A Climate Change Risk Assessment for the UK Electricity Networks

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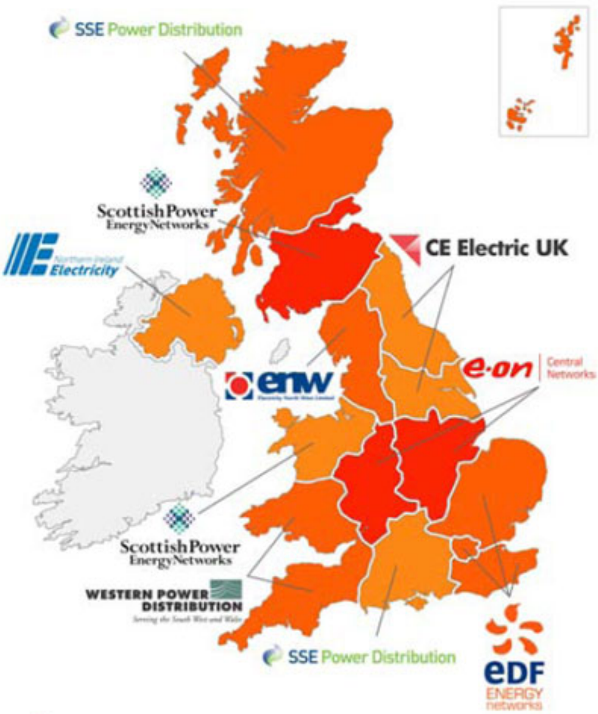
Presented by Stuart Webster

UK's Electricity Network



- The UK's electricity network transfers electrical energy from the generating power plants to customers in 2 stages:
    1. High voltage transmission network from power plant to substations close to population centres.
    2. Lower voltage distribution network from the substation to consumers.
- Both networks are made up of overhead lines, underground cables, substations and transformers.
- Network is split into regions (licence areas)
- Owned by seven separate companies.
- This project commissioned by Energy Networks Association (UK industry body) on behalf of these seven companies.
- Most faults are on distribution network hence these are the main focus of this talk.

Distribution Network faults

- Since 1980, each network fault has been routinely reported to Ofgem (regulatory body).
  - Provides us with a large database to assess present day faults

- Many possible fault causes seen: age/deterioration, fire, interference by third parties, birds, weather.
- Weather causes:
  - Lightning
  - Snow, sleet and blizzard
  - Wind & gale
  - Ice
  - Rain
  - Freezing, fog and frost
  - Solar heat
  - Flooding

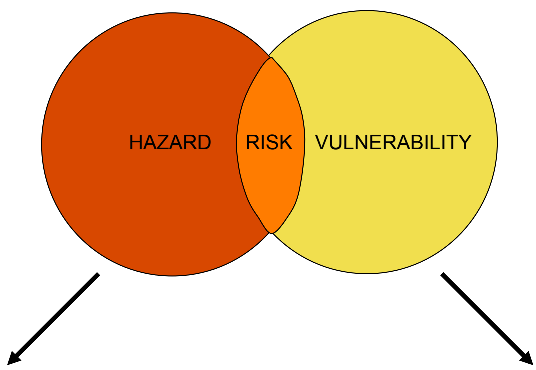
<u>2008/2009</u>

- 258,581 faults
- 21,157 weather-related (8%)
- 1.9 million weather-related CIs

- Additional information reported regarding each fault:
  - Location = Licence Area
  - Customer Minutes Lost,
  - Customer Interruptions (CIs),
  - Voltage & Equipment

Climate Change Risk Assessment for the UK Electricity Network

<u>Aim</u>: how might the risk of weather-related faults change in the future as a result of climate change?



Hazard = the occurrence of a weather-related fault

Vulnerability = average number of customer interruptions per fault

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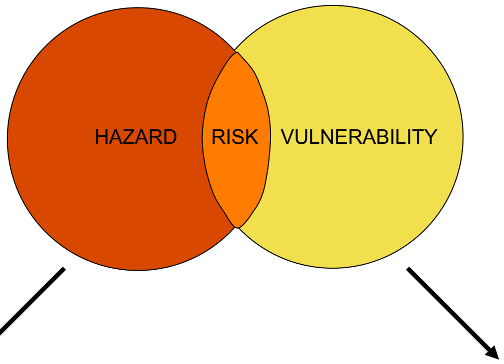

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Baseline

- Objective: understand the network's current sensitivity to weather.
- Methodology: formal statistical analysis.
- Data: daily time series of weather (gridded surface obs + ERA-interim) & fault values .

