Indicators and trends

Monitoring climate change adaptation

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Indicator name				Version
BE6 Customers reliant on electricity substations in areas at flood risk				**31/03/16**
Indicator type:	**Risk/opportunity**	**Impact**	**Action**	
	X			

SCCAP Theme	SCCAP Objective	CCRA risk/opportunity
Buildings and infrastructure networks (Energy)	B1, B2 and B3	FL11b Substations at significant risk of flooding

At a glance

- Scotland's physical energy infrastructure may be vulnerable to climate change due to the potential for flooding of facilities, damage to power lines and disruption to power stations
- It is predicted that rising sea levels and more frequent extreme weather events will increase the frequency of floods in Scotland
- Customers reliant on substations at risk of flooding may be subject to power interruptions, sometimes in tandem with other disruptive effects of flooding
- The application of new guidelines (ETR138) will ensure that the flood resilience of existing major substations is increased, and that future sites will not be located in areas at high risk of flooding

Latest Figure	Trend
2012-2013: • 260,503 customers (including 13 critical customers[1]) are reliant on 43 distribution substations located in areas at risk of flooding.	No data yet available on which to base a trend

Why is this indicator important?

Energy security requires a complex system to generate, store, and distribute energy. Physical infrastructure may be vulnerable to the impacts of climate change because of the potential for flooding, damage to power lines and disruption to power stations (The Scottish Government, 2011). In common with most countries, Scotland's energy capacity has evolved as a primarily centralised

[1] Including hospitals, underground stations, pumping stations and sewage works

network, which means that it is dependent on a relatively inflexible system of critical infrastructural assets (The Scottish Government, 2011).

Substations are critical to transmitting and distributing energy across the electricity network. Flooding coupled with the loss of power can have a severe effect on communities, particularly if other critical infrastructure services are also affected (eg water supply, sewage treatment and land drainage), and may require mass evacuation. Loss of other services that depend on electrical power, such as the emergency services and public communications (e.g. TV, internet, telephony), can also have a large impact on society (ENA, 2009) causing fear and distress to those affected (Pitt, 2008).

Repairing substation equipment damaged by floods may take weeks, and where replacement is required the disruption may last for months (ENA, 2009). This indicator shows the numbers of people and services at risk due to flooding of electricity substations (primary or grid) and is one of four that consider the resilience of electricity substations to flood events.

Related indicators
BE5 Electricity substations located in areas at flood risk
BE7 Substations in areas at flood risk with completed Flood Risk Assessments
BE8 Substations in areas at flood risk with completed or planned flood protection works

What is happening now?

As of 2012-2013, 43 major substations (defined as primary or grid substations) that form part of the electricity distribution network were located in areas at risk of flooding (see BE5). According to the V7 flood mitigation tables, a total of 260,503 customers are reliant on these substations. This number includes both residential and non-residential customers, and the tables do not fully differentiate between the two. For example, of the 43 major substations at risk of flooding, two serve only one high voltage customer each. Thirteen 'critical customers' are reliant on major substations at risk of flooding. These include of six sewage works, three hospitals, two underground stations, and two pumping stations.

A task group with representation from ENA (Energy Networks Association) members companies, the Department for Business, Enterprise and Regulatory Reform (BERR), Ofgem, the Environment Agency (EA) and the Scottish Environment Protection Agency (SEPA) has developed agreed standards for the resilience of electricity substations, including flood resilience. Technical report ETR 138 (ENA, 2009) provides details of these standards. As part of this process, a consistent 'Data Collection Specification' was created in order to identify key flood risk information for each substation (ENA, 2009).

The Distribution Network Operators (DNOs) are required to report flood risk and mitigation measures for substations to Ofgem using the methodology set out by the Technical Report ETR 138. This reporting provides data that is fed into the 'V7 Reports' (ENA, 2015) that have been used for this indicator. This reporting regime will continue to provide useful information in the future.

In Scotland, the data collected include an assessment of:

- Whether the site is on a flood plain for two probability levels – 1 in 200 and 1 in 1000 – for both fluvial and coastal flooding.
- Whether the site benefits from a flood defence scheme provided by the local authority, the site owner, or any other party.
- The condition of the defences protecting the site.
- Flood risk including potential maximum water level for each of the flood probability levels (1 in 200 and 1 in 1000), and an indication of data accuracy and flood zone type.

- The accuracy and age of the terrain mapping.
- Whether the site is located in a SEPA Flood Warning Area.
- The lead time for Flood warning
- The minimum notice required by the network owner to put temporary flood protection measures in place.
- Historical flooding data.

This forms part of the process to assess the resilience of substations located in flood risk areas across Scotland. The ETR 138 (ENA, 2009) agreed standards are also applied to assess proposals for future substation sites so that new substations will not be located in areas at risk of flooding unless there are no viable alternatives. This will reduce the vulnerability of the electricity network in the future.

