Indicators and trends

Monitoring climate change adaptation

climateXchange
Scotland's centre of expertise connecting climate change research and policy

Indicator name				Version
BE15 Electricity supply disruption caused by severe weather events				**August 2018**
Indicator type:	**Risk/opportunity**	**Impact**	**Action**	
		X		

SCCAP Theme	SCCAP Objective	CCRA risk/opportunity
Buildings and infrastructure networks (Energy)	B1, B2 and B3	Severe weather events

At a glance

- Severe weather is a major cause of disruption to electricity supply.
- Ofgem regulates the activities of the Distribution Network Operators (DNOs), setting the levels of investment required to upgrade infrastructure, and providing incentives for DNOs to reduce the frequency and duration of power cuts.
- Interruptions to electricity supply caused by severe weather can be used to track the resilience of the electricity network to climate change.
- Projected rising sea levels, higher temperatures and more frequent extreme weather caused by climate change are likely to increase the frequency of weather-related electricity disruption.

Latest Figure	Trend
2016: 1,688 interruptions due to severe weather events (excluding flooding), resulting in 247,749 Customer Interruptions (CI) and 18,704,232 Customer Minutes Lost (CML).	Equivocal. The number of incidents and related Customer Minutes Lost (CML) vary considerably across the years. This makes it unrealistic to identify a trend over a short time span.

Why is this indicator important?

Energy security depends on a complex system to generate, store, and distribute energy. Physical infrastructure may be vulnerable to climate change because severe weather events may cause damage to power lines and disruption to substations and power stations (Scottish Government, 2011). Every effort is made to ensure network security and network companies have well developed emergency plans to ensure an effective response to a range of weather events. Whilst emergency planning is vital as a means of managing serious incidents, it is not sufficient to counter the increased risks associated with climate change (Energy Network Association (ENA), 2011).

Severe weather events, which are projected to occur more frequently as a result of climate change, pose a threat to the security of the electricity supply and can result in customer interruptions (Ofgem, 2012). An engineering report produced by the ENA in 2011 (ENA, 2011) identifies that rising temperatures and sea levels, and increases in winter rainfall, summer droughts and storm surges, will have the largest impact on electricity networks in the UK based on current climate change projections. Temperature rises could affect overhead line conductors and structures, underground cable systems, switchgear and transformers. Similarly substations and network earthing systems might be adversely affected by an increase in summer drought conditions. Side effects of weather-related changes will also have an effect as, for example, overhead lines are likely to be affected by greater interference from vegetation as a result of the prolonged growing season. Climate change will also increase flooding, and this risk to energy supply is considered separately (see BE4/14).

Disruption to the electricity supply is assessed via two metrics - Customer Interruptions (CI) and Customer Minutes Lost (CML). CI represents the 'number of customers whose supplies have been interrupted per 100 customers each year, where an interruption to supply lasts for three minutes or longer, excluding re-interruptions' (Ofgem, 2012, p 21). CML is a measure of 'the duration of interruptions to supply each year, measured by the average customer minutes lost per customer, where an interruption of supply to the customer lasts three minutes or longer' (Ofgem, 2012, p 21).

The metrics CI and CML are provided for each part of the electricity distribution system:

- High Voltage (HV) Distribution (11kV);
- Low Voltage (LV) Distribution (415V/230V), i.e. domestic supply; and
- Transmission (KV) (132kV/275kV/400kV), the high voltage network that transports electricity across the country at up to 400kV (ENA, 2015).

CI and CML are lagging indicators of network investment, in that changes in these two metrics reflect earlier changes in the level of investment. Where a network is maintained in good condition, there will be fewer and shorter interruptions.

Related Indicators:
BE4/14 Electricity supply disruption due to flooding

What is happening now?

In 2016 there were 1,688 interruptions to the electricity supply due to severe weather events (excluding flooding)[1], resulting in 247,749 CI and 18,704,232 CML. The total number of CI from all sources in 2016 was 1,693,618 and the combined total for CML was 101,553,296. Severe weather therefore accounted for 15% of all CI and 18% of the annual CML in 2016. Table 1 shows severe weather related disruption by distribution/transmission system.

[1] The direct causes included within 'severe weather events' here are listed in Table 2, and in the 'Limitations' section.

