WESTERN POWER DISTRIBUTION

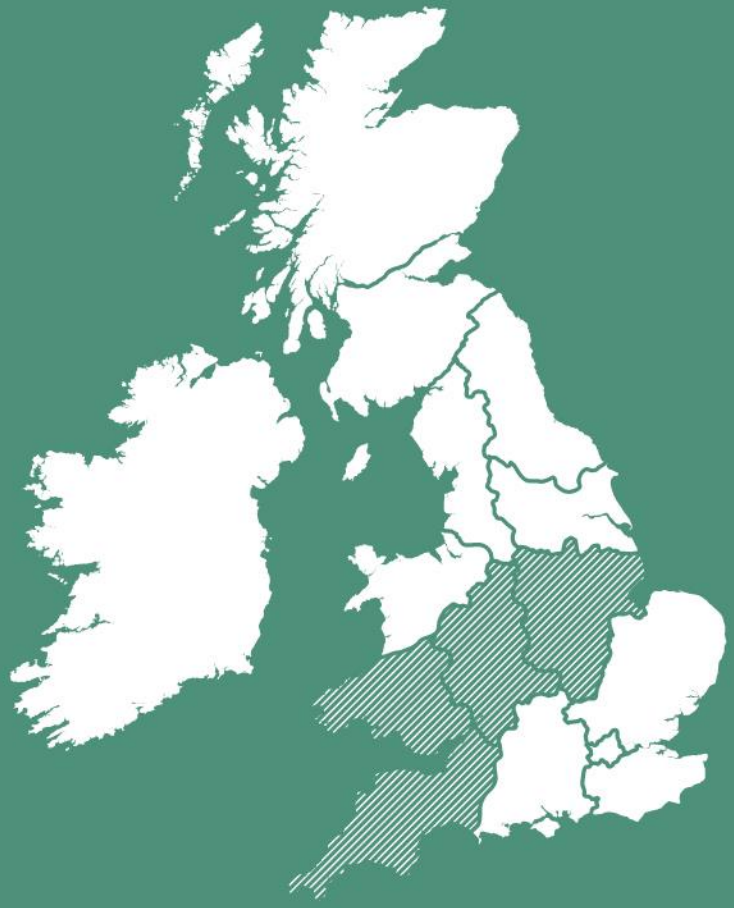
INNOVATION

NEXT GENERATION NETWORKS

Fault Level - FlexDGrid

Balancing Act Conference

Thursday 8th September 2016



Jonathan Berry

Innovation and Low Carbon Networks Engineer

Western Power Distribution

WESTERN POWER DISTRIBUTION INNOVATION

WESTERN POWER DISTRIBUTION PROTEUS NEW

WESTERN POWER DISTRIBUTION FLEXDGRID

WESTERN POWER DISTRIBUTION PLUGS AND SOCKETS

WESTERN POWER DISTRIBUTION SOLA BRISTOL

WESTERN POWER DISTRIBUTION LOW CARBON HUB

WESTERN POWER DISTRIBUTION OPEN LV NEW

WESTERN POWER DISTRIBUTION NETWORK EQUILIBRIUM

WESTERN POWER DISTRIBUTION SMART ENERGY ISLES

WESTERN POWER DISTRIBUTION NETWORK TEMPLATES

WESTERN POWER DISTRIBUTION FALCON

Future Networks Programme

Assets

- Telemetry
- Decision support
- Improved assets
- New assets
- Flexibility
- Automation
- Incident response

Customers

- New connections
- Upgrades
- Information
- Self Serve
- Products/Service
- Tariffs
- Communities

Operations

- Reliability
- Forecasting
- DSO
- DSR
- GBSO Interface
- Efficiency
- SHE and Security

Network and Customer Data

- Airborne Inspections
- AIRSTART[1]
- Telecoms Templates
- Superconducting Cable
- SF6 Alternatives
- MVDC Test Lab
- Smart Energy Laboratory
- Statistical Ratings
- Primary Network Power Quality Analysis

- Hybrid Heat Pump Demonstration
- Hydrogen Heat & Fleet
- Carbon Tracing
- HV Voltage Control
- Solar Storage
- LV Connect and Manage
- Sunshine Tariff
- CarConnect
- Industrial & Commercial Storage

- DSO/SO Shared Services
- Project Sync
- Project Entire: Flexible Power
- Integrated Network Model
- Smart Meter Exploitation
- Distribution Operability Framework
- Data Analytics
- Voltage Level Assessment
- LV Connectivity
- Smart Systems and Heat[2]

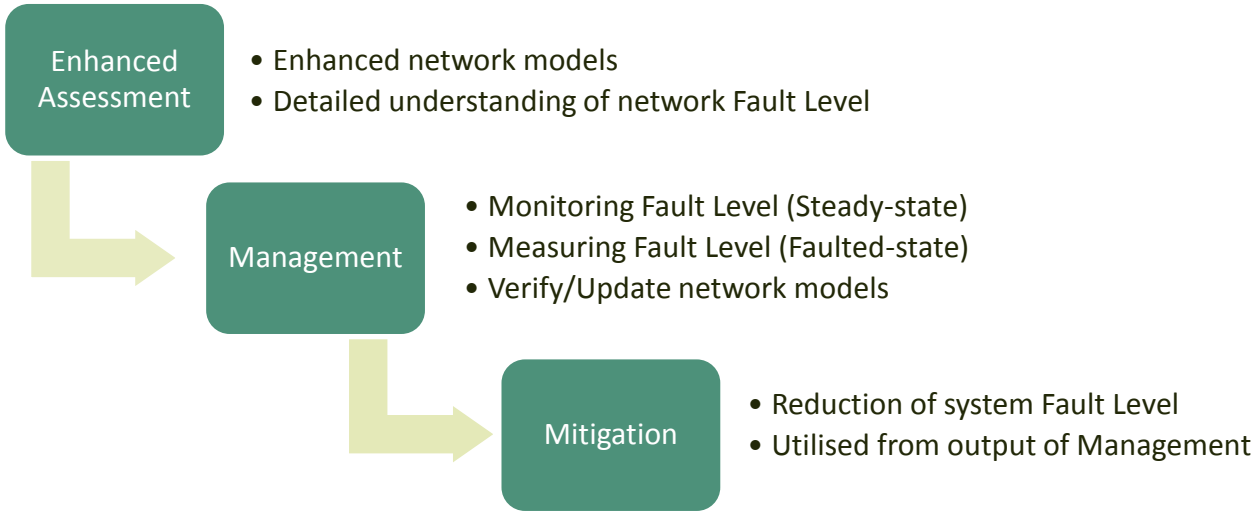
Note: 1 – Funded by Aerospace Technology Institution; Note 2 – Funded by the Energy Systems Catapult

Agenda

- What is FlexDGrid?
- What is Fault Level?
- What causes it to change?
- How is it going to (likely to) change?
- How does FlexDGrid benefit this?
- Next Step

What is FlexDGrid?