Future

- Objective: investigate how the network's future risk to weather-related faults may change.
- Methodology: drive the baseline relationships with climate model output.
- Data: daily RCM time series

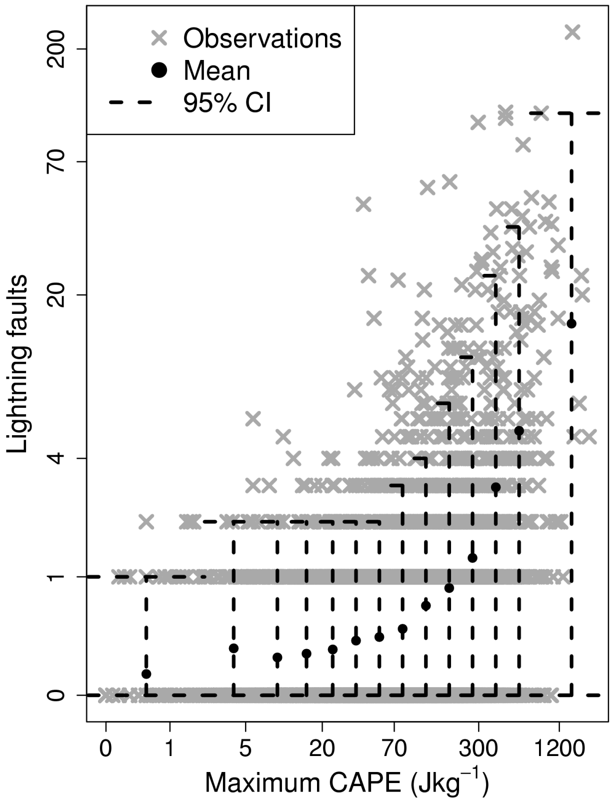
Presentation

- Objective: present the results to customers.
- Methodology: combination of workshops, reports and a webtool.

Example Hazard results: Lightning faults

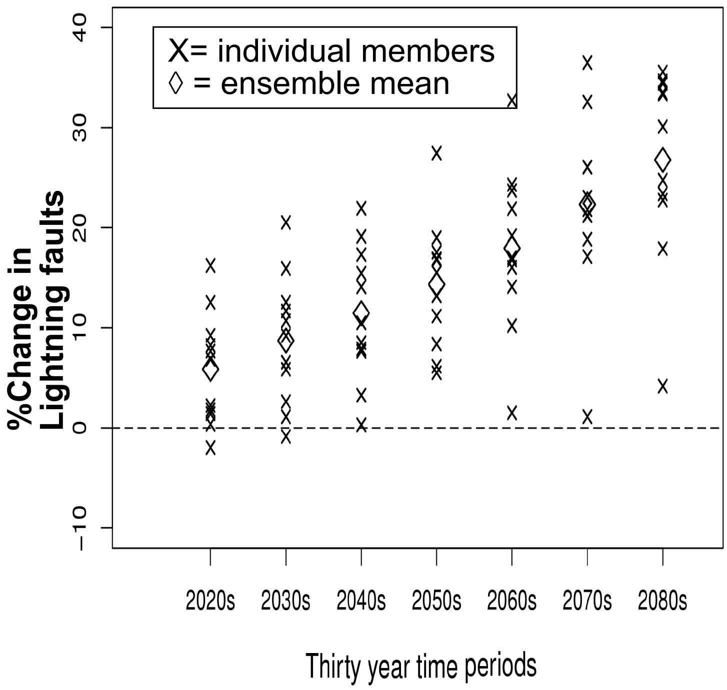
- Lightning is the second most common cause of weather-related faults across the distribution network and the primary cause in the transmission network.
  - Most common is strong winds. However, no clear signal in future change in UK wind strength.
- Since observations & climate projections of lightning strikes are unavailable, CAPE was used as a good alternative proxy.
- As convection in the atmosphere increases (and hence CAPE) the likelihood of lightning strikes increases.

