Electricity Distribution Network: Operational Resilience and Climate Adaptation

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EPSRC
Engineering and Physical Sciences Research Council

Enhancing Current and Future Operational Resilience

Validate existing criteria used to forecast risk vs. the observed fault volume

Identify the appropriate spatial level to monitor and forecast weather within service area

Evaluate additional variables to enhance risk ratings

Inform how risks might change under future climate projections

Aim: Proactive Outage Risk Information

Historical Data can Inform Decision Making

Electricity North West (ENWL)

- Geo-referenced faults with wind listed as the primary cause of failure

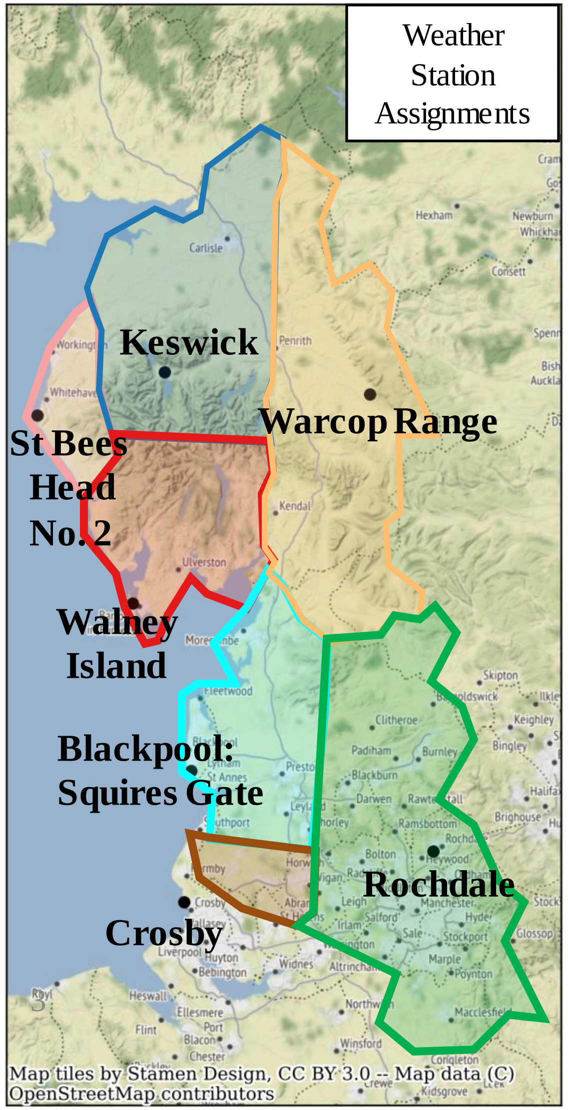
Met Office

- MIDAS: UK Mean Wind Data (maximum wind gust) from weather stations [1]
- Stations filtered based on elevation and data completeness