Three integrated Methods leading to quicker and cost effective customer connections through a timely step change in the enhanced understanding, management and mitigation of distribution network Fault Level.

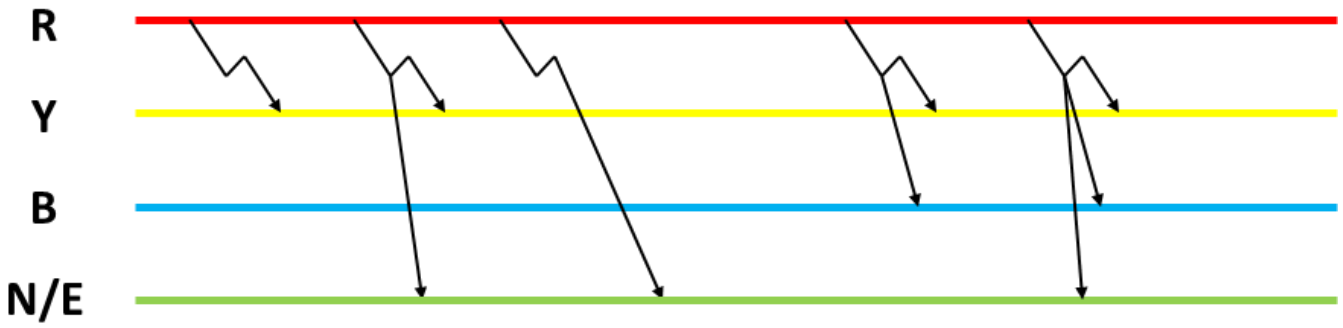


Each Method can be applied on its own whilst the integration of the three Methods combined will provide a system level solution to facilitate the connection of additional Generation.

What is Fault Level / Short Circuit Current?

Technical Definition

A short circuit (fault level) is an electrical circuit that allows a current to travel along an unintended path with no or very low electrical impedance.



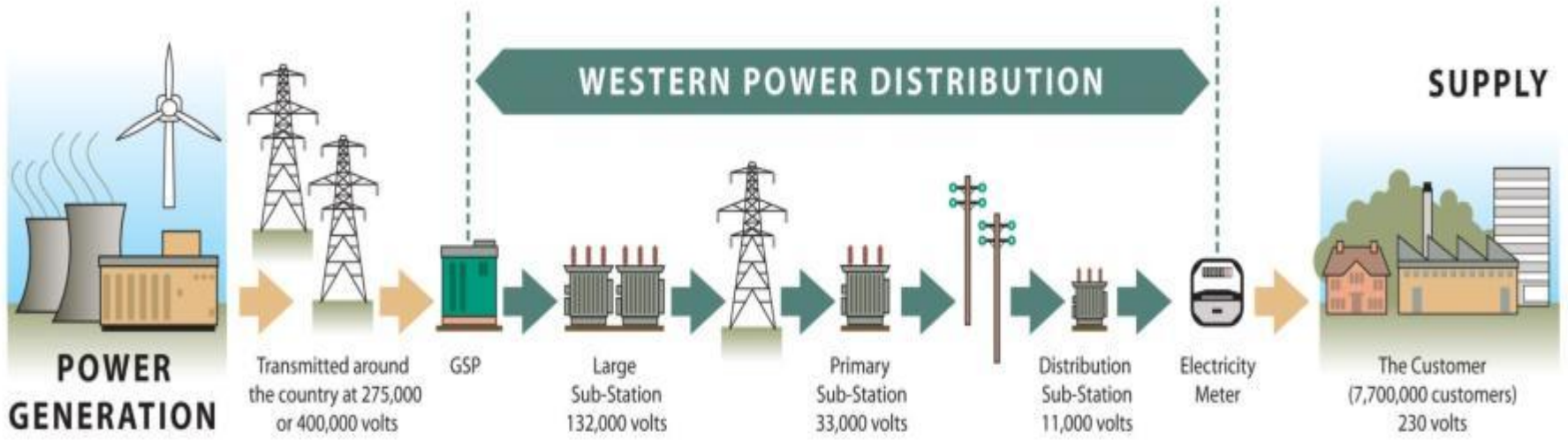
Examples of unintentional conducting paths in a 3-phase system (faults)

What is Fault Level?

What actually causes faults on the system?

