Embedding resilience into energy systems: A new or an old challenge?

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EPSRC Supergen Energy Networks Hub - Risk & Resilience Subgroup on Climate Risk Methods

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In a Nutshell

Main problem

- Energy systems face increasing disruptions from extreme events.
- Resilience is reactive, not proactive —not fully embedded in policy.
- Delays in action = higher failure risks & costs.

Impact

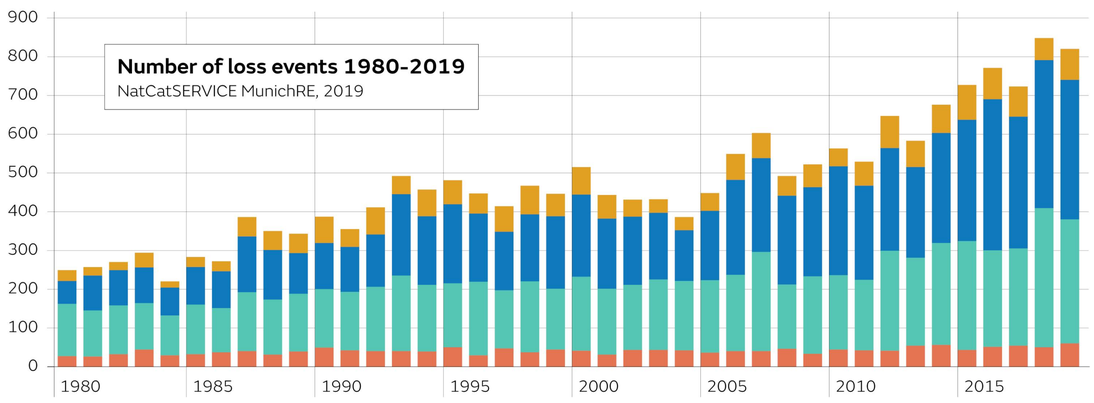
- Resilience weakens over time
- Policy decisions currently driven by impacts of past events.
- Ineffective interventions for strengthening grid resilience

Planned Approaches

- Look back to look ahead: Analyse historical failures and climate projections
- Turn insights into action: Align findings with regulations to drive real-world change.

■ Extreme Weather Events (EWE) in the UK

Met Office Are extremes becoming more frequent?



Credit: Met Office [1]

"Most climate projections indicate that winter storms will increase in number and intensity in the UK as a result of climate change." Independent.co.uk

📈 **Rising Frequency**: More storms, floods, and heatwaves

🌪️ **Greater Intensity**: Stronger winds, heavier rain, and prolonged heatwaves stress infrastructure.

⚡ **Power Grid Risks**: Storms and floods damage power lines, heatwaves strain generation, leading to blackouts.

⏳ **Longer Outages**: Harsh conditions slow repairs: blocked roads, unsafe weather for response teams, and extended recovery times.

■ Current Resilience Standards & Challenges

✅ **Resilience Standards [2]:**

- **Customer outcome**: Measures service reliability (e.g., outage duration).
- **System performance**: Ensures operation after major failures.
- **System recovery**: Defines restoration times & backup supply.

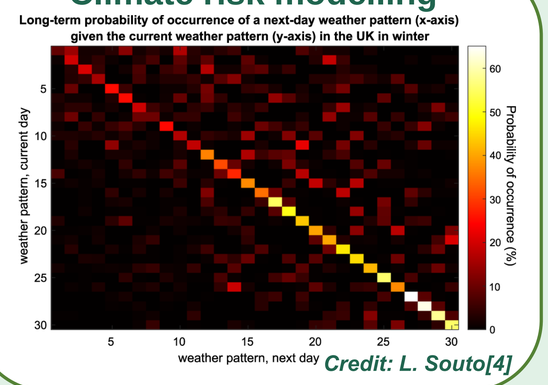
⚠️ **Climate Resilience Gaps (Ofgem RIIO-3 Proposal [3])**

- Regulations use historical data, ignoring future climate risks.
- No mandatory adaptation for rising temperatures, storms, or floods.
- Cascading failures (energy → telecoms, water, transport) not addressed.
- Resilience metrics fail to track climate adaptation progress.

■ Research Goal & Key Objectives

🎯 **Goal**: Develop a framework to evaluate and enhance electricity network resilience under projected climate scenarios.

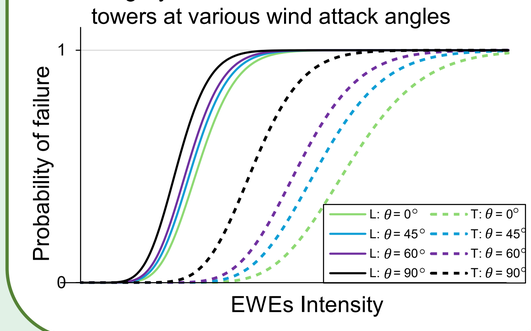
Climate risk modelling



Credit: L. Souto[4]

Grid vulnerability analysis

Fragility curves for transmission lines and towers at various wind attack angles



Key Objectives

- Quantify how resilience evolves over time under changing climate conditions.
- Develop adaptation strategies to enhance grid resilience & reduce failures.
- Integrate climate projections into resilience planning for long-term effectiveness.

■ Expected Outcomes & Industry Application

Climate-Informed Risk Analysis
- Uses data-driven modelling to assess climate risks.
- Supports predictive resilience planning for extreme weather.

Regulatory Insights & RIIO-3 Integration
- Informs Ofgem's resilience metric development.
- Helps align grid investment decisions with future climate challenges.

Operational Guidance
- Provides strategic planning tools for grid operators.
- Reduces emergency response costs through improved resilience strategies.

■ References

[1] Met *Office, How is climate linked to extreme weather?* (Online - https://www.metoffice.gov.uk/weather/climate/climate-and-extreme-weather)

[2] National Infrastructure Commission (NIC), *Resilience Standards Report*, 2019

[3] Ofgem, *RIIO-3 Sector Specific Methodology Consultation - Overview 1 Document*, 2023

[4] L. Souto, et al. Identification of weather patterns and transitions likely to cause power outages in the United Kingdom, 2024