Time Period: 2000-2020

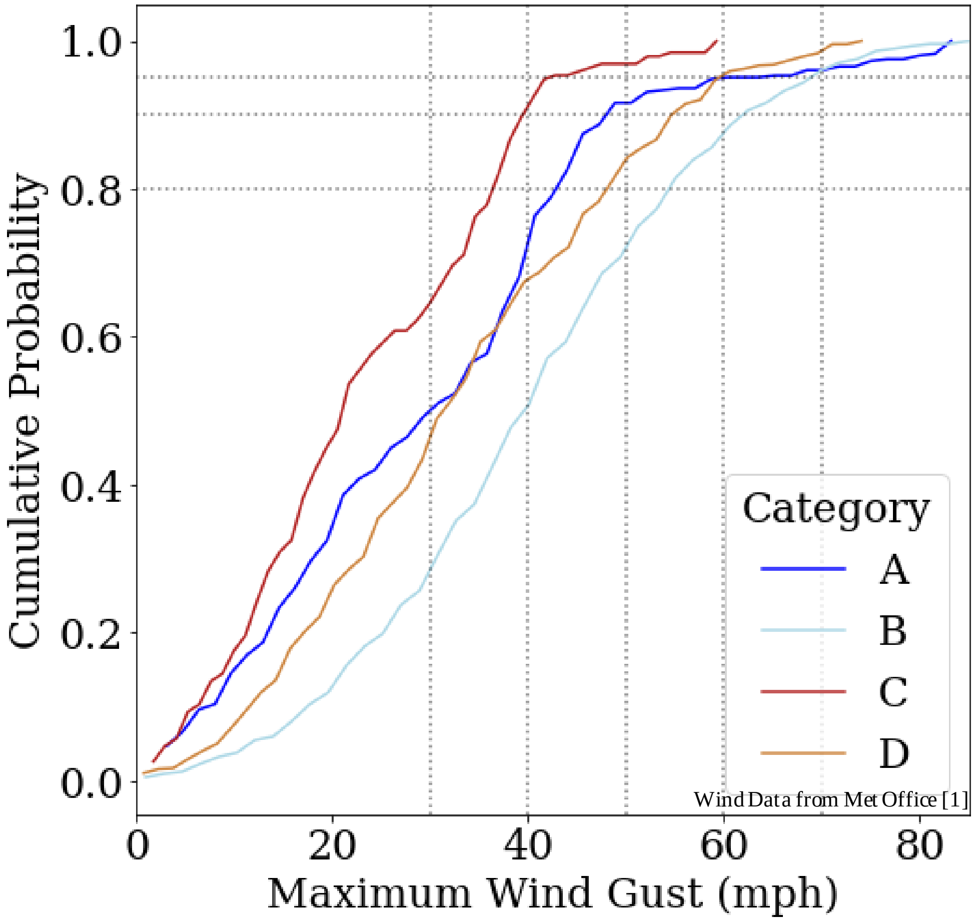
- This period includes major events such as storm Desmond (2015) and storm Ali (2018)

ENWL currently utilizes experience with historical windstorms to prepare for upcoming extreme wind events



Fault Data Supports ENWL Criteria

VALIDATE



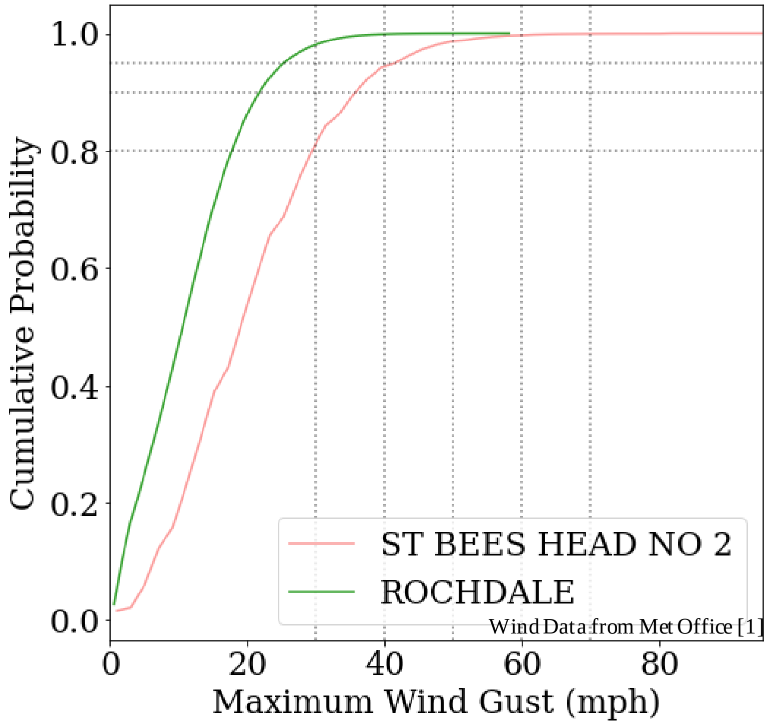
- Current ENWL risk informed by three criteria: wind gust speed, direction and season
- Cumulative densities differ across these criteria
- Mapping of these criteria with probability thresholds can inform scheduling of resources and personnel