Example Hazard results: Lightning faults: present day



- Plot shows daily data
- Max CAPE from ERA-interim.
- The relationship is non-linear
  - hence log-log scale
  - Mean + 95% confidence interval shown for different CAPE bins.
- Uncertainty associated with estimating lightning faults can be high.
  - Large CAPE might not produce lightning
  - Lightning might not strike network equipment

Example Hazard results: Lightning faults: projected change



- Projected changes in CAPE give projected changes in lightning.
- Future CAPE calculated using daily data from 11 Met Office regional climate model simulations (dx=25km).
  - Medium emissions scenario (A1B SRES)
- Lightning faults are projected to increase in the future – this is a consequence of more days with larger CAPE (and hence stronger convection).
- Almost 40% increase possible by 2080s.

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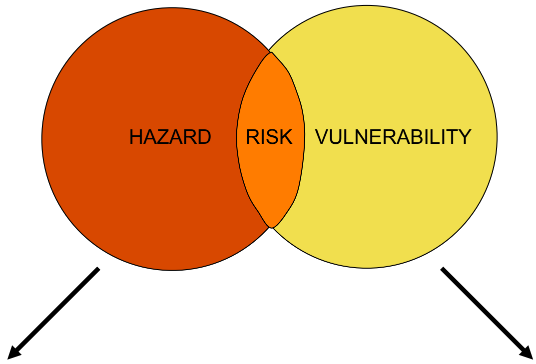

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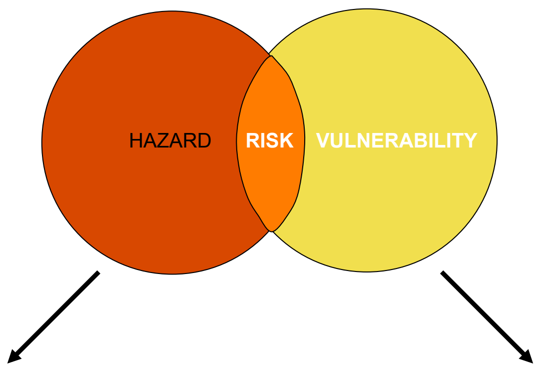

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Vulnerability : Present Day

Met Office

- Vulnerability is quantified using the average number of Customer Interruptions (CIs) per weather-related fault.
- Regional variations due to a number of factors:
  - Length of network
  - Number of customers
  - Relative amount of over/under ground equipment
- Vulnerability assumed constant over time.
  - simply because we have no information on how it might change
- Hazard and vulnerability are combined by converting each into a simple index and multiplying together to give a measure of the Risk.

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Contingency Table for Lightning faults in one region

Faults	Customer Interruptions		
	Low: < 100	Medium: 100 -500	High: > 500
Low: < 5	87%	4%	6%
Medium: 5 – 10	<1%	<1%	<1%
High: > 10	0%	<1%	2%

