Electricity
Distribution

Assessment of Climate Change Event Likelihood Embedded in Risk Assessment Targeting Electricity Distribution (ACCELERATED)

Webinar
28 March 2023

nationalgrid

Agenda

1. Project background
2. Historic weather impact assessment
3. Climate change impact analysis on network performance and visualisation of future risks
4. Climate change impact on embedded generation and demand
5. Climate Change impact assessment procedure
6. Q&A

01

Project Background

ACCELERATED – Project Information

ACCELERATED is about understanding and visualising the impact of historic weather and climate change on WPD network performance.

Delivery timeframe: January 2022 – February 2023

Funding mechanism: Network Innovation Allowance

Total budget: £244,511.30

In partnership with:

Electricity Distribution

02

Historic weather impact assessment

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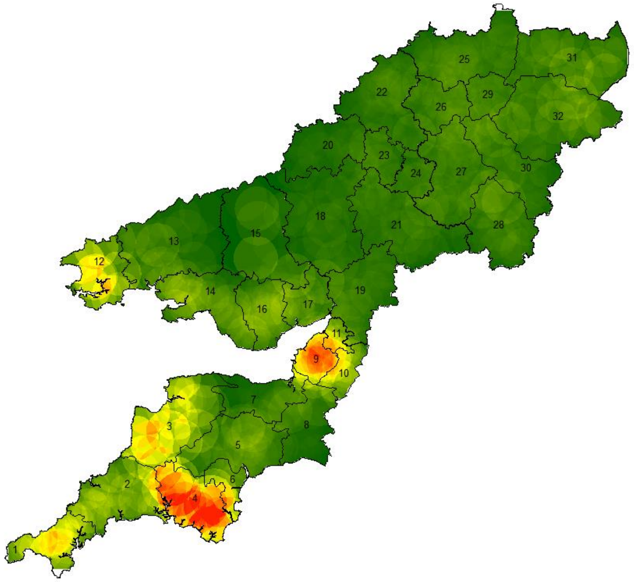
Historic weather records/assets used in the analysis

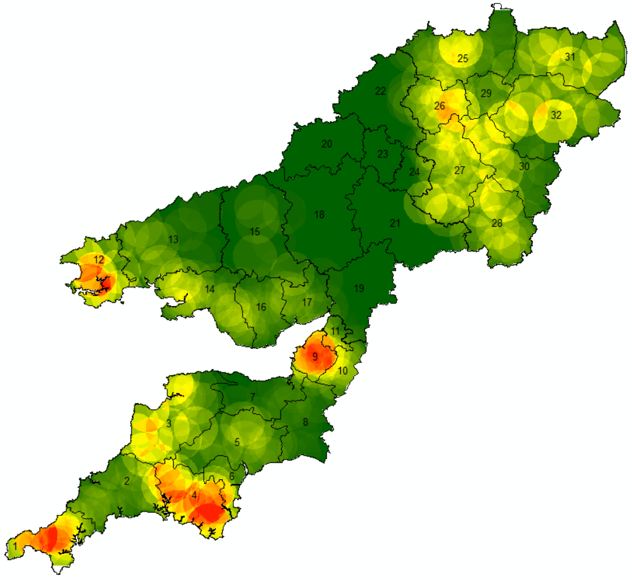
Weather impact	NaFIRS Cause Category	Weather Data
Wind	Tree Related or Wind & Gale	Met Office UKv Forecast Model (daily max 10m wind gusts)
Rain	Rain	HadUK-Grid (daily accumulated rainfall)
Lightning	Lightning	No data available
Flooding	Flooding	HadUK-Grid (daily accumulated rainfall)
High Temperature	Solar Heat	HadUK-Grid (daily max temperature)
Low Temperature	Ice Snow, Sleet & Blizzard Freezing Fog and Frost	HadUK-Grid (daily min temperature)

Equipment
OHL mains and service
Switchgear and Protection
Transformers
Underground mains and service
Other/Misc

Dates covered: mainly 2005 - 2020

Lightning Related Faults – Heat Maps





Highest number of faults recorded is 169

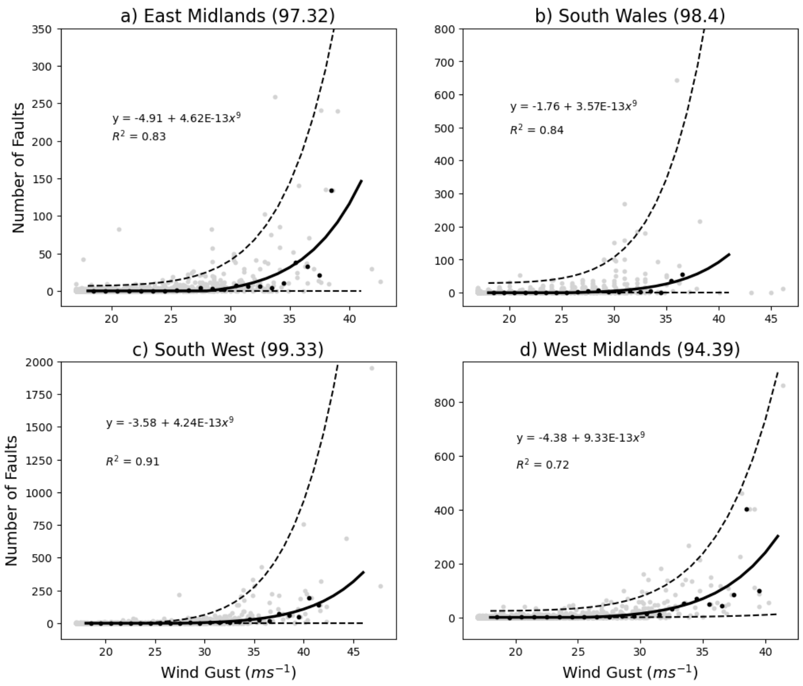
The highest value of CML is 2,235,042 (156,613 average)

Analysis of Historic Wind Faults

Fragility curves (black lines) are fitted using a linear regression to black dots (median faults per wind gust integer)