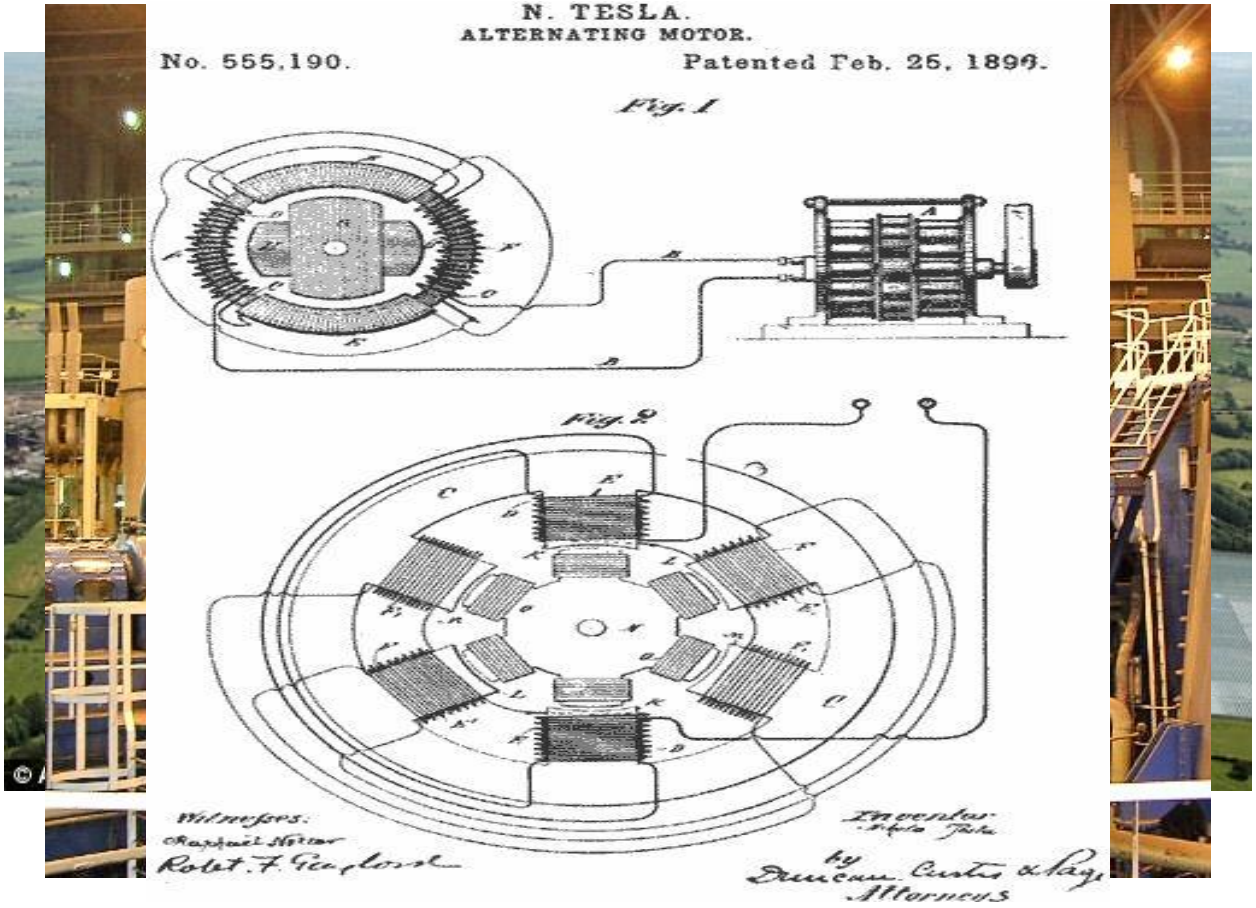
What is Fault Level?

What effects it and how does it change?



What is Fault Level?

What dominates the distribution fault level?



What is Fault Level?

How is it generated and changed?

$$V = IR$$

What is Fault Level?

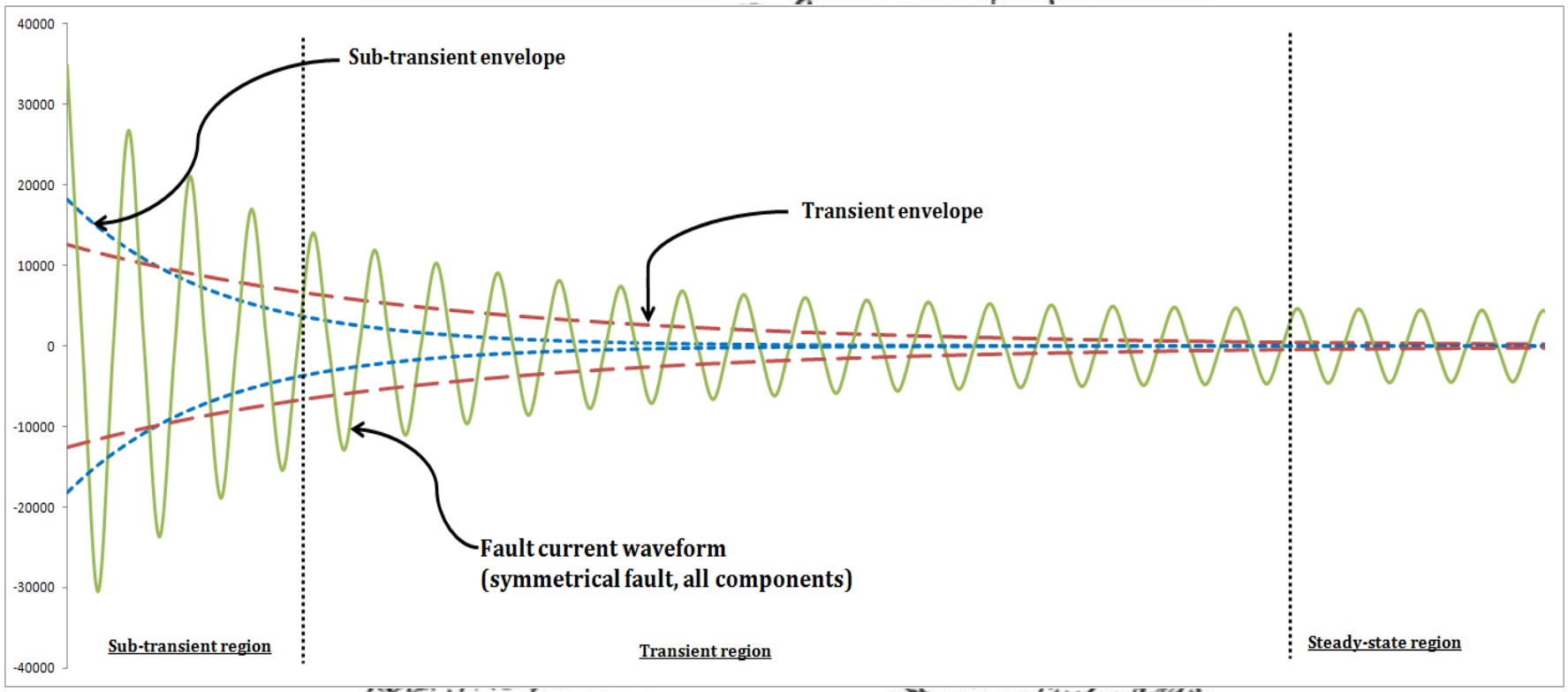
How is it generated and changed?

$$V = IZ$$

$$Z = R + X$$

What is Fault Level?