Distribution system	Total incidents	Customer Interruptions (CI)	Customer Minutes Lost (CML)
High Voltage (HV) Distribution	1,240	215,203	17,263,122
Low Voltage (LV) Distribution	394	2,504	381,388
KV - Transmission	54	30,042	1,059,722
Total	1,688	247,749	18,704,232

Table 1 Electricity supply disruption due to severe weather events (excluding flooding), 2016

Electricity distribution network operators (DNOs) are responsible for providing the network that transports electricity from the transmission system to consumers. There are two DNOs in Scotland, Scottish Power and Scottish & Southern Energy, and each is granted a distribution licence to operate. Ofgem sets price controls to define the revenues that each DNO may collect from customers, and also puts incentives in place to promote innovation, efficiency, and the provision of adequate network capacity, security, reliability and quality of service.

In 2008, eleven energy companies commissioned the Met Office to conduct an investigation into the impact of climate change on the UK energy industry. Climate scientists and industry experts worked together to develop practical applications and business strategies to meet the challenges posed by climate change (ENA, 2011). Subsequently the Met Office was commissioned to build a risk model in order to quantify the relationship between climate and network faults. Based on the risks identified, ENA member companies identified adaptation actions for the top priority risks.

What has happened in the past?

Figure 1 shows the number of incidents of weather-related disruption (excluding flooding) to the electricity supply for each year between 1995 and 2016, for HV and LV distribution, and KV transmission networks, and the total for all three combined. The total number of incidents has varied quite widely across this period, with the lowest number of reported incidents in 2016 (1,688), and the highest number in 2011 (5,721). The chart also shows that the number of customer interruptions is generally similar for HV and LV networks, and is lower for KV networks.

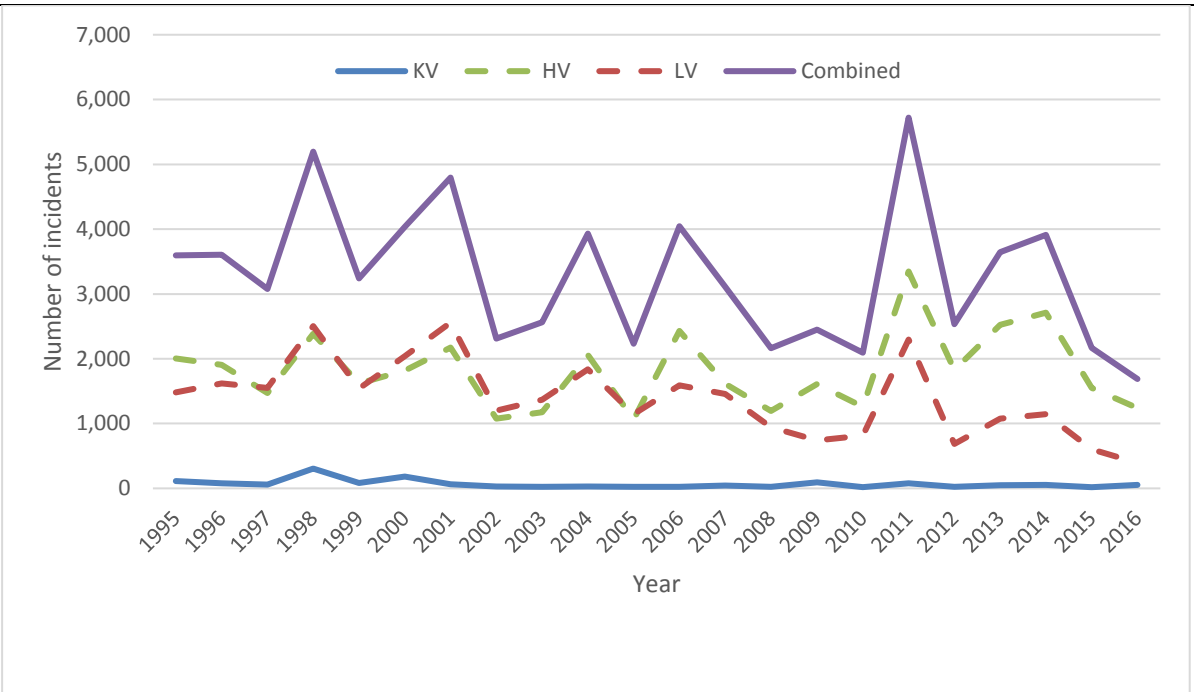

Figure 1 Number of interruptions to the electricity supply caused by severe weather, 1995-2016

