Scenarios for Extreme Events

Alpha Phase – End of Phase Show and Tell

April 22, 2024

ESO

Who are we?

Jenna Macgregor

Resilience Engineer

ESO

Luke Edelston

Senior Consultant

FRAZER-NASH CONSULTANCY
A KBR COMPANY

ESO is transforming...

- From Summer 2024, the Electricity System Operator will transform into the **National Energy System Operator**
- New responsibilities including whole energy network planning, resilience and security of supply reporting and a government advisory position.
- Will **inform policy and investment decision** by reporting on risks to industry and security of supply
- An **annual Energy Resilience Assessment Report** , issued to government, will assess the resilience of the energy sector

How could a model support resilience assessments?

Activity

*We **identify** risks that could damage or disrupt the GB Whole Energy System*

*We **assess the socio-economic impact & likelihood***

We **provide recommendations**

How could a model support resilience assessments?

Activity

*We **identify** risks that could damage or disrupt the GB Whole Energy System*

*We **assess the socio-economic impact & likelihood***

We **provide recommendations**

Problem

Qualitative

Subjective expert opinion

Time intensive

Limited view of sector interactions

Vision

*Develop a **model framework** that describes vulnerabilities to the GB energy network, using weather and non-weather **stress event scenarios** and key system interfaces (including but not limited to telecoms and water), to inform **risk assessment** and **resilience planning.***

Why do we need to innovate?

- A high-level view of the whole energy system
- Ability for networks to interact and impacts to cascade
- Resilience metrics must relate impact to consumers
- Able to use weather and non-weather scenarios as inputs scenarios

Risk assessment framework

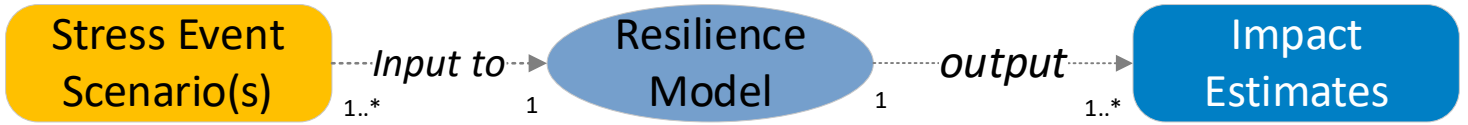
Past data is analysed to form **stress event scenarios**, which occur with a given **likelihood**, such as:

