areas, NPgN and NPgY
NPgN	Northern Powergrid Northern, one of NPg's licensed areas
NPgY	Northern Powergrid Yorkshire, one of NPg's licensed areas

Acronym or abbreviation	Description
Ofgem	Office of Gas and Electricity Markets, the regulatory body for electricity distribution. Ofgem is governed by Gas and Electricity Markets Authority (GEMA)
Ofgem stage 1 Review	Report entitled *December 2013 storms review – impact on electricity distribution customers.* Published by Ofgem March 2014
POD	Power Outage Device
PSR	Priority Services Register. Customers with additional needs in relation to energy (including being of pensionable age, with a disability, with hearing and/or visual impairments, with long term ill health)
QoS	Quality of Service
RIIO-ED1	Revenue = Incentives + Innovation + Outputs The price control which set the outputs the 14 licence holders are required to deliver and the associated revenues they are allowed to collect for the period 1 April 2015 to 31 March 2023
RIGs	Reporting Regulatory Instructions and Guidance (issued by Ofgem to provide, among other things, a framework to enable the collection of data from DNOs in a consistent format)
SCADA	Supervisory Control and Data Acquisition
SLC	Standard licence condition (as published by Ofgem in the 'Standard conditions of the Electricity Distribution Licence – 22 April 2014')
SPD	Scottish Power Distribution, one of SPEN's licensed areas
SPEN	Scottish Power Energy Networks, one of the six companies. It operates two licensed areas, SPD and SPMW
SPMW	Scottish Power Distribution Manweb, one of SPEN's licensed areas
SPN	Southern Power Networks, one of UKPN's licensed areas (formerly South Eastern Power Networks)
SSEPD	Scottish and Southern Energy Power Distribution, one of the six companies. It operates two licensed areas, SSEH and SSES
SSEH	Scottish and Southern Energy Hydro, one of SSEPD's licensed areas
SSES	Scottish and Southern Energy Southern, one of SSEPD's licensed areas
SWales	South Wales, one of WPD's licensed areas
SWest	South Western, one of WPD's licensed areas
ToR	Terms of Reference
UKCP09	UK Climate Projections. For more detail see ukclimateprojections.metoffice.gov.uk

Acronym or abbreviation	Description
UKPN	UK Power Networks one of the six companies. It operates three licensed areas, EPN, LPN and SPN
WAG	Welsh Assembly Government
WMID	West Midlands, one of WPD's licensed areas
WPD	Western Power Distribution, one of the six companies. It operates four licensed areas: EMID, WMID, Swales and SWest

12 Appendices

Appendices are produced as stand alone documents. They comprise reviews of each company, together with a note on the use of NEWSAC and additional information on call centres.

Appendix 1 ENW

Appendix 2 NPg

Appendix 3 SPEN

Appendix 4 SSEPD

Appendix 5 UKPN

Appendix 6 WPD

Appendix 7 Staff transfers under NEWSAC

Appendix 8 IDNOs

Appendix 9 Contact centre analysis