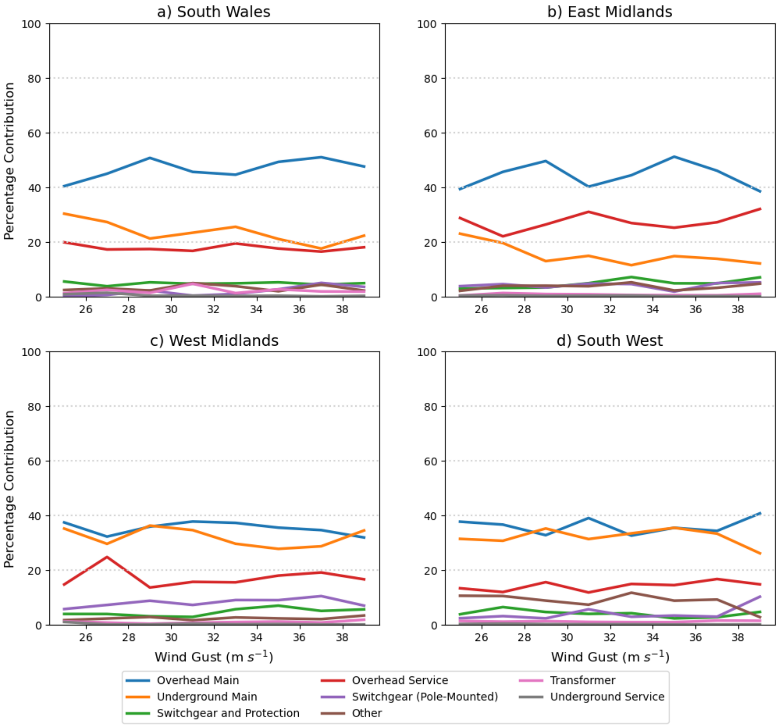
- **Predicts the number of faults expected to be exceeded on 50% of occasions that a certain wind gust occurs**
- **Can be used to make predictions if the maximum gust windspeed of an approaching storm is known**
- **Large spread in the relationship potentially related to other factors**
  - Wet soil
  - Wind direction
  - Time of year
- **Similar relationships can be made for CML**