- ➢ High wind events
- ➢ Gas supply restrictions

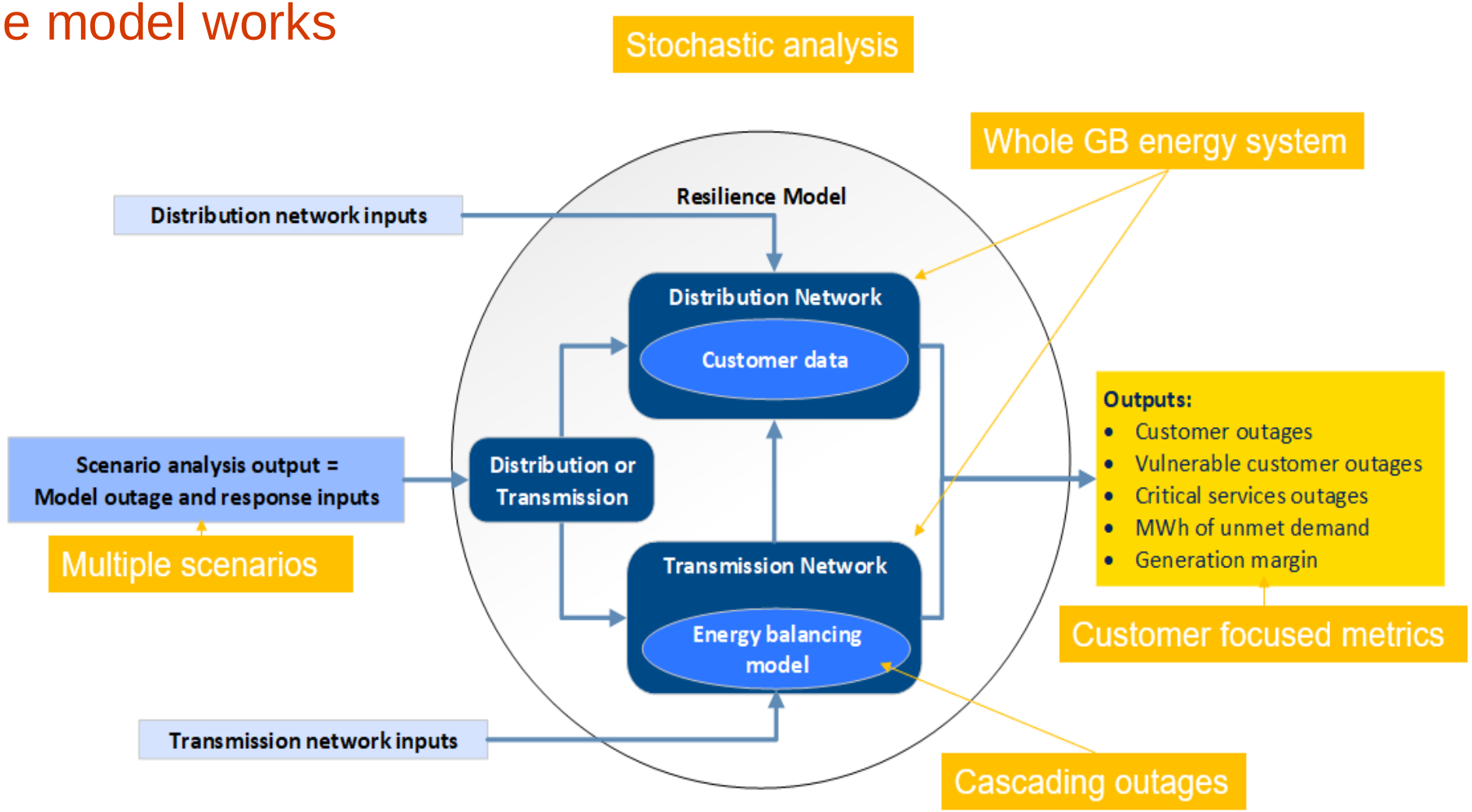
Scenarios are fed into a **model** of the GB energy system

The model estimates the **impact** to consumers that can be compared to **resilience metrics**, such as:

- Number and duration of consumers disconnected.