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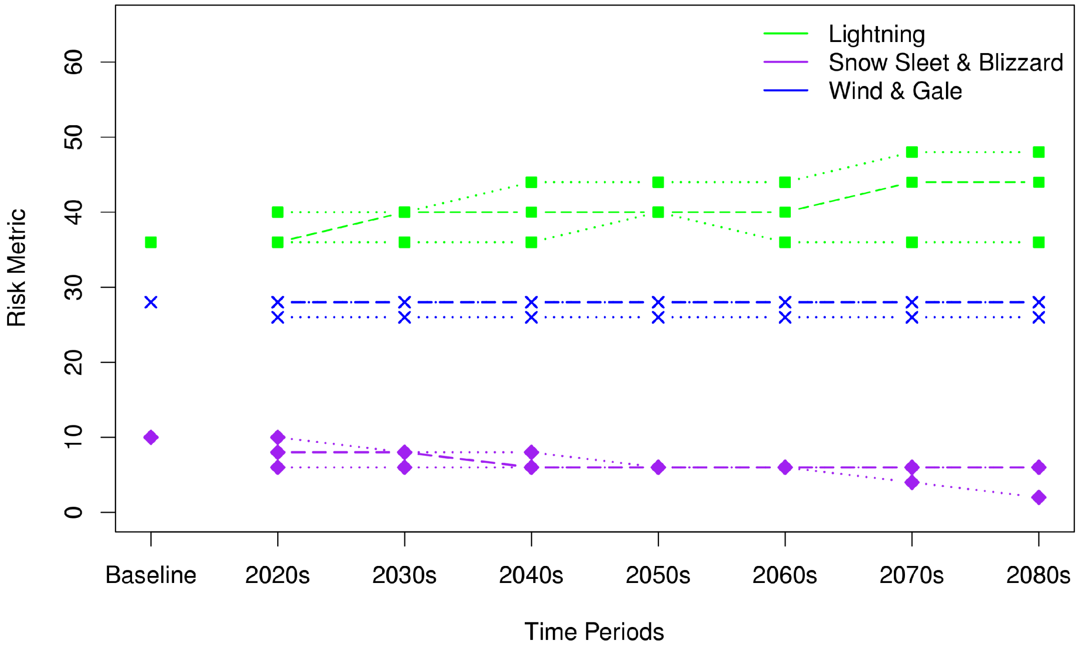
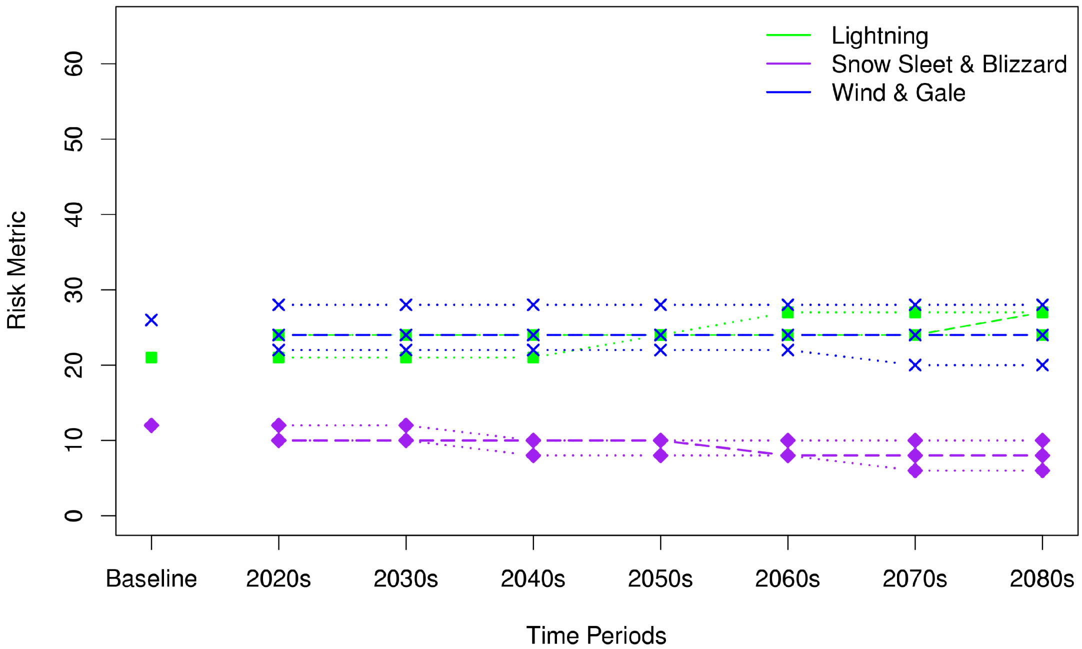
Risk metric examples