Wind Impact Varies with Region

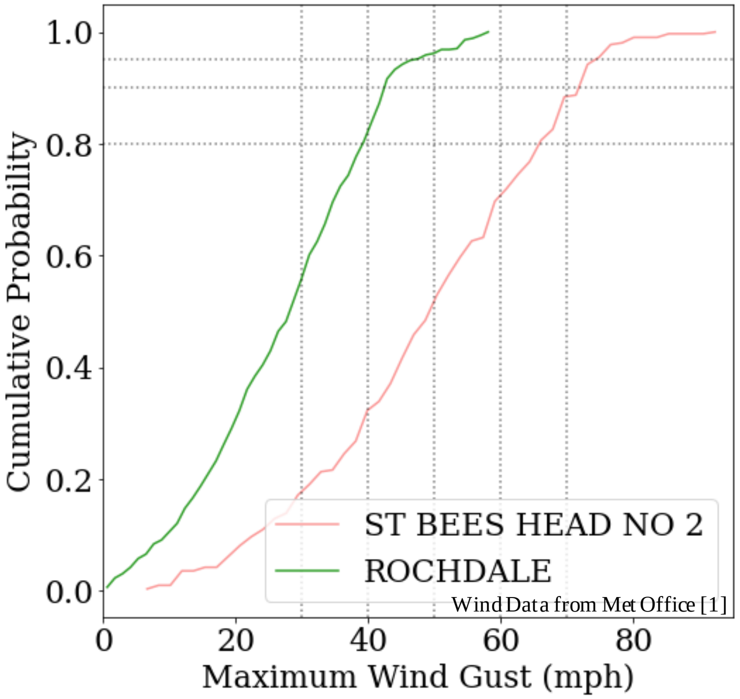
IDENTIFY

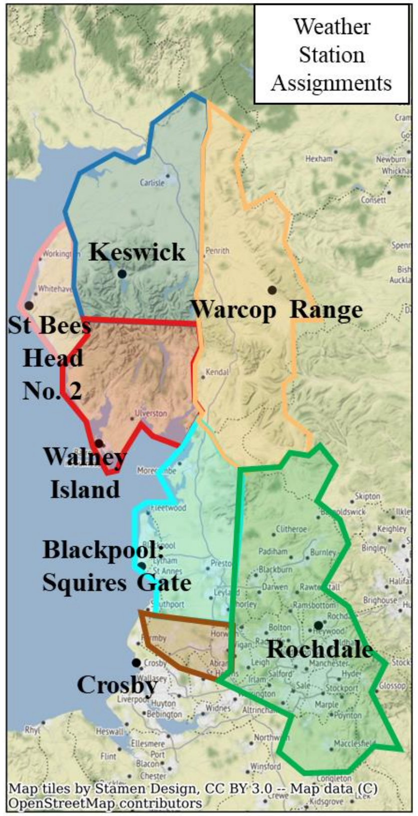
- Understanding of the wind speeds within each region can support better operational awareness