Figure 2 shows the number of CML due to interruptions to the electricity supply caused by severe weather events (excluding flooding) for each year between 1995 and 2016 for HV, LV, KV, and the total for all three combined. The total number of CML varies greatly, with a series of peaks and troughs across the period. The highest value is recorded in 1998 (254,325,431 CML) and the lowest in 2016 (18,704,232 CML). The figure also shows that most CML resulted from interruptions to HV networks. This suggests that although interruptions on HV and LV networks occur with similar frequency, those on the HV network have a greater impact on customers.

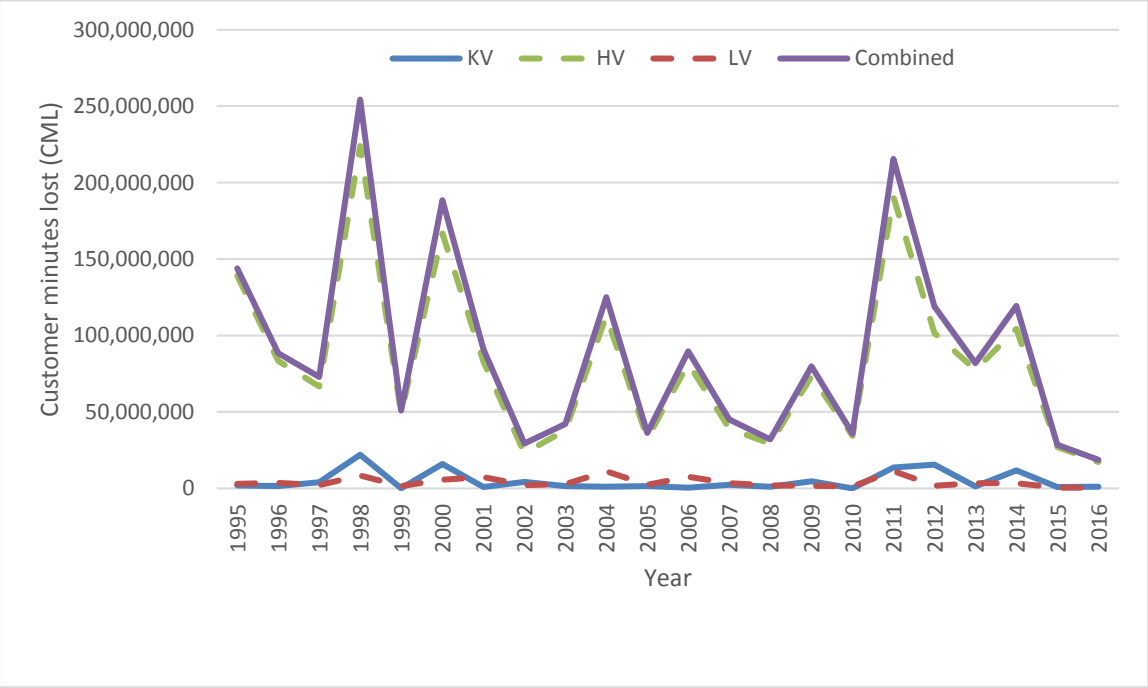

Figure 2 Customer minutes lost as a result of severe weather, 1995-2016

Figure 3 shows the percentage of interruptions, CI and CML (all causes) that are due to severe weather (excluding flooding). Whereas severe weather is responsible for a relatively low percentage of total interruptions (varying between 7% and 22%), it results in a significant share of total CML (varying between 16% and 58%). During this series, severe weather accounted for at least half of all CML in three years, 1998, 2000, and 2012.