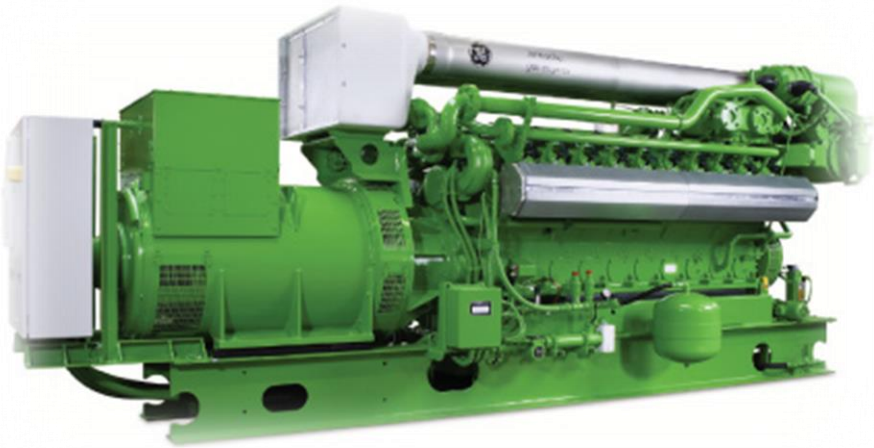
How is it generated and changed?

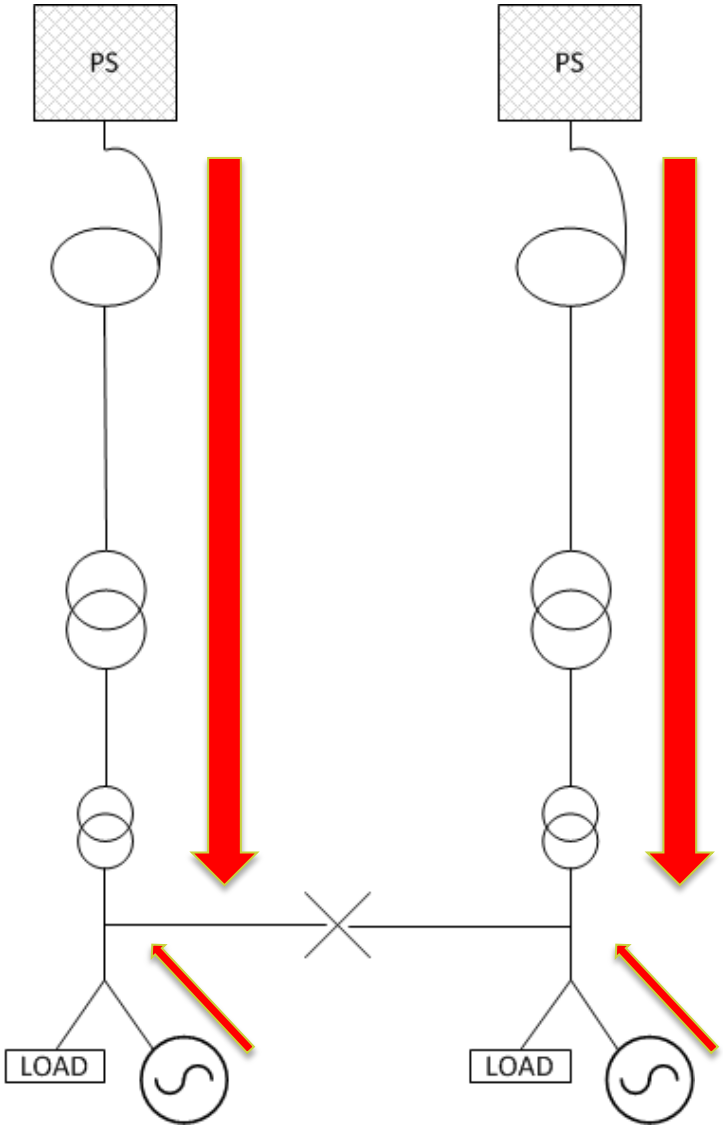


$$2I = \frac{V}{Z}$$

What is Fault Level?

Other changes to Fault Level





How is it going to (likely to) change?

How is it going to (likely to) change?

Average Combined Heat and Power Fault Level Infeed – **4.5MVA/MVA**

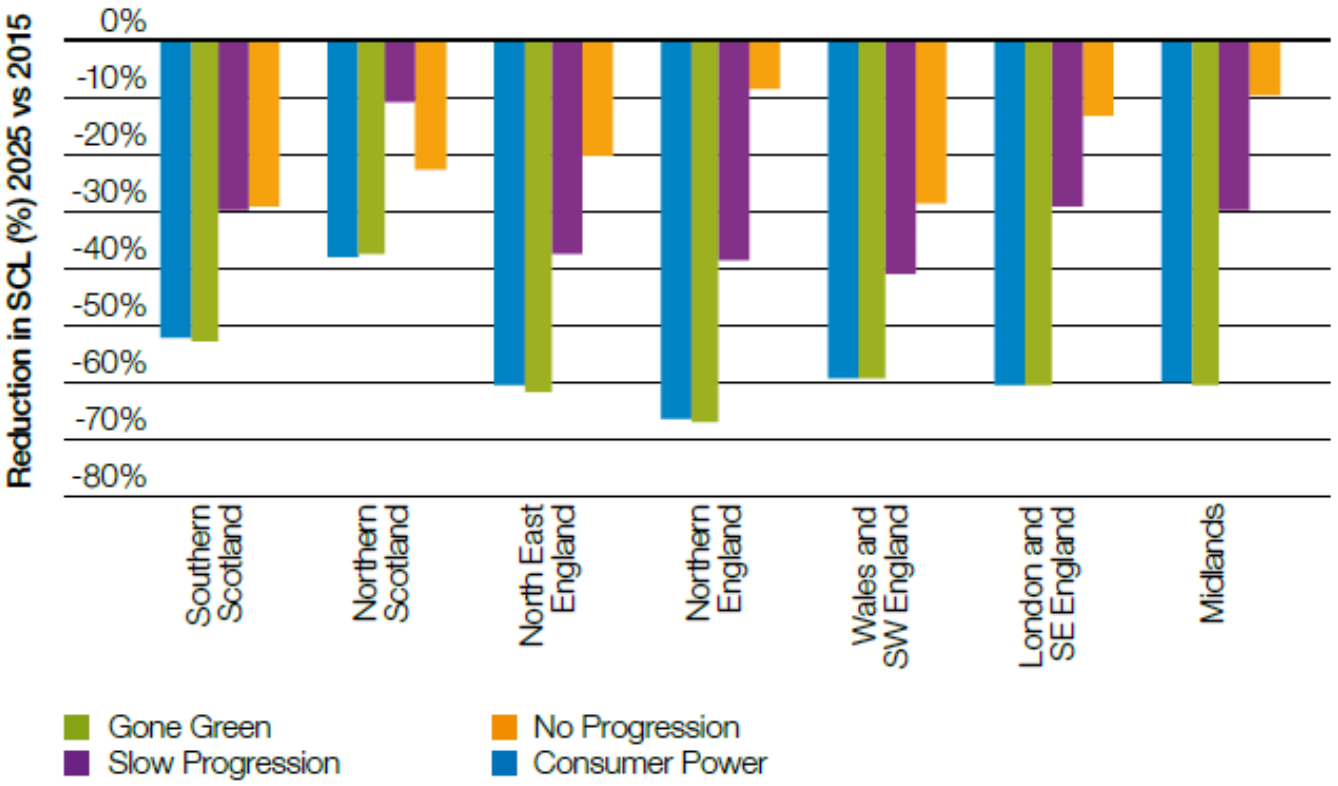
Average Inverter Fed Generator Infeed – **1.2MVA/MVA**