Number of Faults vs. Maximum Wind Gusts in Windstorm

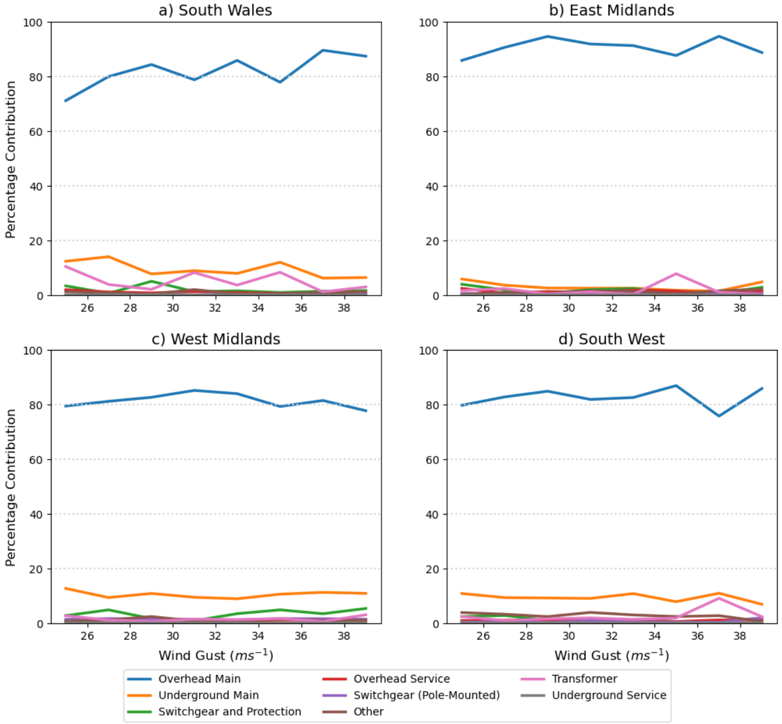


Asset Contributions to Faults/CML during Windstorms

Faults



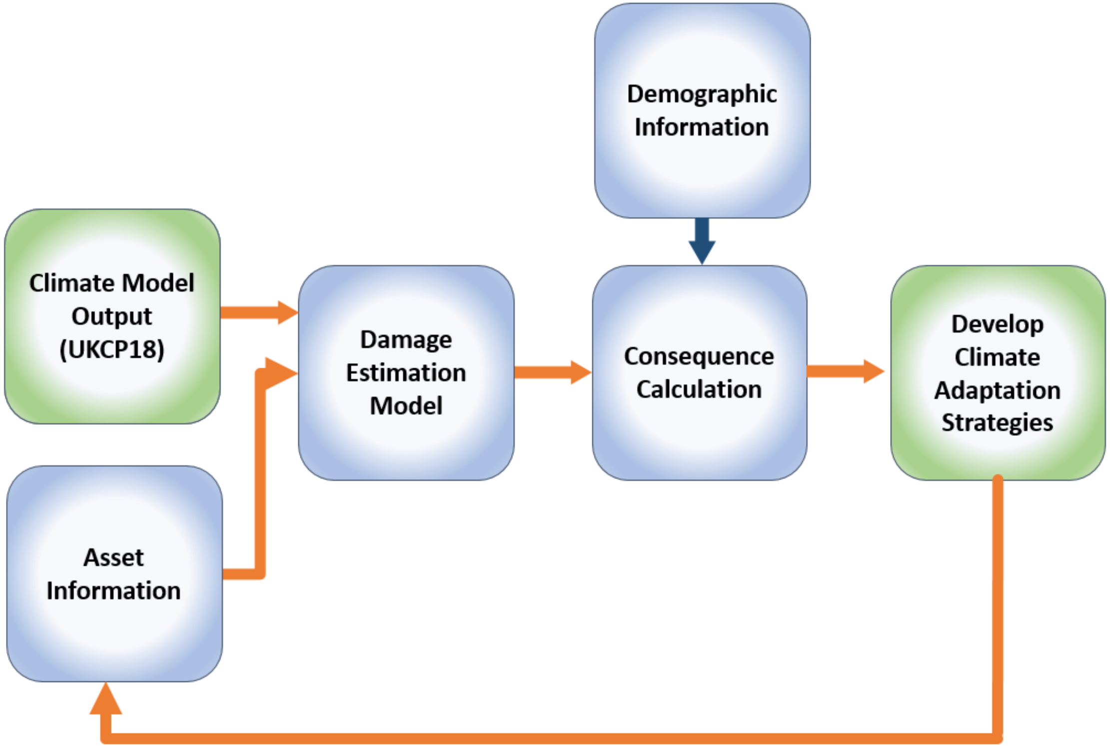
CML



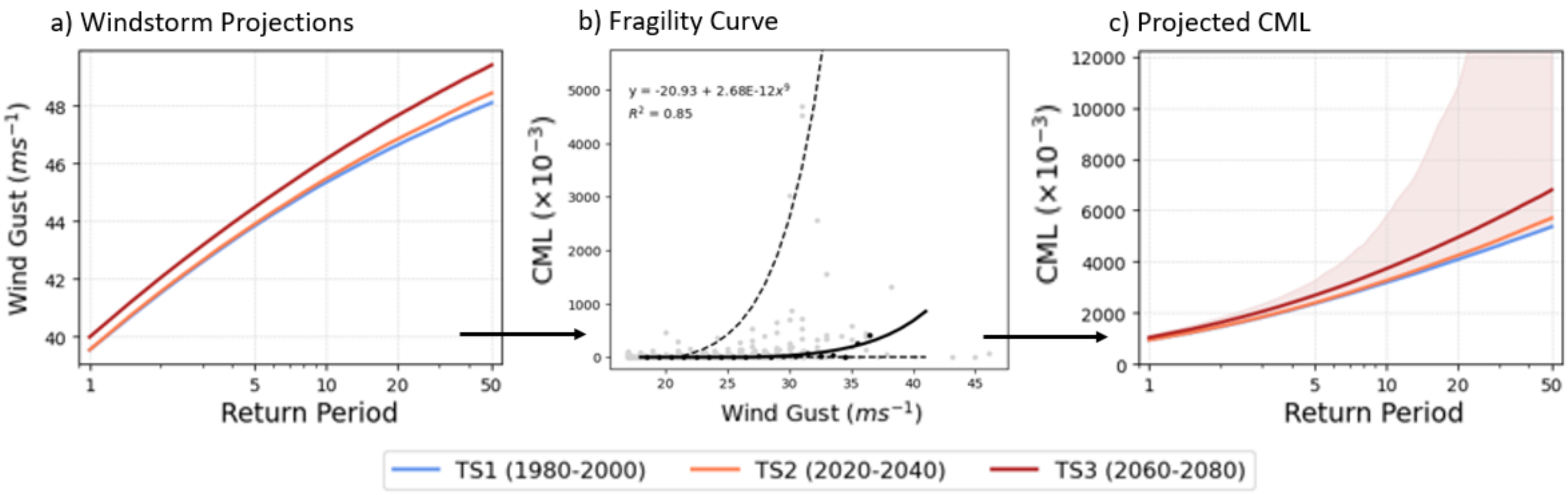
03

Climate change impact analysis and visualisation of future risks

Methodology for Future Projections of Climate, Faults and CMLs

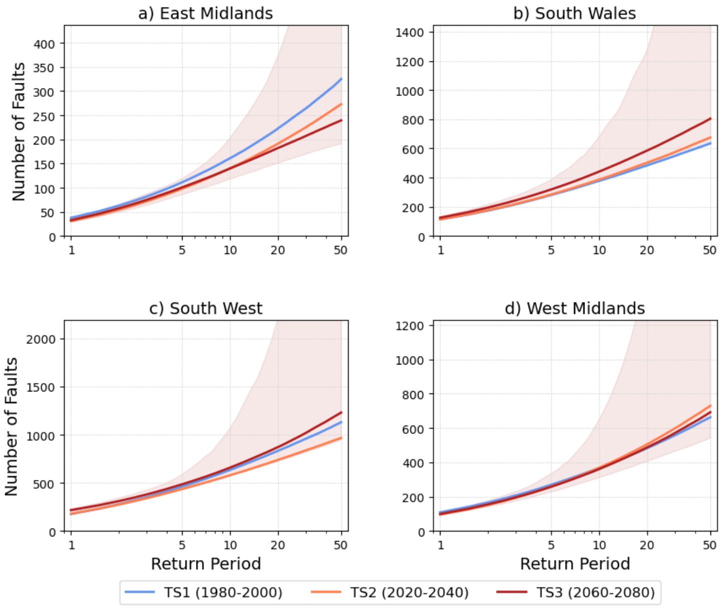


UKCP18, Fragility Curves and Impact Projections

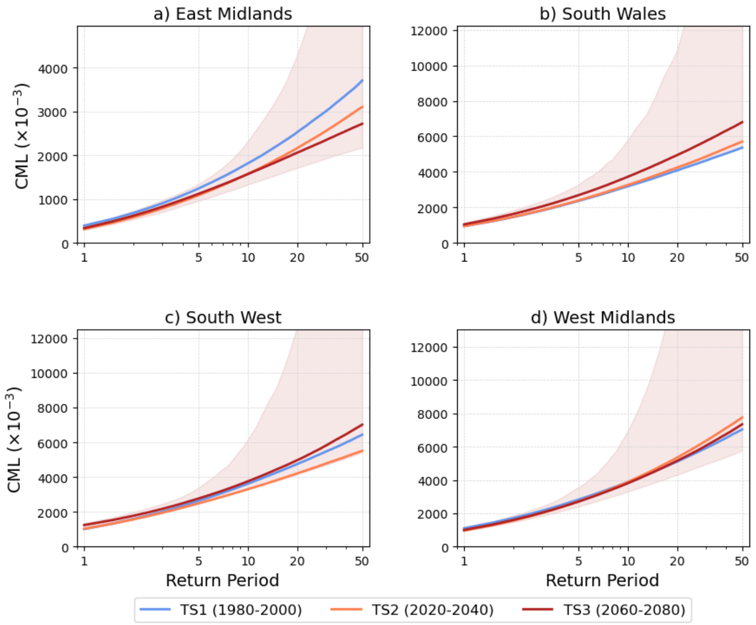


Applying UKCP18 Projections to Fragility Curves: Wind

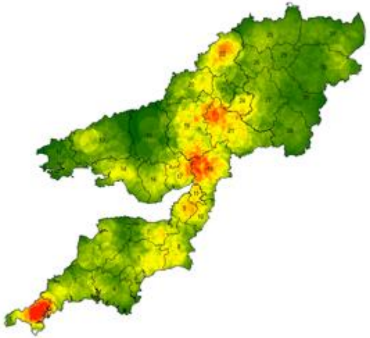
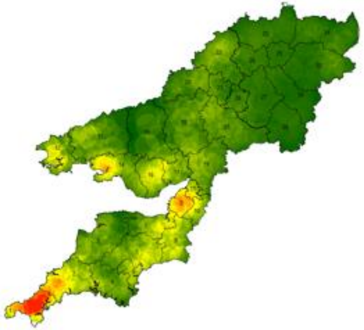
Fault Projections