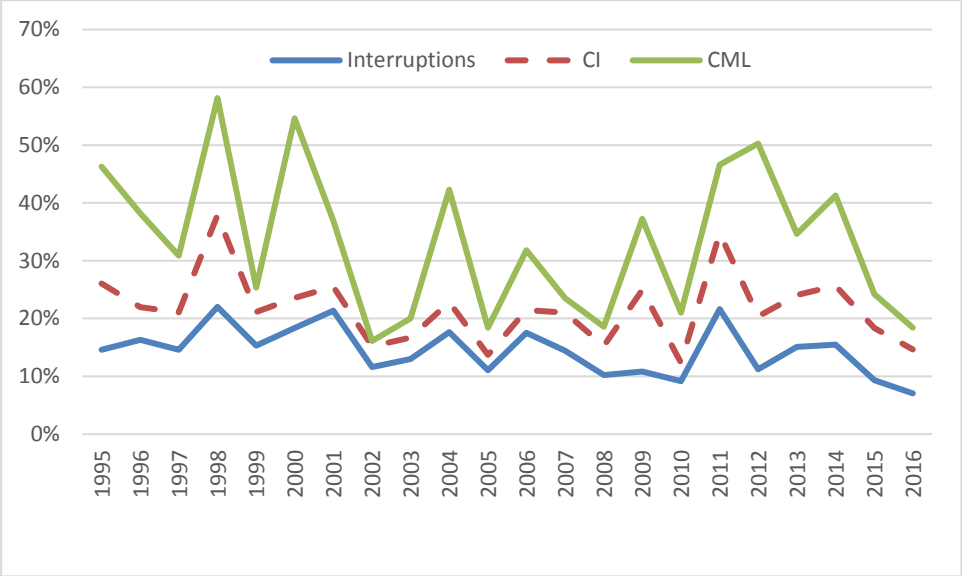

Figure 3 Percentage of disruption to electricity supply caused by severe weather, 1995-2016

Table 2 provides a summary of interruptions and CML due to adverse weather across Scotland's energy network during the period 1995-2016. The top three disruptors are Wind & Gale (1,041,111,495 CML), Snow Sleet & Blizzards (420,621,012 CML), and Lightning (338,429,022 CML)

Cause	Disruption incidents	CML ('000s)
Lightning	14,929	338,429
Rain	1,505	9,012
Snow, Sleet and Blizzard	7,476	420,621
Ice	936	108,126
Freezing Fog and Frost	158	1,552
Wind & Gale (excl Windborne Material)	34,199	1,041,111
Solar Heat	206	5520
Airborne Deposits (excl Windborne Material)	260	16,216
Condensation	348	3,364
Corrosion	10,422	35,478
Mechanical Shock or Vibration	1,308	7,006
Ground Subsidence	361	2,319

Table 2 Weather related disruption to electricity supply; Customer Minutes Lost 1995-2016

What is projected to happen in the future?

The UK climate projections (UKCP09) provide climate information for the UK up until the end of the century. Predicted increases in temperature, precipitation, sea levels and storm surges (ENA, 2011) are expected to 'increase the severity and frequency of natural hazard threats to critical energy infrastructure, including exposure to flooding, extreme temperatures, and subsidence' (The Scottish Government, 2011). This may increase the risk of interruption to the electricity supply. Updated climate projections, UKCP18, are currently being prepared[2].

The RIIO-ED1 price control framework for provision of lower voltage electricity to homes and businesses runs from 2015 until 2023. During its first 2 years of operation, at a UK level there have been significant improvements in network reliability; although the second year saw a slight decrease in performance attributed to poor weather and storms (Ofgem, 2017).

Patterns of change

Based on an assessment carried out by the Met Office, the ENA (2011) report that the projected change in faults due to wind and gale in 2080 ranges from a decrease of 23% to an increase of 20% on the distribution network, and from a decrease of 30% to an increase of 25% on the transmission network. Lightning faults are predicted to increase in the future. In the year 2080, the projected change in the UK Lightning faults ranges from a decrease of 3% to an increase of 75% at most, on both the distribution and transmission networks. The change may be greatest in North England, North Wales and Scotland. The projected change in future snow, sleet and blizzard faults is for a decrease of approximately 50% to 90% on both the distribution and transmission networks, though the North of Scotland may exhibit a smaller reduction than the rest of the UK (ENA, 2011).

Interpretation of indicator trends

The data on disruption does not show an obvious pattern of incidents and faults each year. The number of incidents and related CML vary considerably across the years, which, given the irregular occurrence of severe weather events, is not surprising. This makes it difficult to interpret the data, as a single extreme weather event could occur in any given year and have a marked impact on CML. Thus changes over the course of a just a few years may not reflect adaptation.