Even if the Power Station was equivalent to a CHP unit a 2000MW station would have an infeed value of **9000MVA**

If all that power was generated by inverter fed distributed generation the fault level infeed would be reduced by **6600MVA** to **2400MVA**

How is it going to (likely to) change?

National Grid's projection of fault level reduction from 2015 to 2025



What does this mean?

Short Term

Centralised Generation and Distributed Generation

What does this mean?

Medium Term

Reduced Centralised Generation and Increased Distributed Generation

What does this mean?

Long Term

Minimal Centralised Generation and Dominated Distribution Generation

FlexDGrid Learning and Benefits

How to model and access the impact?

- Development of a model from National Grid infeed to the remote end of the 11kV network
  - More accurate assessment of the system and new connections
  - Refined load contribution analysis
  - Enables increased access to fault level data

- Supports FlexDGrid's other two methods

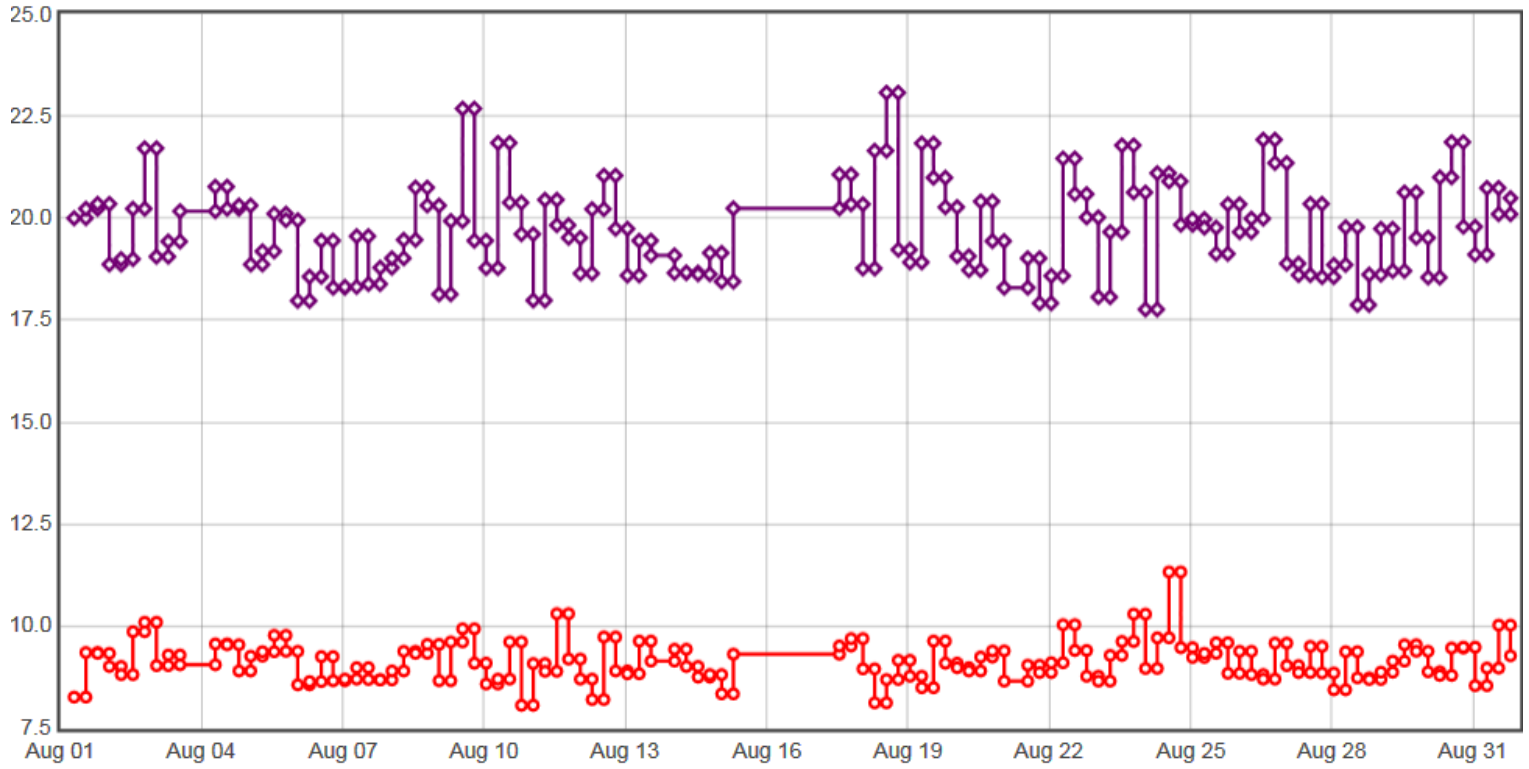
FlexDGrid Learning and Benefits

Greater visibility of the network?