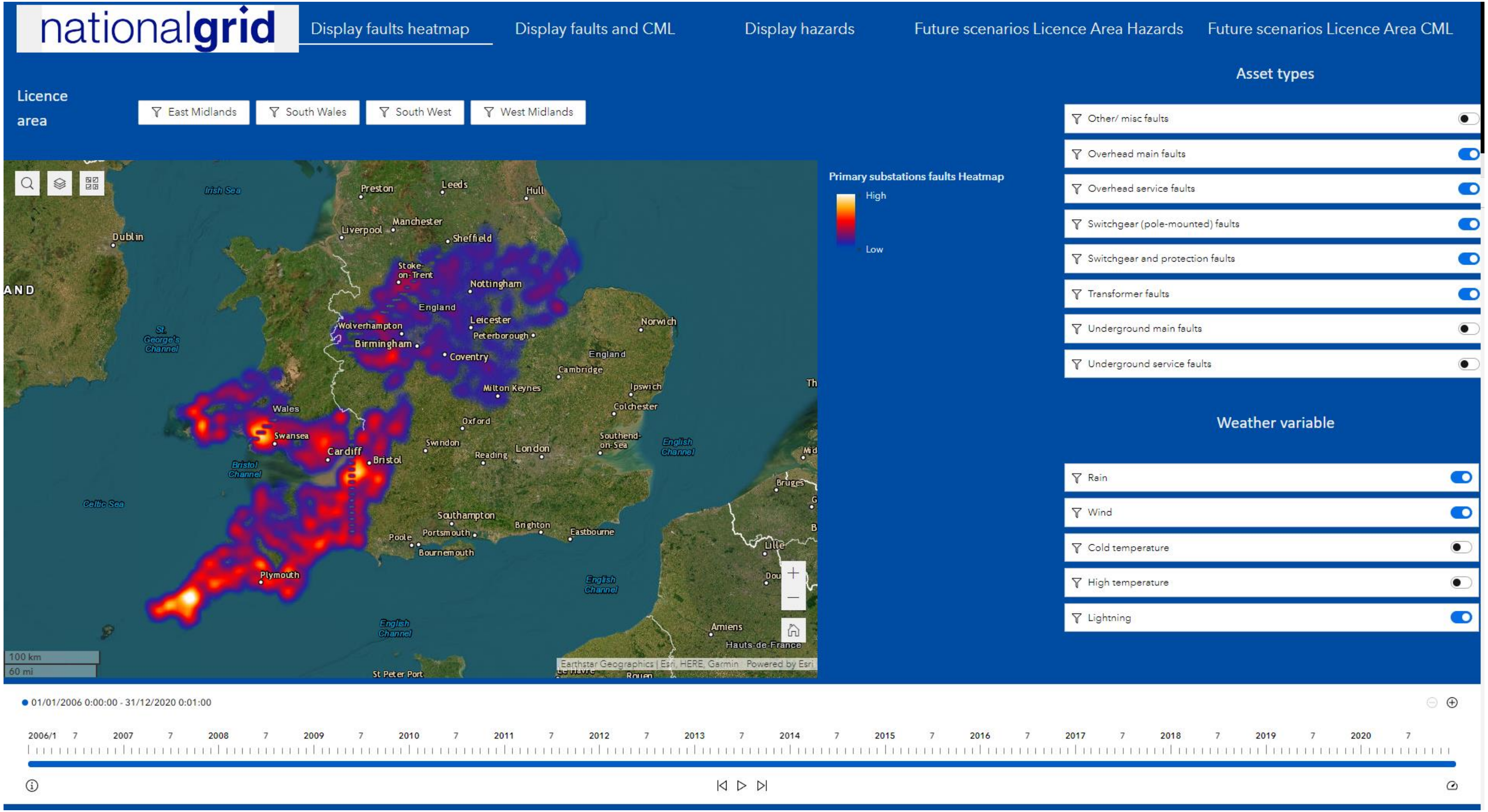
CML Projections



Historic Wind Related Faults

	Tree Related Wind Faults	Wind and Gale Faults (exc. Windborne materials)
Number of faults	244 	283 
CMLs	13,406,839 	9,828,709 

GIS tool for visualising and exploring the data



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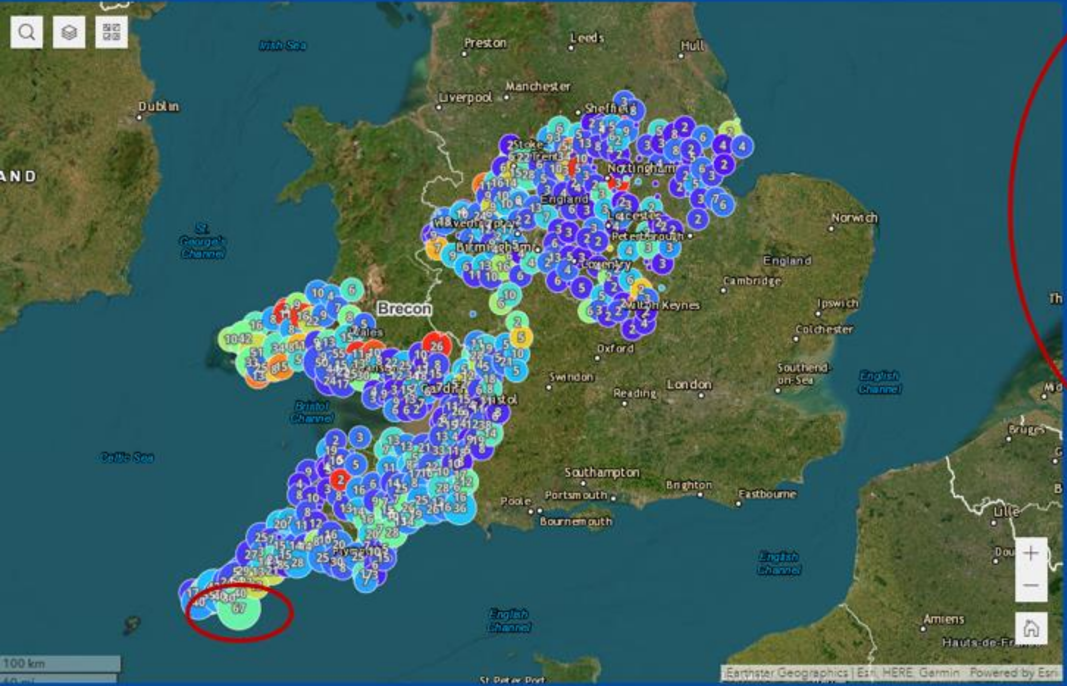
Display faults heatmap | Display faults and CML | Display hazards | Future scenarios Licence Area Hazards | Future scenarios Licence Area CML

Licence area

East Midlands | South Wales | South West | West Midlands



Primary substations faults Total CML

CML

> 81,879

40,941

< 3

Number of faults

> 67

50

35

20

< 2

WPD License Boundary Areas

Asset types

- Other/ misc faults
- Overhead main faults
- Overhead service faults
- Switchgear (pole-mounted)
- Switchgear and protection faults
- Transformer faults
- Underground main faults
- Underground service faults

Weather variable

- Rain
- Wind
- Cold temperature
- High temperature
- Lightning

Date (February - March)