How the model works



Indicative model results

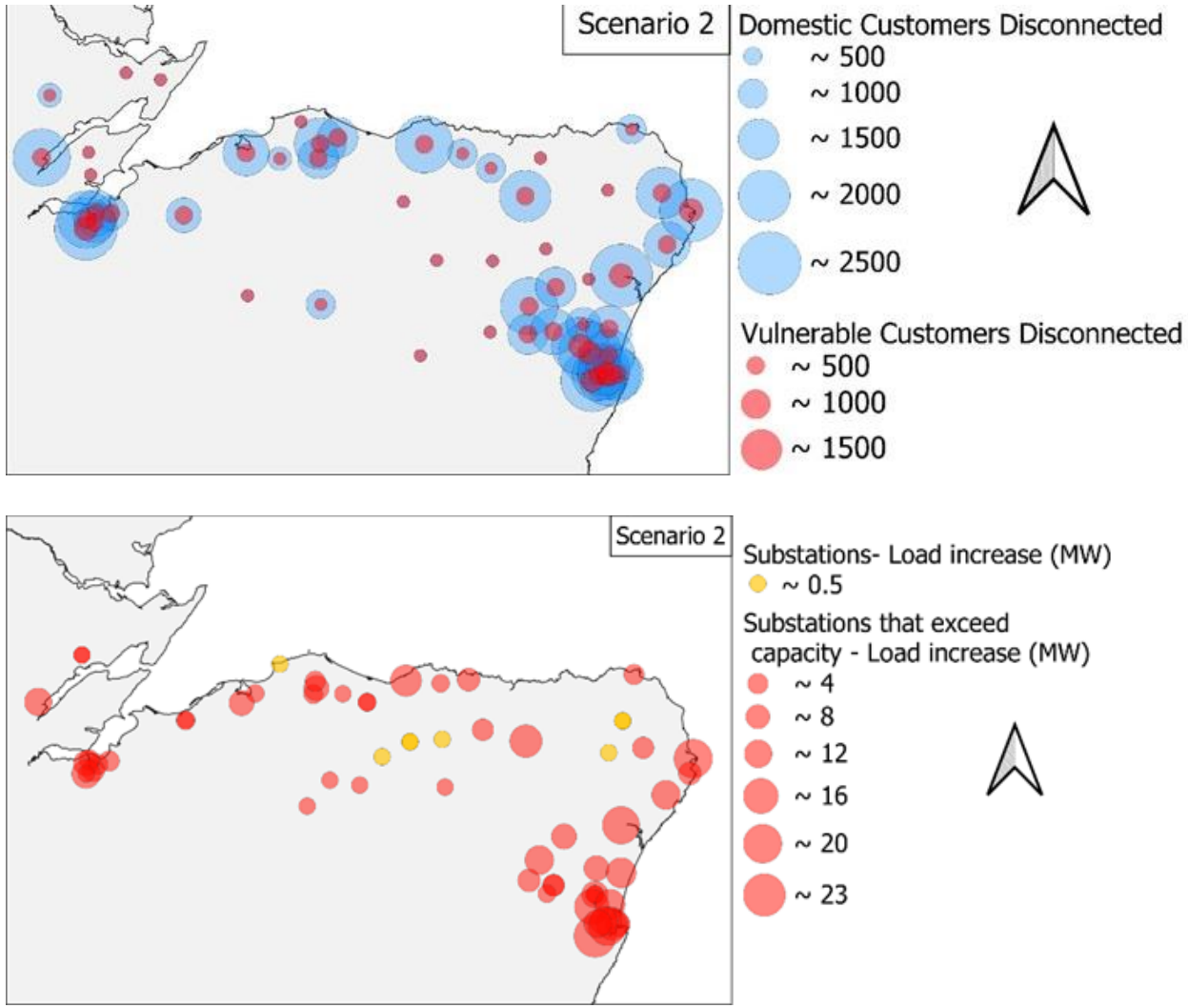
Loss of gas supply to consumers

↓

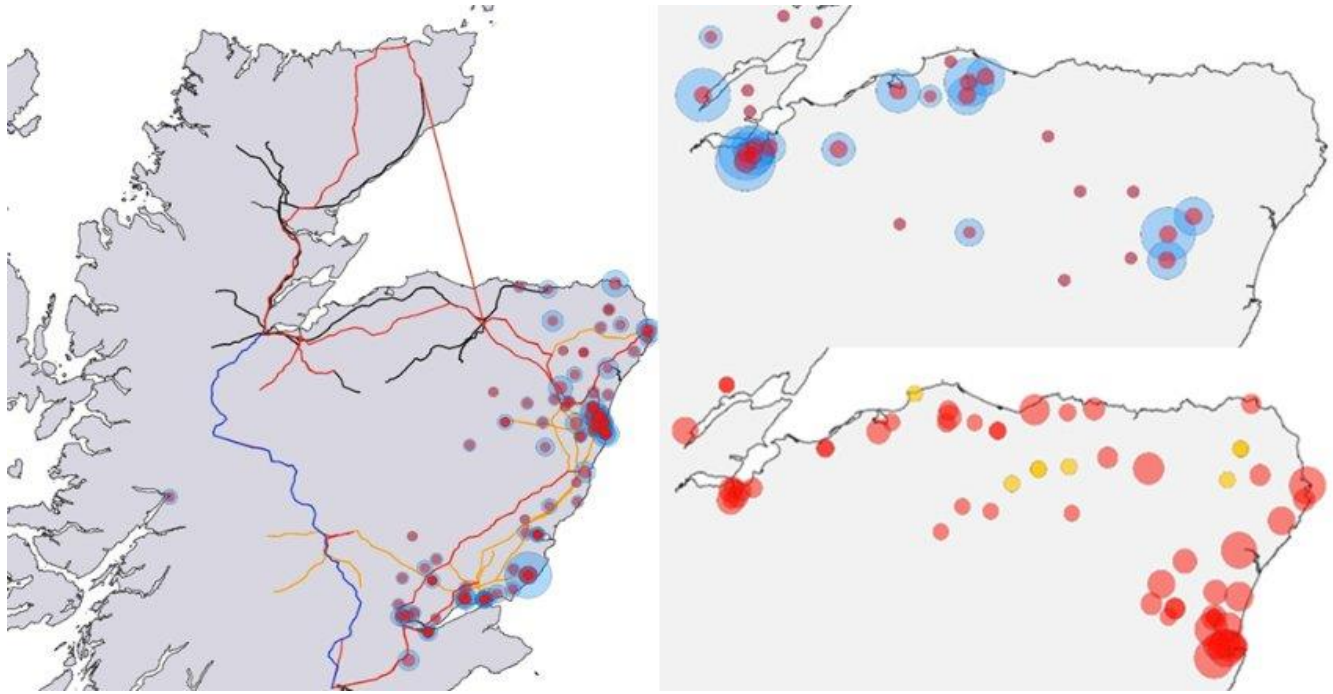
Consumers switched to electricity based heat/cooking where possible

↓

Increased load of electricity system caused substation failures



Model learnings and next steps