- Installation of 10 Fault Level Monitors (FLM)
  - For the first time real-time make and break fault levels of the 11kV system can be generated

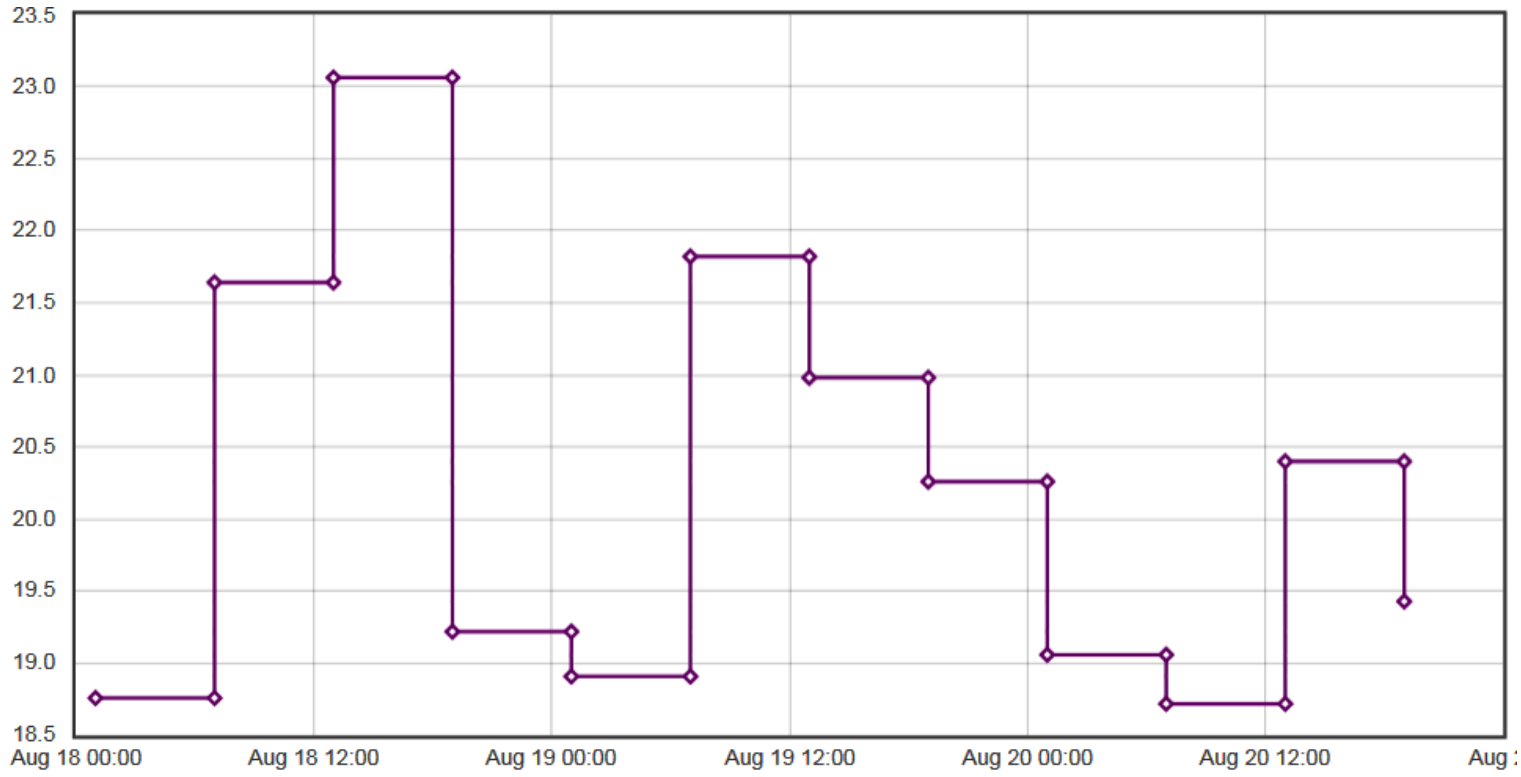
FlexDGrid Learning and Benefits

Make and Break fault level (MVA) for August 2016



FlexDGrid Learning and Benefits

Make Fault Level (MVA) for three days



FlexDGrid Learning and Benefits

Benefits of real-time Fault Level monitoring

- Enables design engineers to have greater information:
  - System fault level infeed by substation
  - Historic data to inform customers about the possibility of flexible connections
- Enables control engineers to have greater information to:
  - Increase network security of supply
  - Connect / Disconnect generation
- Future Use:
  - Inform requirements for network reconfiguration
  - Understand the requirements and purpose of dynamic protection settings
  - Enact the use of synthetic inertia