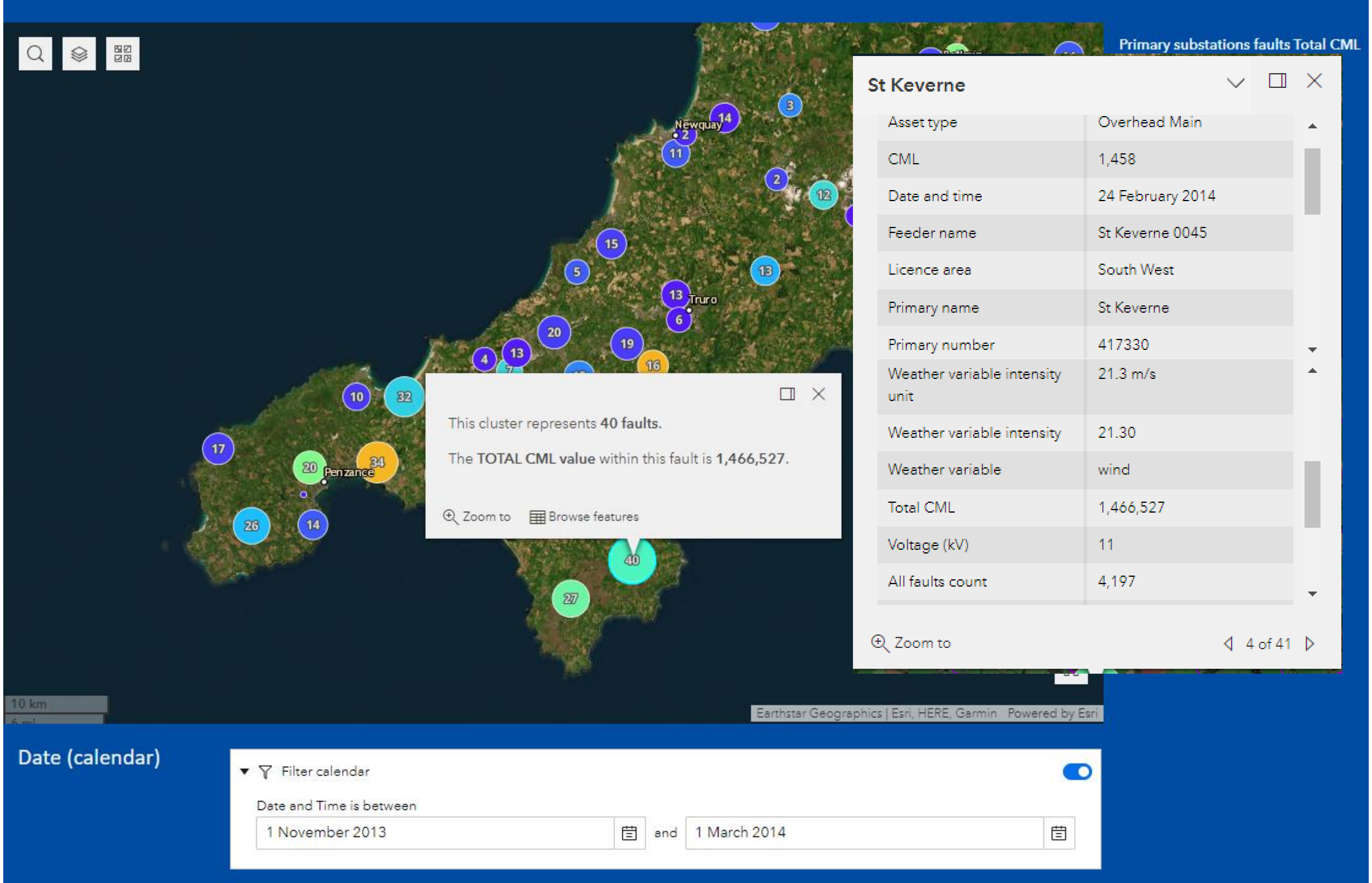
2005/ 2006 | 2006/ 2007 | 2007/ 2008
2008/ 2009 | 2009/ 2010 | 2010/ 2011
2011/ 2012 | 2012/ 2013 | 2013/ 2014
2014/ 2015 | 2015/ 2016 | 2016/ 2017

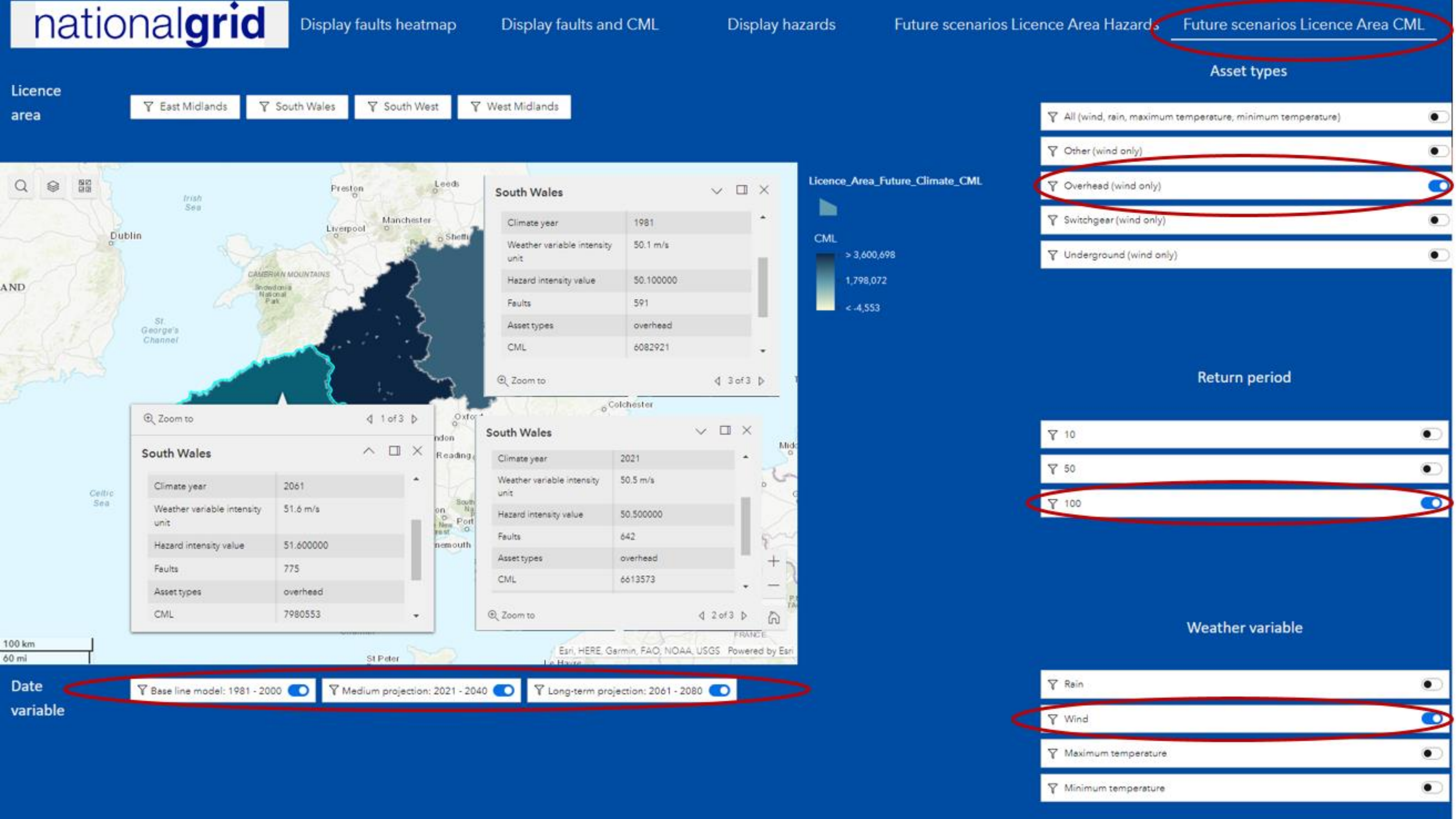
Date (calendar)