- Prototype model is capable of modelling interactions between gas and electricity networks
- Impacts can be estimated in terms of customer focussed resilience metrics
- Can be scaled to GB
- Further work to refine scenario definitions, fragility and restoration curves and different network configurations

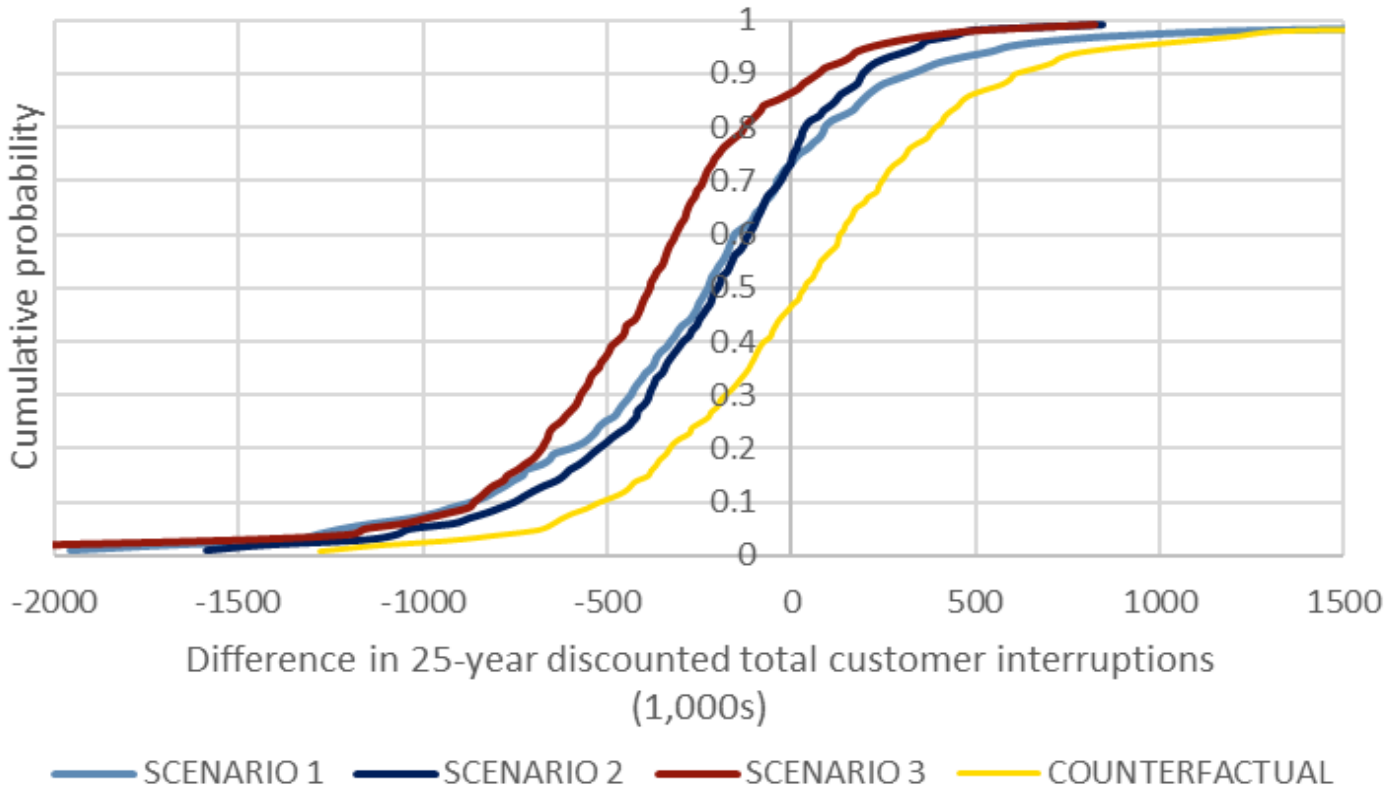
How do we quantify the impacts?