- Region 1



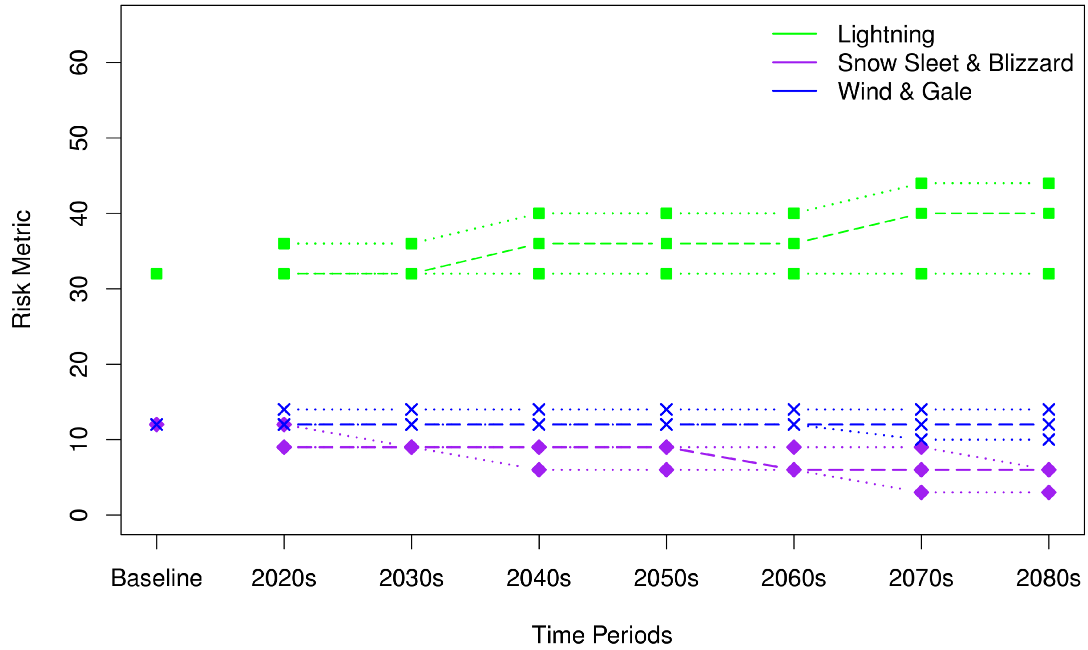
Risk metric examples

- Region 2



Risk metric examples

- Region 3



Risk metric examples

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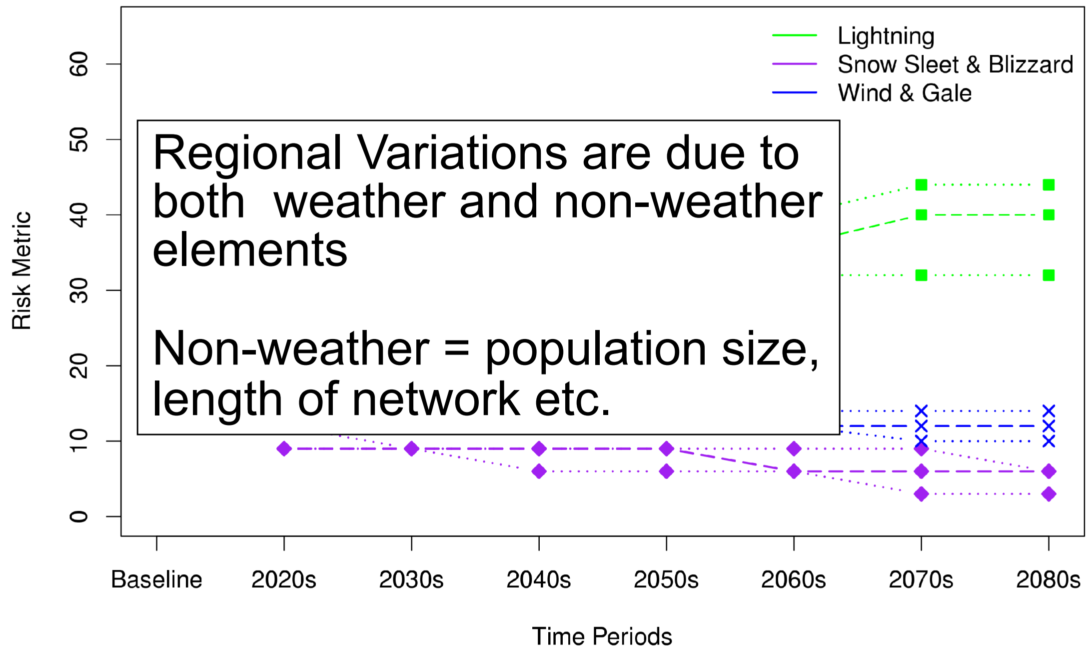

Summary

Risk Assessment:- Headline UK results

- In the majority of regions (licence areas) the network is currently at greatest risk from lightning, followed by wind and gale followed by snow.
  - Biggest hazard = wind and gale faults
  - Biggest vulnerability = to lightning faults.

- The risk of the network to lightning is likely to increase in the future due to a projected increase in lightning faults by up to 40%.

- The risk of wind and gale may remain the same, or increase/decrease by a small amount.

- The risk of the network to snow-sleet-blizzard faults is projected to decrease by up to 80%, but when it does snow the intensity of the event could be the same or larger.

Questions

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