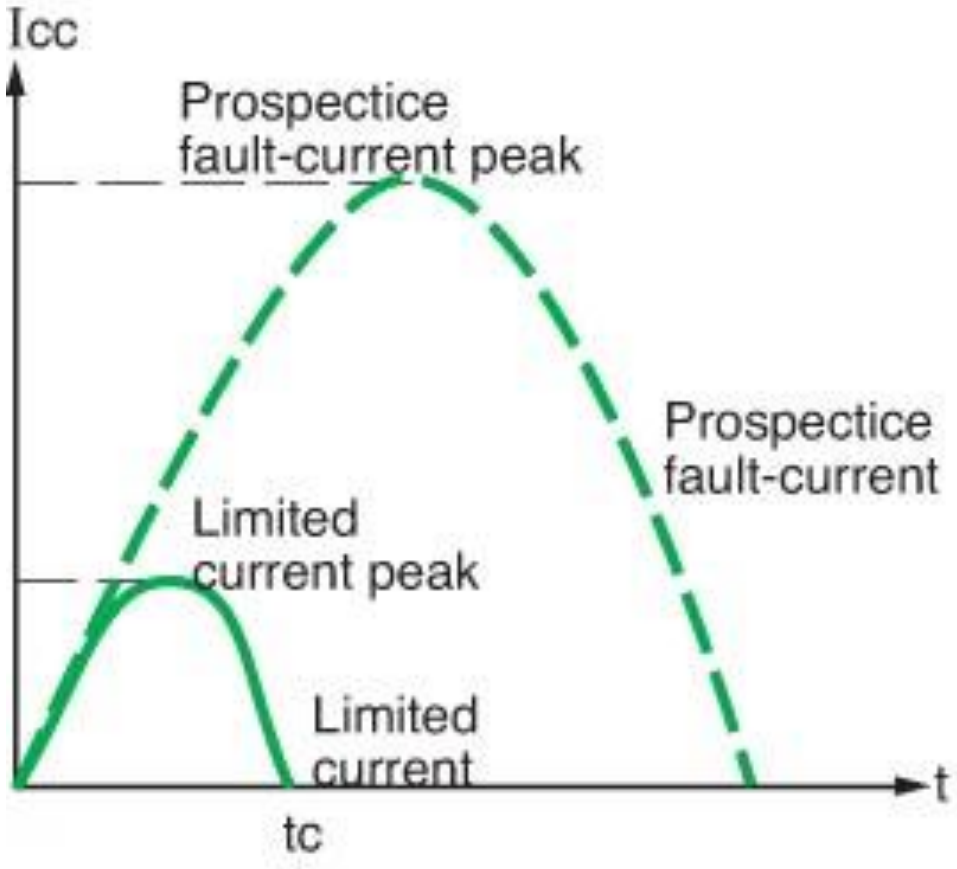
FlexDGrid Learning and Benefits

Fault Level Mitigation

- Technologies to increase the impedance (Z) of the system, on inception of a fault, to limit fault level flow through it

