Indicators and trends

Monitoring climate change adaptation

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Indicator name				Version
BE5 Electricity substations located 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, B3	FL11b Sub-stations at significant risk of flooding

At a glance

- Scotland's energy infrastructure may be vulnerable to climate change due to the risk of flooding, damage to power lines and disruption to power stations
- Rising sea levels and more extreme weather will increase flood frequency, and the number of major substations at risk of flooding, though the proportion at risk is small at present
- An industry task group has developed standards for the resilience of substations. These guidelines (ETR138) will ensure that the flood resilience of existing major substations is increased, and that future developments will not be located in areas at high risk of flooding

Latest Figure	Trend
2012-2013: • 49 major electricity substations (primary or grid) are at flood risk • 43 are distribution substations; 6 are transmission substations • Data is incomplete but it appears that less than 4% of sites are at risk	There are no historical data to allow for analysis of trends.

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 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). Monitoring substations at flood risk can help inform emergency planning for weather related hazards, such as flooding, and reduce disruption to local communities and businesses (Adaptation Sub-Committee (ASC), 2014).

Related Indicators:
BE6 Customers reliant on electricity substations 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, 49 major substations (defined as primary or grid substations) were identified as being located in flood risk areas. As shown in Table 1, six are part of the transmission network (used to transport electricity at high voltages from generation units to distribution companies) while 43 form part of the electricity distribution network (which delivers electricity to most customers through lower voltage networks).

To put this into context, there are a total of 1127 distribution substation sites in Scotland, of which 43 are at flood risk[1]. This represents just 3.8% of distribution substations.

Data is incomplete for transmission substations. Of the 152 transmission substations operated by SP Energy Networks, just 6 are at flood risk, or 3.9%[2].

Table 1 Substations at Risk of Flooding

	Distribution substations	DS at flood risk	Transmission substations	TS at flood risk
SP Energy Networks	618	22	152	6
SSE	509	21	74	-
Totals	1127	43	226	-

A task group formed to review the resilience of electricity substations to flooding has developed agreed standards for the resilience of electricity substations. The group has representation from the ENA (Energy Networks Association), member companies, the Department for Business, Enterprise and Regulatory Reform **(**BERR), Ofgem, the Environment Agency (EA) and the Scottish Environmental Protection Agency (SEPA). Technical report ETR 138 (ENA, 2009) provides details of these standards.

[1] SP Energy Networks have 152 transmission sites and 618 distribution sites. SSE has 74 Transmission sites and 509 Distribution sites. Of the 43 distribution substations at flood risk, SP operate 22, and SSE operate 21.

[2] Scottish Power has 6 transmission stations at flood risk. SSE did not supply details for transmission stations

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 -1/200 and 1/1000 - 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 two 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 proposed 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 future vulnerability of the electricity network.

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 predicted changes 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 is likely to increase the number of substations located in areas at risk of flooding.

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 (ENA, 2009). Additionally, future developments will not be located in areas at high risk of flooding. Therefore, it is predicted that while flood risk may increase, the implementation of ETR 138 will ensure that the vulnerability of the electricity network will not.

Patterns of change

Of the 43 distribution substations at risk of flooding, Scottish Power operate 22, and SSE operate 21. Scottish Power has 6 transmission stations at risk of flooding, and SSE did not supply details of transmission stations at risk of flooding.

Interpretation of indicator trends

The current lack of historical data does not allow for identification of trends

Limitations

A figure for the total number of substations in Scotland is not yet available. The authors are seeking clarification from the two power distribution companies so that numbers can be put into context.

The exercise to identify major substations at risk of flooding only reflects risks posed by fluvial and coastal flooding, because at the time of the assessment these were the only risks about which SEPA provided data (ENA, 2009). Thus the number of major substations at risk from all types of flooding may be higher when pluvial flooding is also considered. The latest iteration of the SEPA flood maps (SEPA, 2015) includes pluvial flooding, and it is proposed that the indicator should be developed as information about additional sources of flooding becomes available.

There are difficulties in interpretation of the data. Firstly, it is unclear whether the data contains details of all of the major substations located in flood risk areas, or just those where action is being taken. Secondly, the information supplied by one of the operators only contains details of major substations that are part of the distribution network, while the other operator also supplied information about those that are part of the transmission network. The authors have been unable to confirm whether this is because in one of the operator areas, none of the major transmission substations are located in areas at risk of flooding, or if this is missing data. If the latter, the numbers reported here may be an underestimation.

References

Adaptation Sub-Committee (ASC) (2014). *Managing climate risks to well-being and the economy: Progress Report 2014.* Available at: http://www.theccc.org.uk/publication/managing-climate-risks-to-well-being-and-the-economy-asc-progress-report-2014

Energy Network Association (ENA) (2009). *ETR 138: Resilience to Flooding of Grid & Primary Substations*. Energy Networks Association.

Energy Network Association (ENA) (2015) V7 Flood Mitigation Reports 2012-2013. Unpublished Data.

Pitt, M. (2008). *Learning lessons from the 2007 floods.* London: Cabinet Office.

Scottish Government (2011). *Scotland's Climate Change Adaptation Framework (SCCAF): Energy Sector Action Plan.* The Scottish Government. Available at: http://www.gov.scot/Resource/Doc/175776/0114907.pdf

SEPA (2015) Flood Extent Maps. [online]. Available from: http://map.sepa.org.uk/floodmap/map.htm

[accessed April 2015].

Further information

Energy Network Association (ENA). V7 Flood Mitigation Tables – May be available from operators via ENA on request.

The Scottish Government (2015). *Action to manage flooding risk in Scotland* [online]. Available at: http://www.gov.scot/Topics/Environment/Water/Flooding

Acknowledgements

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Appendix One: Indicator metadata and methodology

Table 1: Indicator metadata

	Metadata
Title of the indicator	BE5 Electricity substations located 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.

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	Scottish Power supplied data for both transmission and distribution sites, while SSE supplied data only for distribution sites.
Spatial resolution: Scale/unit for which data is collected	The data is supplied at the scale of the individual substation.
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 data is not publicly available at present. It was supplied through contacts at the ENA, SP and SSE.

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 to us 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.