Filter calendar

Date and Time is between

1 November 2013 and 1 March 2014


Primary substations faults Total CML
St Keverne
Asset type | Overhead Main
CML | 1,458
Date and time | 24 February 2014
Feeder name | St Keverne 0045
Licence area | South West
Primary name | St Keverne
Primary number | 417330
Weather variable intensity unit | 21.3 m/s
Weather variable intensity | 21.30
Weather variable | wind
Total CML | 1,466,527
Voltage (kV) | 11
All faults count | 4,197
Zoom to
4 of 41
This cluster represents 40 faults.
The TOTAL CML value within this fault is 1,466,527.
Zoom to
Browse features
Newquay
Truro
Penzance
10 km
Earthstar Geographics | Esri, HERE, Garmin Powered by Esri
Date (calendar)
Filter calendar
Date and Time is between
1 November 2013
and
1 March 2014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Display faults heatmap
Display faults and CML
Display hazards
Future scenarios Licence Area Hazards
Future scenarios Licence Area CML
Licence area
East Midlands
South Wales
South West
West Midlands
South Wales
Climate year 1981
Weather variable intensity unit 50.1 m/s
Hazard intensity value 50.100000
Faults 591
Asset types overhead
CML 6082921
Zoom to
3 of 3
South Wales
Climate year 2061
Weather variable intensity unit 51.6 m/s
Hazard intensity value 51.600000
Faults 775
Asset types overhead
CML 7980553
Zoom to
1 of 3
South Wales
Climate year 2021
Weather variable intensity unit 50.5 m/s
Hazard intensity value 50.500000
Faults 642
Asset types overhead
CML 6613573
Zoom to
2 of 3
Licence_Area_Future_Climate_CML
CML
> 3,600,698
1,798,072
< -4,553
Esri, HERE, Garmin, FAO, NOAA, USGS Powered by Esri
100 km
60 mi
Date variable
Base line model: 1981 - 2000
Medium projection: 2021 - 2040
Long-term projection: 2061 - 2080
Asset types
All (wind, rain, maximum temperature, minimum temperature)
Other (wind only)
Overhead (wind only)
Switchgear (wind only)
Underground (wind only)
Return period
10
50
100
Weather variable
Rain
Wind
Maximum temperature
Minimum temperature

Historic weather and future climate analysis - conclusion

Historic Faults are mainly wind related, followed by lightning

12 Largest single events for CML include 5 windstorms, 2 rain/flood events, 3 cold snaps, and 2 heat waves

UKCP18 projects that intense windstorms are projected to increase in the future

Median CML are set to increase by 35% (2070) in South Wales (for example); however, there is large uncertainty associated

UKCP18 projects a large increase in maximum temperatures during warm spells

Median CML for a 10-year event are set to increase by 50% (2030s) and 150% (2070s) compared to climate in 1990s

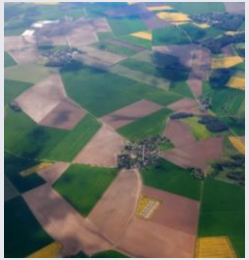
04

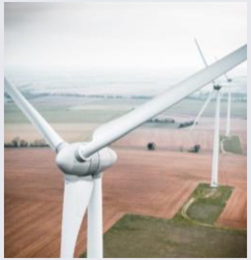
Climate change impact on embedded generation and demand

Approach overview

- Earlier WPs looked at historical trends and future climate projections (impact: faults on the network)
- This WP considered the impact of changes on demand and embedded generation output
  (impact: diurnal profiles)
  - Temperature
  - Wind
  - Solar
- Coordinated with NGED forecasting team to complement existing processes

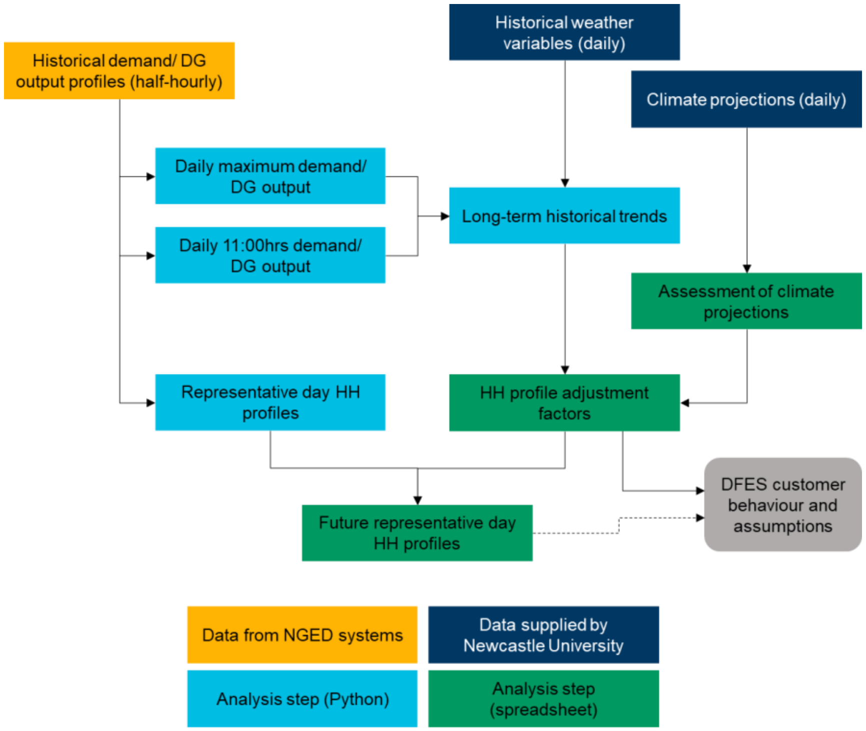
Temperature	Solar radiation	Wind speed
↑	↑	→
Demand	**Solar DG output**	**Wind DG output**
↓	↑	→





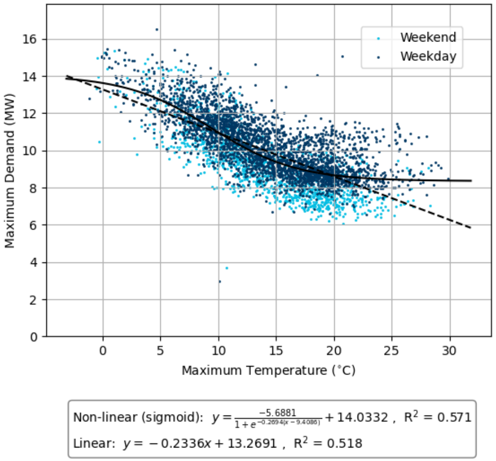
Process

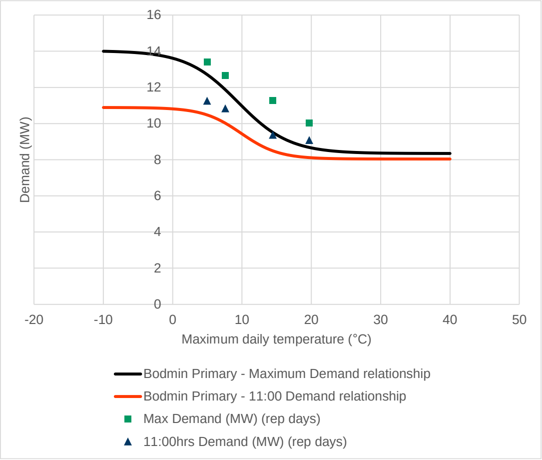
- Python analysis of historical datalogger measurements (demand and generation)
  - Relationships between historical primary substation demand / distributed generation (DG) output and weather observations
  - Half-hourly (HH) profiles derived for representative days
- Excel analysis of adjustments to representative day profiles accounting for climate projections