Hourly Historical Gusts



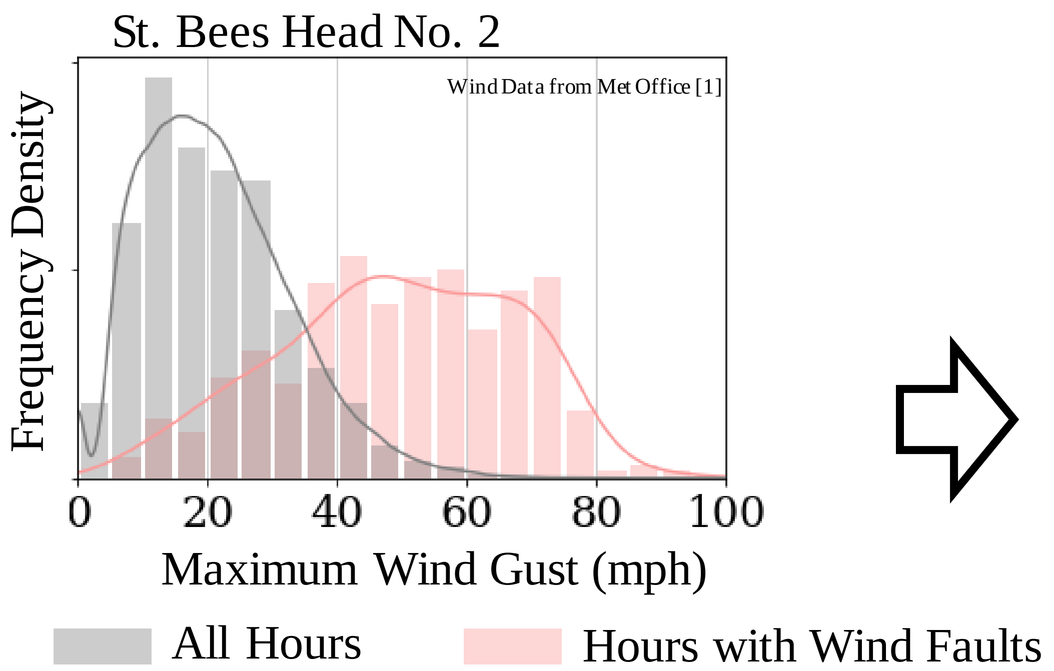
Hourly Fault Gusts

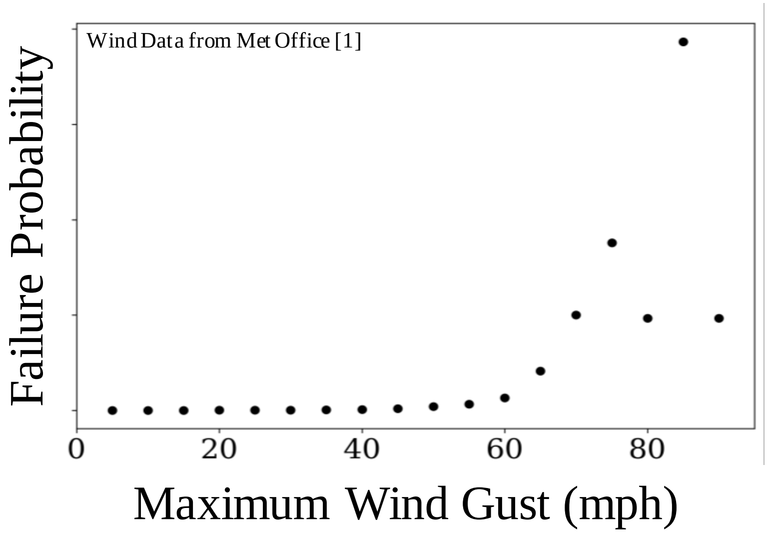




Weather Data for Fault Prediction

IDENTIFY





- Historical fault records can be used to project how many faults to expect for a particular weather forecast
- Values should be normalized when comparing across regions
- These expectations can be used to inform risk metrics