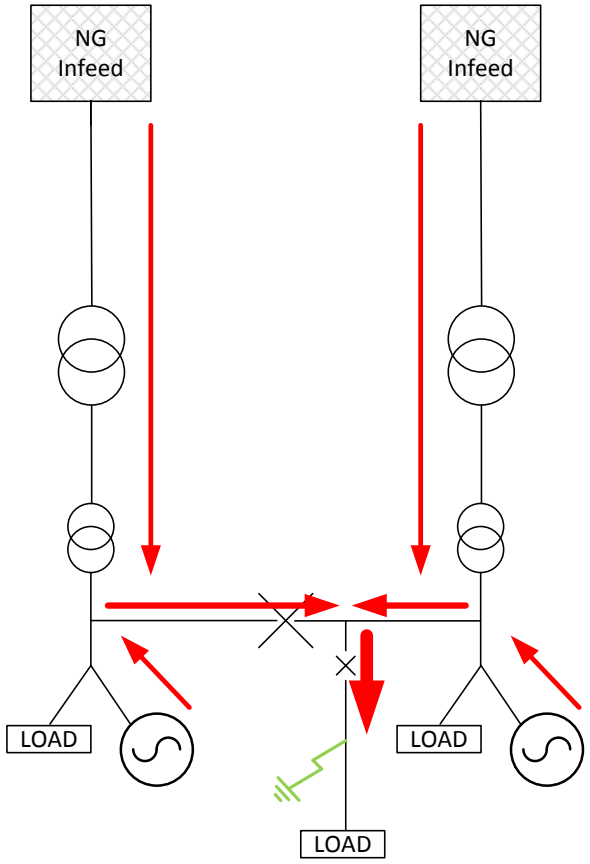
FlexDGrid Learning and Benefits

Fault Level Mitigation



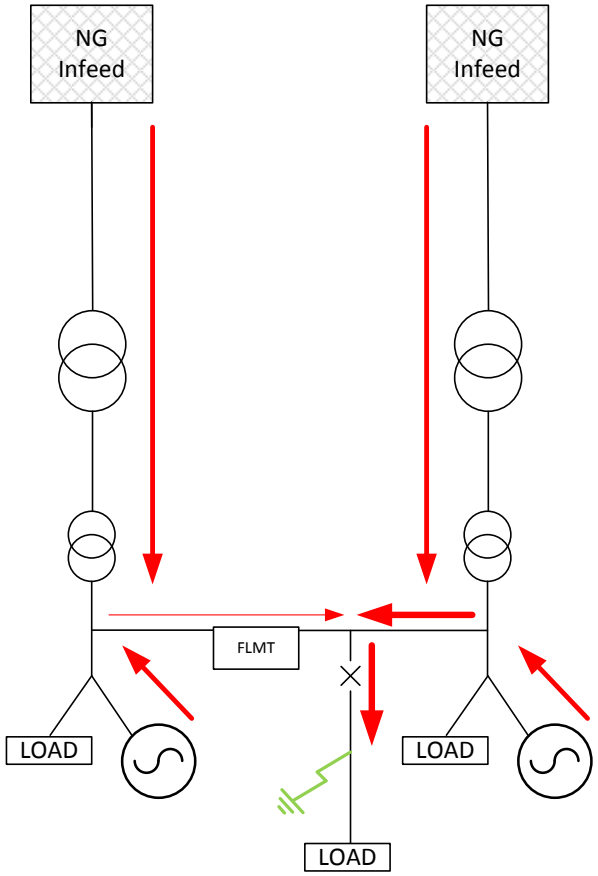
FlexDGrid Learning and Benefits

Fault Level Mitigation

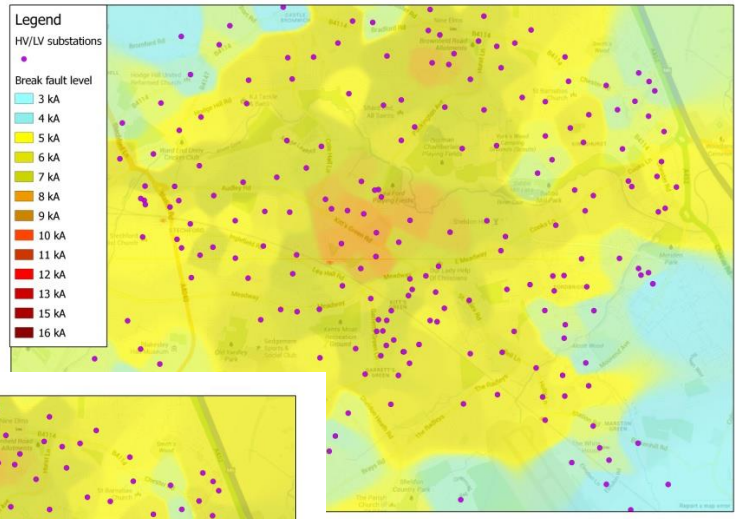


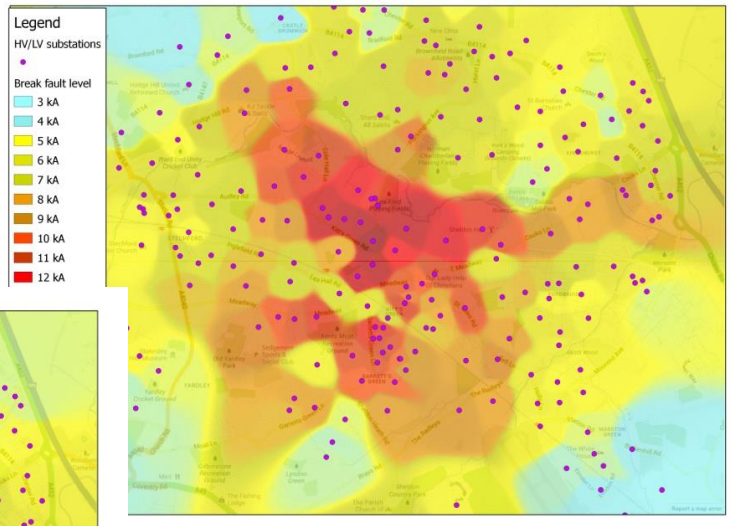
FlexDGrid Learning and Benefits

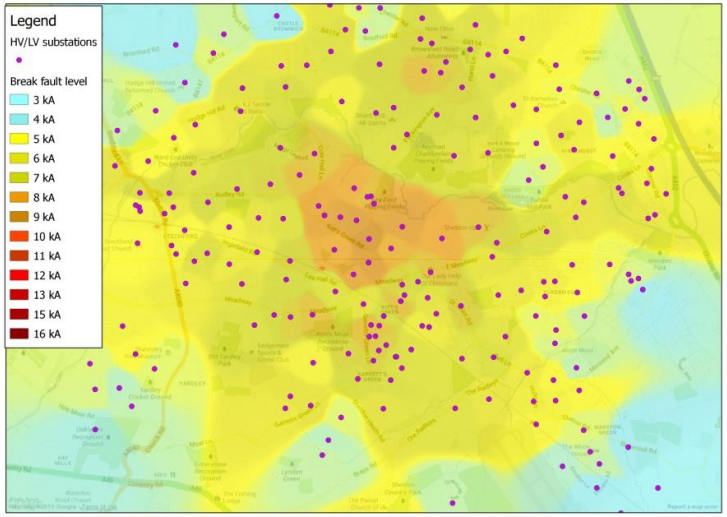
Fault Level Mitigation



Effect on Fault Level

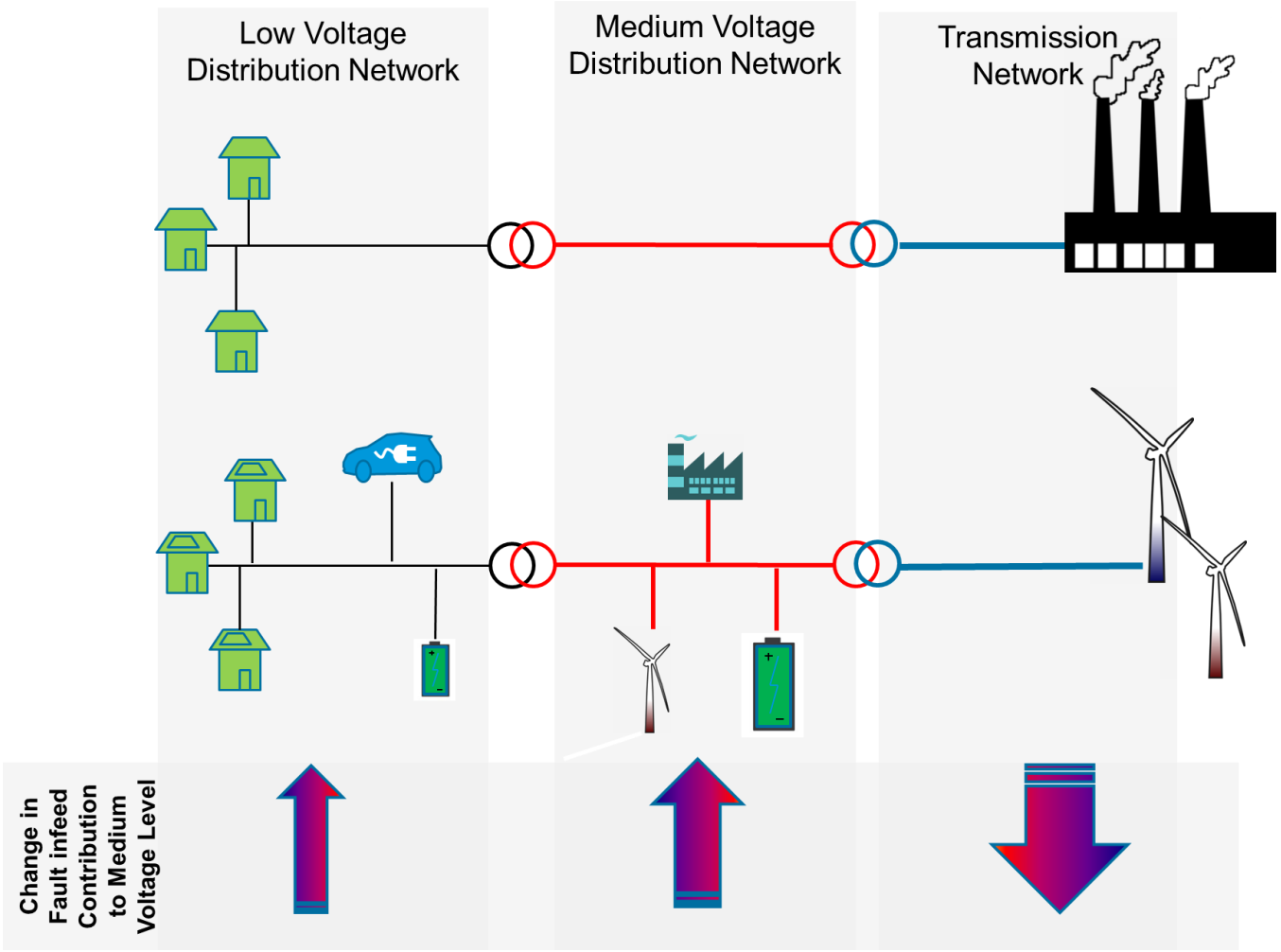






Fault Level Heat Maps

Conclusion and Next Steps



THANKS FOR LISTENING

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Serving the Midlands, South West and Wales

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