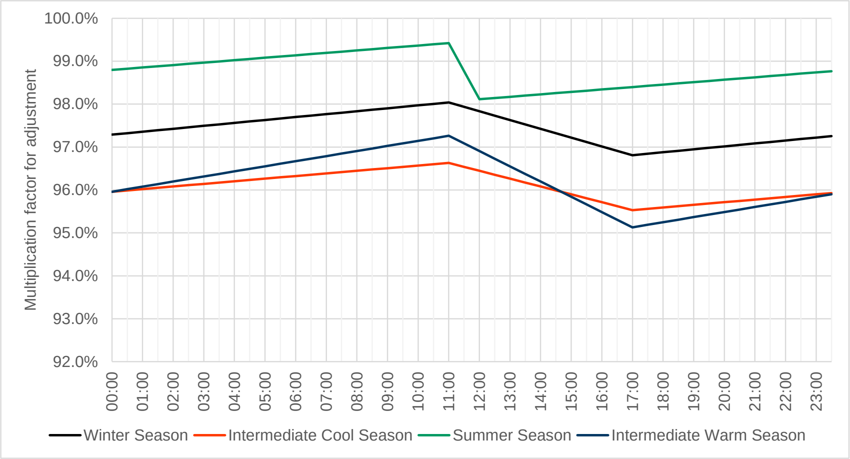


Analysis steps

- Long-term historical relationships (Python analysis)
  - Daily max and 11:00hrs demand/DG
  - Daily max temperature, wind speed and solar radiation
- Adjusted profiles (Excel analysis)
  - HH adjustment factors based on S-curve (sigmoid) relationships
  - Applied adjustments to historical unadjusted profiles / average profiles



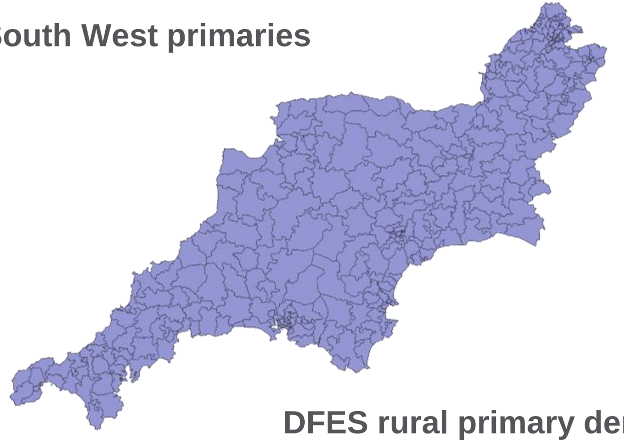




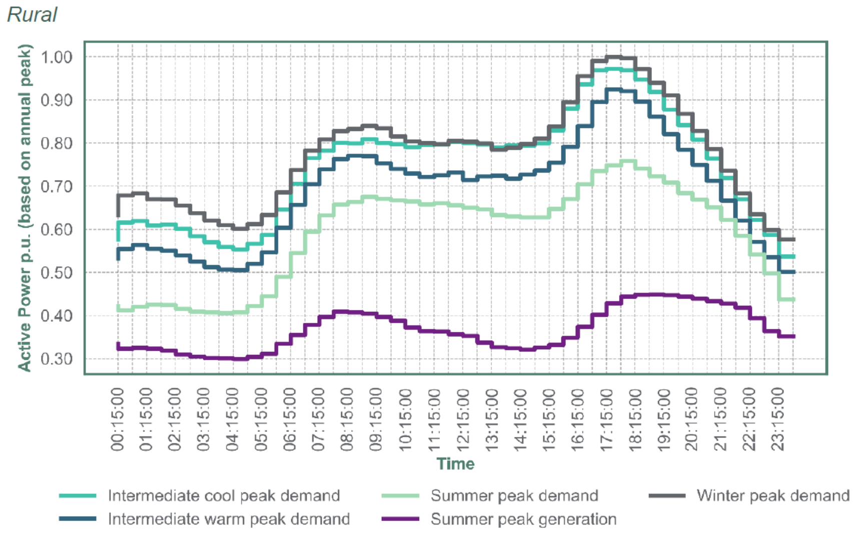
Alignment with DFES

- Primary substations categorised as rural, urban or morning peak
- Definition of seasons consistent with DFES (EREC P27/2):
  - **Winter:** Jan, Feb and Dec
  - **Intermediate Cool:** Mar, Apr and Nov
  - **Intermediate Warm:** May, Sep and Oct
  - **Summer:** Jun, Jul and Aug
- Peak demand in each (minimum coincident generation)
- Summer peak generation (minimum coincident demand)

South West primaries



DFES rural primary demand profiles

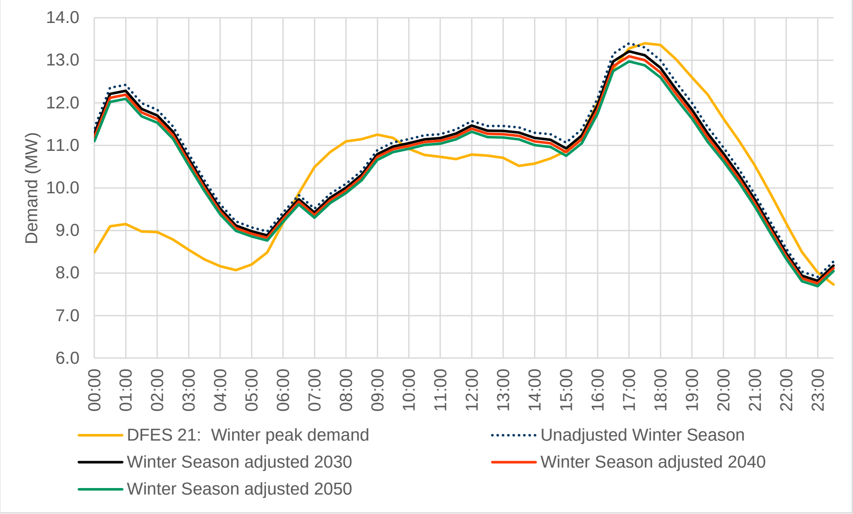


Conclusions

- Approach complements DFES (adjustments applied to underlying historical or average profiles)
- Historical location-specific profiles can differ from DFES average
- Some long-term relationships have weak correlations, but S-curves limit adjustments to within reasonable bounds