EVALUATE

Exploration of Other Variables

Age of Asset

Time of day

Elevation

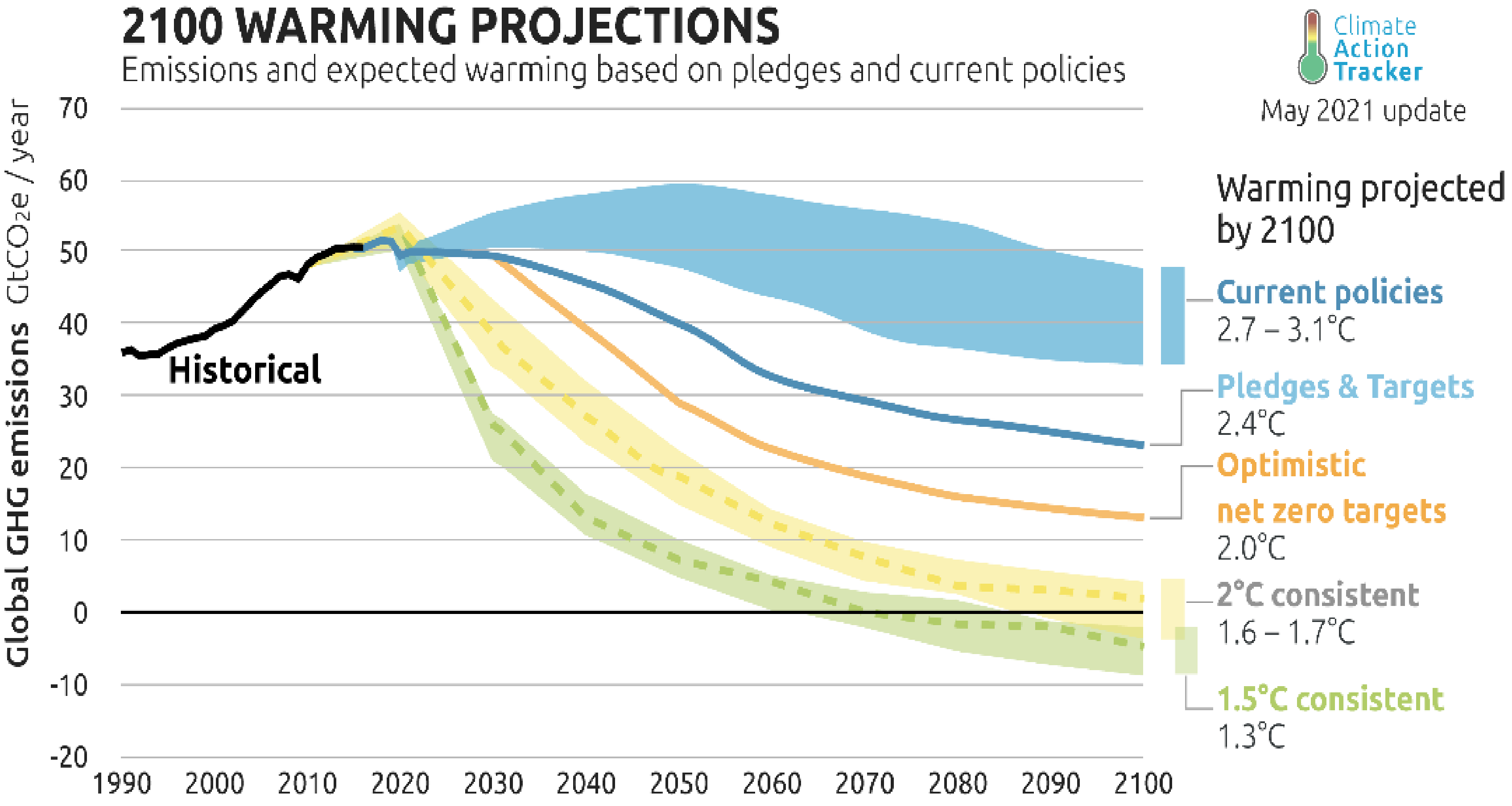
Vegetation indices

Weather leading up to fault

Precipitation

Temperature

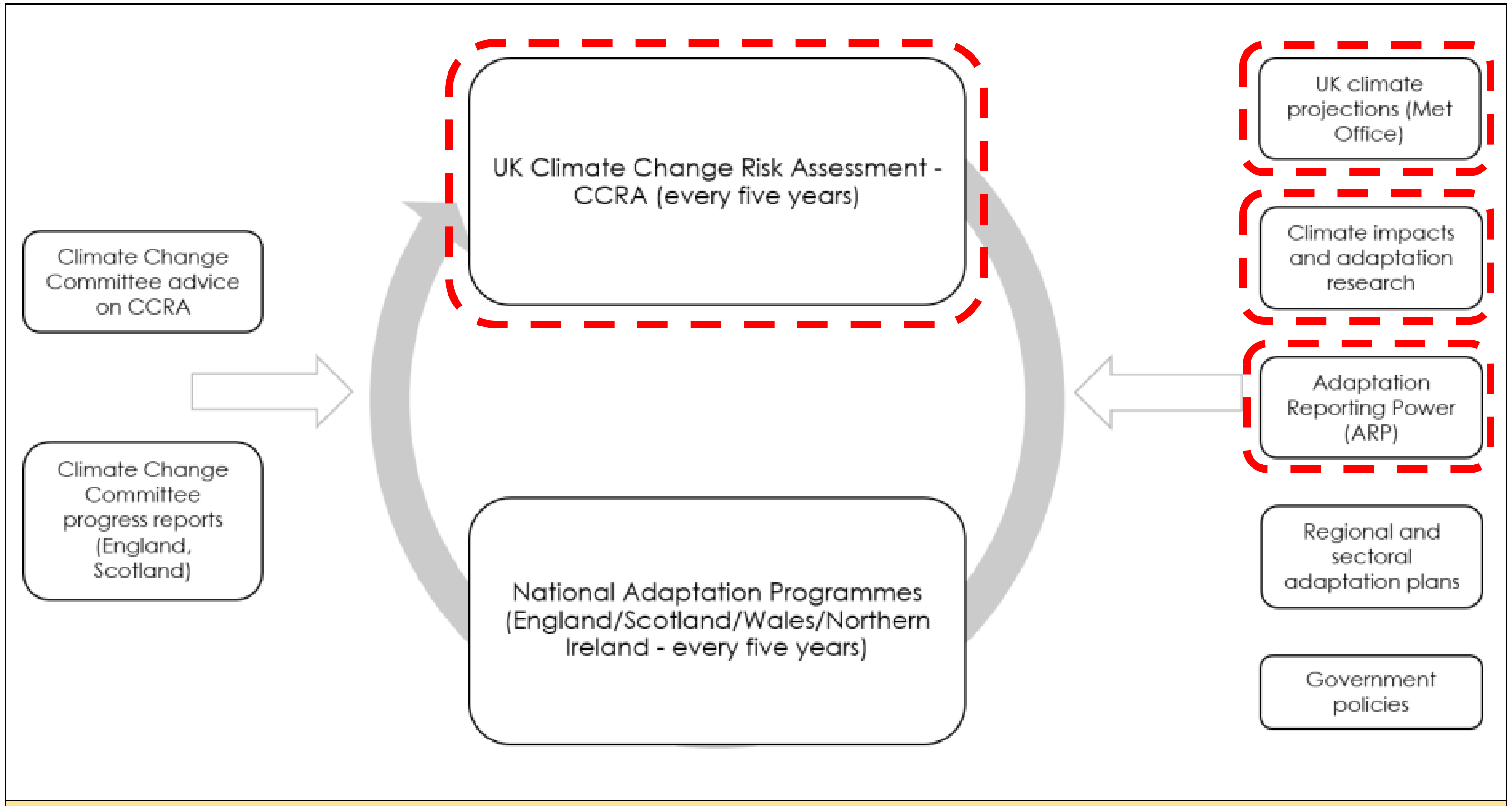
Future operational resilience



<u>We need to mitigate AND adapt</u>

- Climate mitigation (or Net Zero or decarbonisation)
- Climate adaptation (or resilience)

Climate resilience in UK



- CCRA 3 released in June 2021
- DNOs reporting under third round of ARP
  - current & future effects of climate change
  - proposals for adapting to climate change

Source: modified from CCRA 3, Introduction [2]

Climate resilience & ENWL

- Adaptation Reporting Power round 1 (~2011) and 2 (~2015) impacts [3]:
  - **Flooding**, actions to protect substations
  - **Increase in temperature**, reduce infrastructure performance and increase demand
  - **Increased vegetation growth**, modify inspection and cutting regimes
  - **Resilience to extreme events**, lighting and high winds, no evidence this will change.
- ARP 3 due 2021

Image source [3]