In addition to flood risk, the impact of flooding is also assessed, which involves comparing the predicted flood level in relation to that of critical equipment that will cause services to be interrupted. The potential impact on society is also considered, taking into account the number of customers who would lose supplies, and the effect of supply loss on other critical infrastructure sites (ENA, 2009).

What has happened in the past?

Severe flooding incidents occurred in England during 2005 (Carlisle) and 2007 (South Midlands & Yorkshire) highlighting that electricity substations across the UK were potentially vulnerable to flooding. These events called into question whether historic levels of flood protection would be sufficient to protect UK substations in the longer term given the projected effects of climate change (ENA, 2009). However, due mainly to differences in topography, Scotland has not experienced the same level of river and coastal flooding as England so the increase in risk to its substations may be less severe than further south in the UK.

What is projected to happen in the future?

The projected rise in sea level and frequency of severe weather events 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 number of substations in areas at risk of flooding, and therefore the number of customers who are likely to be affected by flooding.

Although distribution networks are inherently resilient, specific points in the network may be at risk of flooding, either from more severe, or more frequent, flooding, which could result in more regular or prolonged interruptions to supplies for Scottish customers on a localised basis. This vulnerability represents a risk to existing energy infrastructure and will also have implications for future infrastructure plans and investments (The Scottish Government, 2011).

New standards relating to the resilience of electricity substations (ETR138) will increase the level of substation protection against flooding (ENA, 2009), thus reducing the risk of increased flooding.

Patterns of change

The data for 2012-2013 provide a baseline number of customers reliant on major electricity substations located in areas at risk of flooding. There are two competing patterns to consider. Climate change projections include sea level rise and more frequent severe weather events, both of which may place more major substations at risk over time, consequently increasing the number of customers reliant on 'at risk' substations. However, the implementation of new guidelines on the security of primary and grid substations (ETR138) will ensure that the flood resilience of existing

major substations is increased. Additionally, future developments will not be located in areas at high risk of flooding. It is therefore predicted that although flood risk may increase, the implementation of ETR 138 should ensure the security of the electricity network, thereby stabilising or decreasing the number of customers at potential risk of supply loss due to flooding of major substations.

Interpretation of indicator trends

Limitations

Currently, the assessment of major electricity substations at risk of flooding reflects only fluvial and coastal flood risk; because these are the only data SEPA provide (ENA, 2009).
This suggests that the total number of major substations at risk of flooding, and consequently the number of customers dependent on this category of substation, may be higher than reported once additional sources of flooding are considered. The latest iteration of SEPA flood maps (SEPA, 2015) include pluvial flooding, and it is recommended that this indicator should be developed as information about additional sources of flooding become available.

A further limitation is that 'the number of customers reliant on electricity substations at risk of flooding' metric does not differentiate between domestic and industrial/commercial customers. The figure of 260,503 customers dependent on 43 substations includes two substations that each serve only one customer, but loss of service to these two substations may have a wider impact, as the customers that they serve also supply services to the public. Similarly, loss of power to the critical customers reliant on these major substations would also have a more severe societal impact than the numbers alone might suggest. Critical customers include hospitals, underground stations, pumping stations and sewage works.

References

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Further information

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Appendix One: Indicator metadata and methodology

Table 1: Indicator metadata

	Metadata
Title of the indicator	BE6 Customers reliant on electricity substations in areas at flood risk
Indicator contact: Organisation or individual/s responsible for the indicator	ClimateXChange
Indicator data source	V7 Flood Mitigation Data
Data link: URL for retrieving the indicator primary indicator data.	The data is not publicly available, but was supplied via the contacts listed above (Acknowledgements).

Table 2: Indicator data

	Indicator data
Temporal coverage: Start and end dates, identifying any significant data gaps.	The data is for the 2012-2013 period.
Frequency of updates: Planned or potential updates	Updates could be obtained from future V7 reports. Potentially this data could also be supplied by the Scottish Environmental Protection Agency.
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 data regarding the number of customers dependent on each substation is composed of both residential and non-residential customers.
Spatial resolution: Scale/unit for which data is collected	Number of customers
Categorical resolution: Potential for disaggregation of data into categories	
Data accessibility: Restrictions on usage, relevant terms & conditions	The data is supplied on the condition that individual substations will not be identified.

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.
V7 Flood Mitigation Tables – May be available from operators via ENA on request.

Table 4 Indicator methodology

Indicator methodology The methodology used to create the indicator data
The data for this indicator were extracted from V7 Flood mitigation tables, which were supplied in edited form, as Excel spreadsheets. These contain details of individual substations located in areas at risk of flooding based on assessment against SEPA's flood extent maps, the absolute number of customers to which each substation supplies electricity, and the number and type of critical customers that depend on each substation.