Temperature increase: 1.5 - 2.6° C

Max demand reduction: 0%-9.6% (winter: 0.6-3.2%)



05

Climate Change impact assessment procedure

Procedure overview

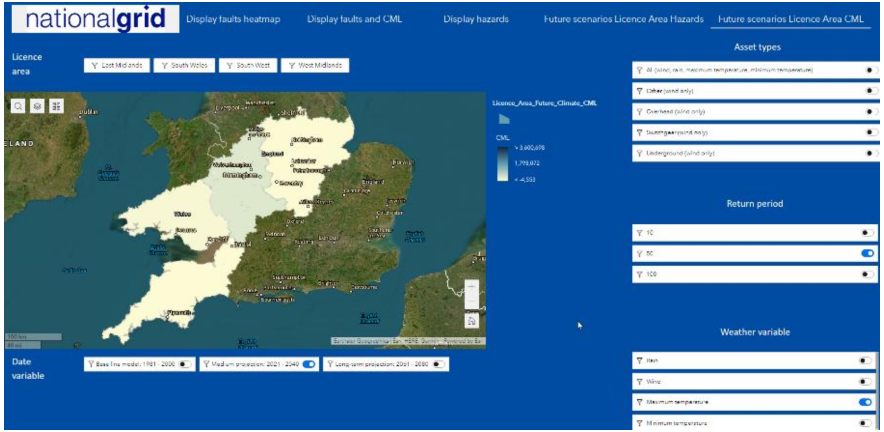
Procedure document prepared to:

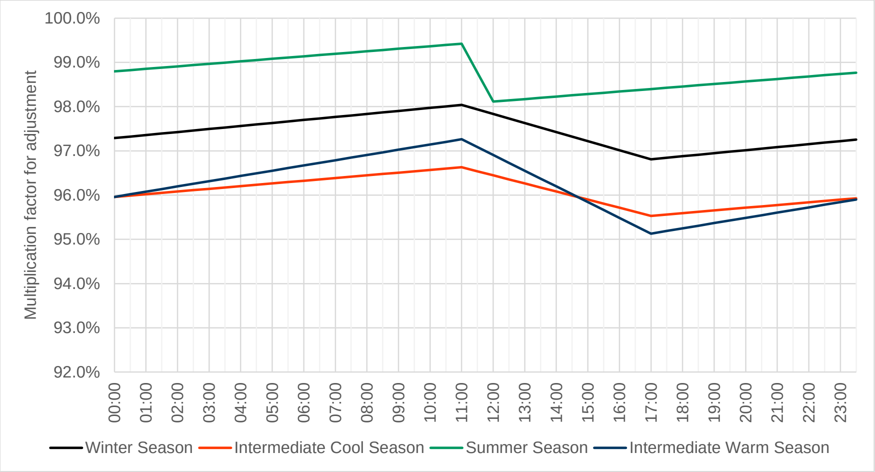
- Complement existing processes
- Implement adoption of improved analysis into Business as Usual (BaU)
- Better understand the nature of climate change risks
- Enable the evaluation of prospective adaptation measures

Internal reference document

Introduction to approaches:

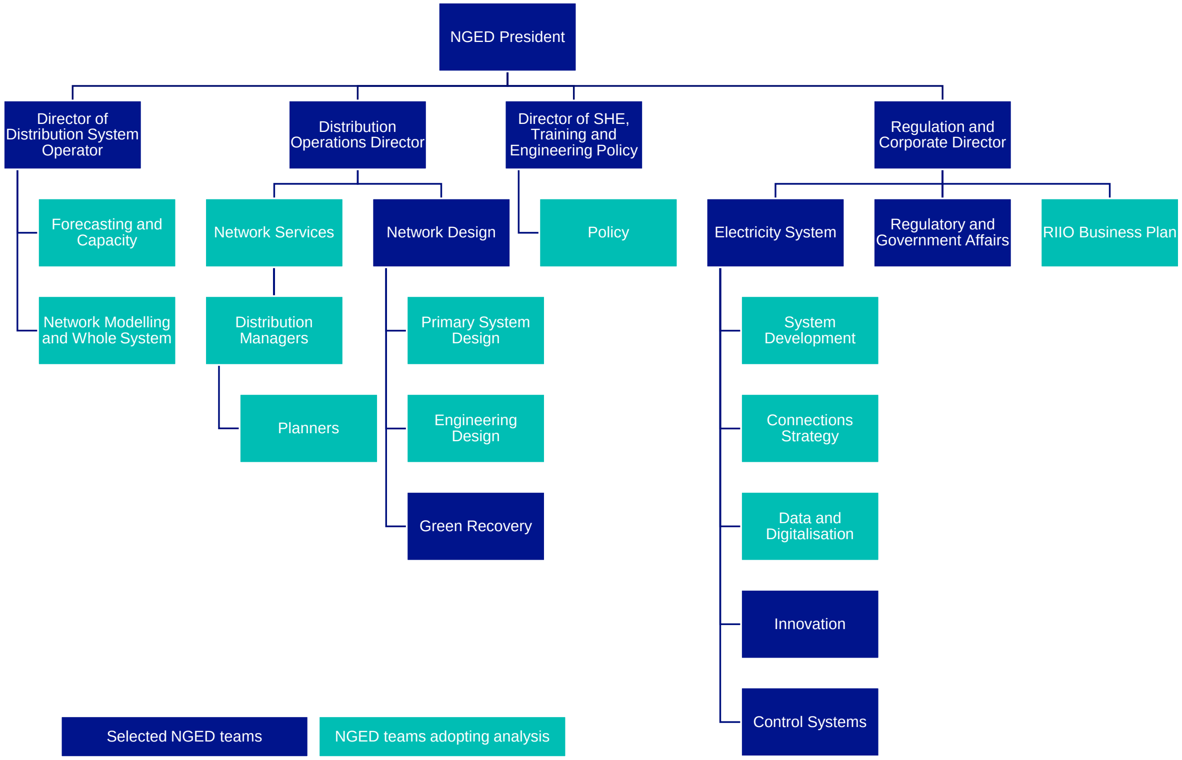
- GIS tool for visualisation of historical and projected impacts of weather-related faults
- Spreadsheet analysis prepared by GHD for adjustment of demand and DG output profiles





Teams affected

- Analysis relevant to different teams, e.g.:
  - Policy: New equipment requirements for extreme/ambient conditions
  - Design: Choice of equipment to provide additional resilience
  - Planners: Changes to demand and generation profiles



Potential applications

- Four potential applications of analysis identified

ID	Application name	Application description
1)	ED3 Business Plan	Evaluate the need for additional climate resilience expenditure
2)	Feedback to Policy team	Suitability of equipment specifications / selection of specifications under different conditions
3)	DFES preparation	Generation and demand profile adjustment
4)	ENA work	Update the industry on ACCELERATED approach and work collaboratively on risk assessment and resilience measures

06

Q&A

Thank you!

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