- The model estimates the impact to consumers that can be compared to resilience metrics
  - Able to identify different types of consumer
  - Enables open and transparent conversations with industry
  - Risks can be compared numerically

Electricity Resilience Metrics
Number and length of **consumer** disconnections
Total Energy Not Supplied (MWh pa)
Number and length of **vulnerable consumer** disconnections
Value of lost load

Gas Resilience Metrics
Number and length of **consumers** off gas supply
Number and length of **vulnerable consumer** off gas supply

Alpha shows significant benefits can be realised through GB energy system modelling and focussed investments



Estimate value of unmet demand

	25-year discounted cost of unmet demand (£m)			
CF	£1,980			
	Reduction in 25-year discounted cost of unmet demand (£m)			
Scenario	mean	P10	P50	P90
1	-£203	-£693	-£190	£287
2	-£230	-£664	-£181	£208
3	-£401	-£836	-£350	£27

Savings order of ~£100m+ over 25 years

Counterfactual: No change in statistical parameters (5.5 events, α = 1.7)
Scenario 1: 10% Fewer events (5 per year), same severity distribution
Scenario 2: Same # events, lower severity probability (α = 1.9)
Scenario 3: Fewer events and lower severity (5 events & α = 1.9)

Alpha achievements

A basis for how quantitative information will support the Energy Resilience Assessment Report

- A defined methodology for defining extreme event scenarios
- Prototyped fast running, whole energy system model
- Consumer-focused output metrics based on numerical evidence
- Innovative simulation scaling – ability to adjust scenario parameters and monitor how impact changes.
- Ability to compare consumer impacts from different risks

What's next?

With the beta application submission due in May 2024, the vision is to:

- Geographically scale the model from the Scottish region to the GB wide system.
- Develop the proof-of-concept scenarios
- Investigate use of AI reinforcement
- Deepen the precision of network modelling
- Expand feedback loops

A special thanks to all those directly involved!

FRAZER-NASH CONSULTANCY
A KBR COMPANY

ESO

University of Strathclyde Glasgow

Met Office

Scottish & Southern Electricity Networks | Powering our community

national gas

Cadent
Your Gas Network

Any questions?