Limitations

Severe weather events exhibit large annual variability, so yearly monitoring of CML may be insufficient to reflect adaptation. In addition, the information in NaFIRS gives only the broad cause of the interruption and the customer minutes lost. For example, it does not provide contextual information about loss of other community services that depend on electricity.

From the data it was observed that the number of incidents reported is not proportional to the impact (CML). In some instances a small number of incidents resulted in large impacts in terms of CML. Data will be more meaningful if the nature of the incident is also included.

[2]http://ukclimateprojections.metoffice.gov.uk/24125

The NaFIRS database includes multiple causes within the category of weather-related disruption. Of these, this indicator includes the following direct causes:

Lightning; Rain; Snow, sleet and blizzard; Ice; Freezing fog and frost; Wind and gale (excluding windborne material); Solar heat; Airborne deposits (excluding windborne material); Condensation; Corrosion; Mechanical shock and vibration; Ground subsidence.

The indicator does not include:

Flooding; Fire not due to faults; Growing or falling trees (not felled); Windborne materials; Environment.

References

Energy Network Association (ENA) (2015). *Guide to the UK and Ireland Energy Networks 2015.* Energy Network Association, London. Available at: http://www.energynetworks.org/news/publications/guide-to-the-networks.html

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Ofgem (2012). *Electricity Distribution Annual Report for 2010-11.* London: Ofgem. Available at: https://www.ofgem.gov.uk/ofgem-publications/46553/electricitydistributionannualreportfor201011.pdf

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Further information

Acknowledgements

The data used in this indicator is from the National Fault and Interruption Reporting Scheme (NaFIRS) and was supplied by Brodie Rutz at the Energy Network Association (ENA).

The 2016 version of this indicator was compiled by Ailsa Strathie, Lynne Jack and colleagues at Heriot-Watt University with input from Katherine Beckmann and others at ClimateXChange.

Appendix One: Indicator metadata and methodology

Table 1: Indicator metadata

	Metadata
Title of the indicator	BE15 Electricity supply disruption caused by severe weather events
Indicator contact: Organisation or individual/s responsible for the indicator	Ruth Monfries, Royal Botanic Garden Edinburgh/ClimateXChange
Indicator data source	National Fault and Interruption Reporting Scheme (NaFIRS)
Data link: URL for retrieving the indicator primary indicator data.	Data not publicly available.

Table 2: Indicator data

	Indicator data
Temporal coverage: Start and end dates, identifying any significant data gaps.	1995-2016
Frequency of updates: Planned or potential updates	Data is updated annually. A year runs from 1st April to 31st March (e.g. 2016 data covers 1st April 2016 to 31st March 2017)
Spatial coverage: Maximum area for which data is available	Scotland
Uncertainties: Uncertainty issues arising from e.g. data collection, aggregation of data, data gaps	The NaFIRS database does not include details of the location of the interruption so it is not possible to separate interruptions affecting power stations from those affecting other infrastructure.
Spatial resolution: Scale/unit for which data is collected	Scotland-wide
Categorical resolution: Potential for disaggregation of data into categories	Licence areas 13 and 14 (13 is Scottish Power (SP Trans/SP Dist), 14 is SSE Hydro). Electricity supply chain transmission and distribution networks (HV, KV & LV) Specific weather types (lightning, rain etc.)

Data accessibility: Restrictions on usage, relevant terms & conditions	Data is not publicly available

Table 3 Contributing data sources

Contributing data sources Data sets used to create the indicator data, the organisation responsible for them and any URLs which provide access to the data.
The data was sourced from the National Fault and Interruption Reporting Scheme (NaFIRS) data supplied by the Energy Network Association.

Table 4 Indicator methodology

Indicator methodology The methodology used to create the indicator data
The National Fault and Interruption Reporting Scheme database contains data on the number of interruptions to customers' electricity supplies, and the resulting customer minutes lost. The dataset provided for this indicator held data from 1980 to 2016 for the two separate licence areas in Scotland. However, due to changes in the reporting methodology, only data from 1995 onwards were used. Data for each year was summed to give a total for CI and CML as a result of weather-related disruptions (excluding flooding).