Changes to UK Wind Profiles remain Uncertain

INFORM

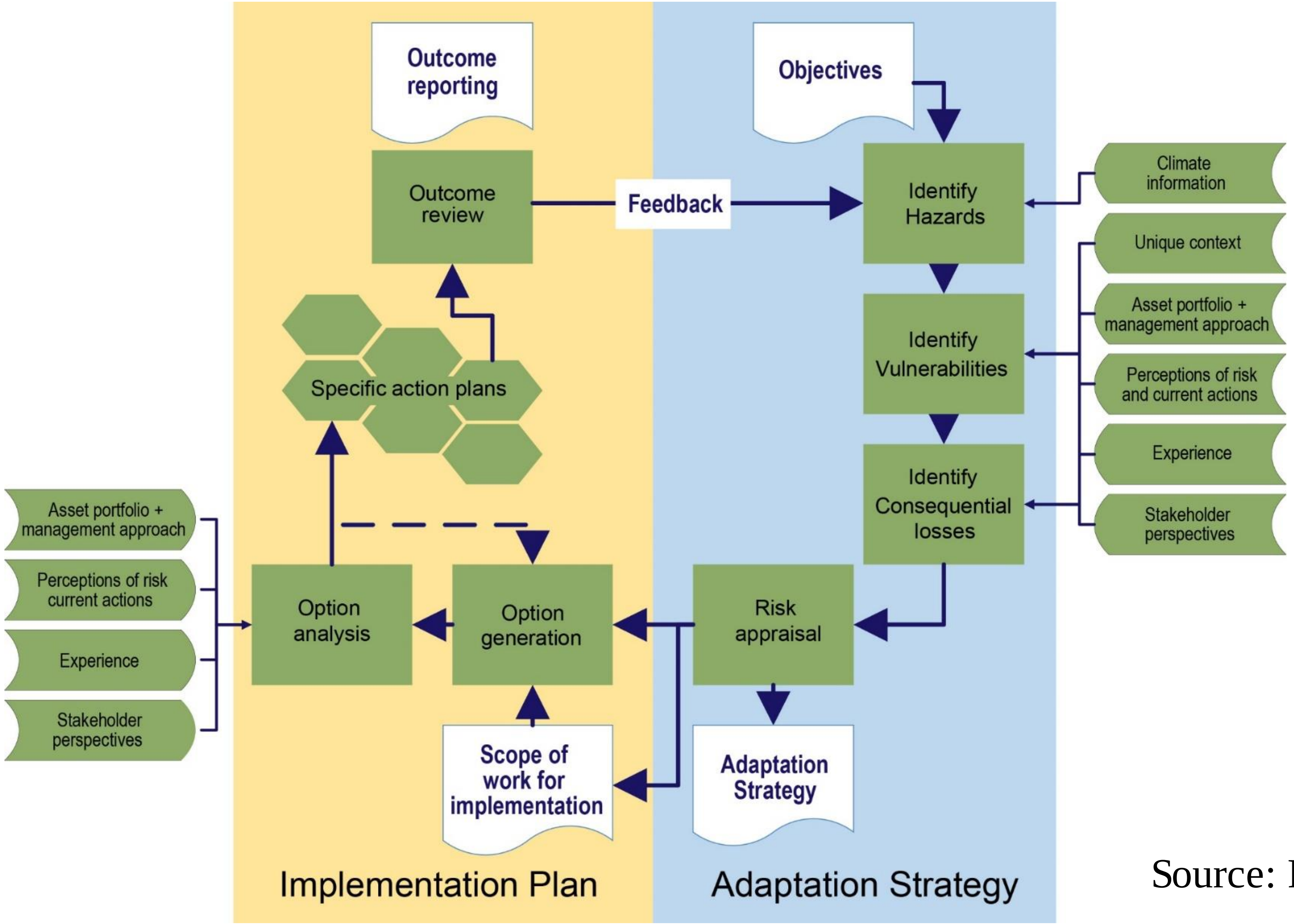
- Observations over four decades show no change in storminess, as measured by maximum gust speeds [4]

- The Met Office climate models suggest that in the future there may be more warm and wet conditions resulting from strong westerly winds, but this pattern is not replicated in all climate models [5]

➢ DNOs should continue to monitor impact of weather on infrastructure, and ongoing research, as part of iterative climate adaptation

Framework for Climate Adaptation

INFORM



Climate Adaptation is:

- BAU – operations & strategy
- Iterative
- Collaborative
  - Interdependencies
  - Share different expertise (two-way)

Source: Rail Adapt [6]

UK Climate Change Risk Assessment [7]

1. Interdependencies / interacting risks

- Increasing dependence on electricity sector increases consequences of power outages.
- Increased dependencies with other sectors (e.g. ICT) makes cascade failures more probable

2. Net zero changing the profile of risk

- Greater renewables generation changing the spatial distribution of supply
- Infrastructure risk from changing energy mix uncertain, e.g. increasing reliance on offshore wind whilst climate impact of storms and high waves is uncertain.

3. Uncertain projections for future wind generation

➢ **Adaptation shortfall for storms, lightning & high winds in energy sector**

Conclusions

- Analysis of historical fault records in concert with meteorological information can lead to more proactive scheduling of resources and personnel
- Statistical analysis can inform experientially based metrics
- The wind and fault behavior can differ significantly across a single Distribution Network Operator’s service territory and therefore, risk metrics should be assessed at a regional level
- Understanding current operational resilience supports longer term climate adaptation, especially given future uncertainties from interdependences, changed net-zero risk and climate projections

Any Questions?

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