WESTERN POWER DISTRIBUTION

FLEXDGRID

HEAT AND POWER FOR BIRMINGHAM

INNOVATIVE DG CONNECTIONS

LCNI 2014 Tuesday 21st October

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LCN Fund Low Carbon Networks · THE UNIVERSITY OF WARWICK · PARSONS BRINCKERHOFF

Agenda

- Project Introduction
- Fault Level Modelling
- Fault Level Monitor Installations
- Fault Level Mitigation Technology Installations

FlexDGrid – What and Why

What are we doing?

Understanding, Managing and Reducing the Fault Level on an electricity network

Why are we doing it?

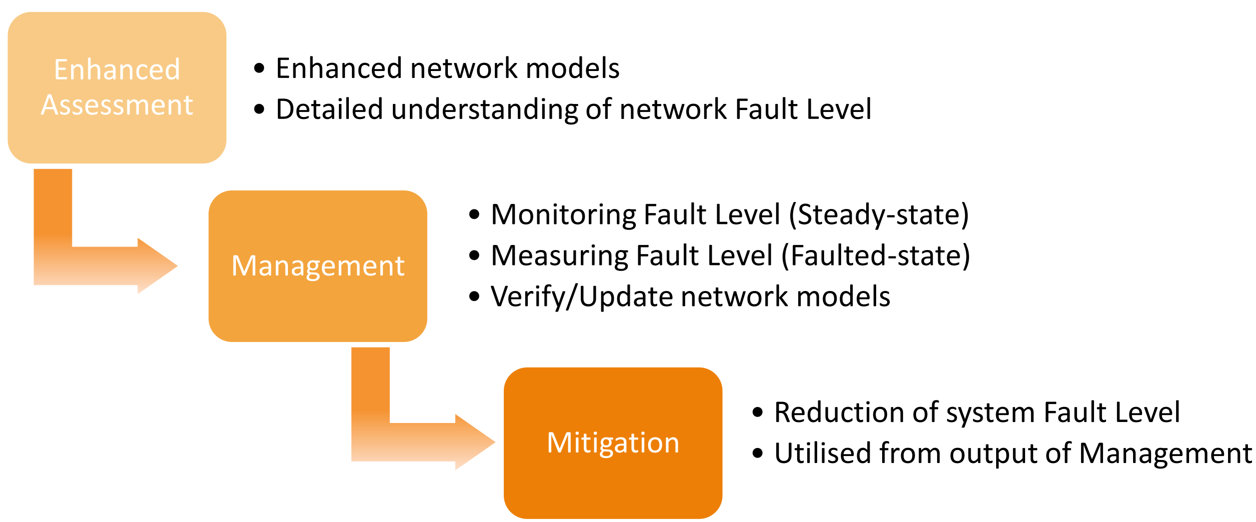
Facilitating the early and cost effective integration of Low Carbon generation

Why are we doing it now?

Supporting the Carbon Plan – Connection of generation to the grid and development of heat networks – reducing carbon emissions

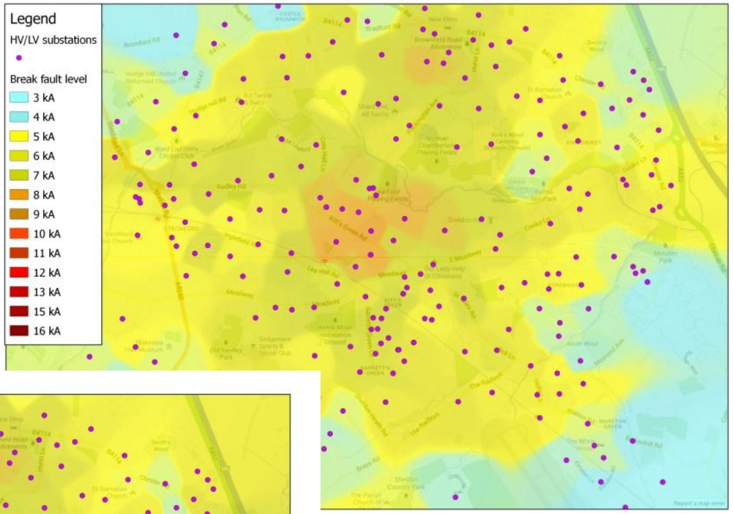
What is FlexDGrid?

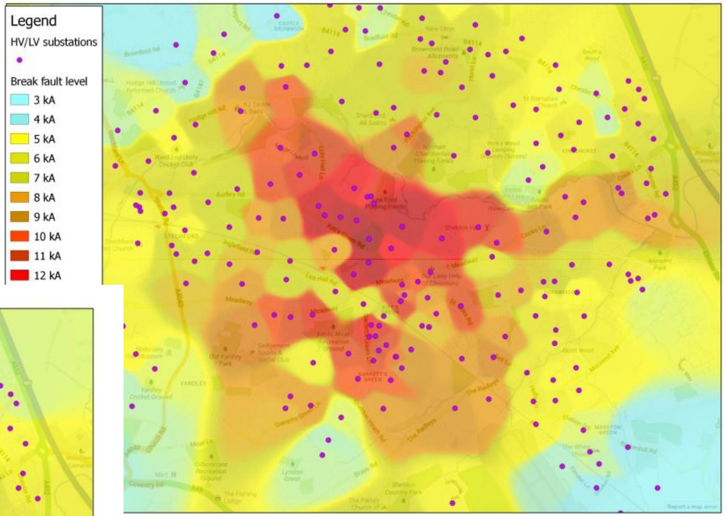
Three integrated Methods leading to quicker and cost effective customer connections through a timely step change in the enhanced understanding, management and mitigation of distribution network Fault Level.

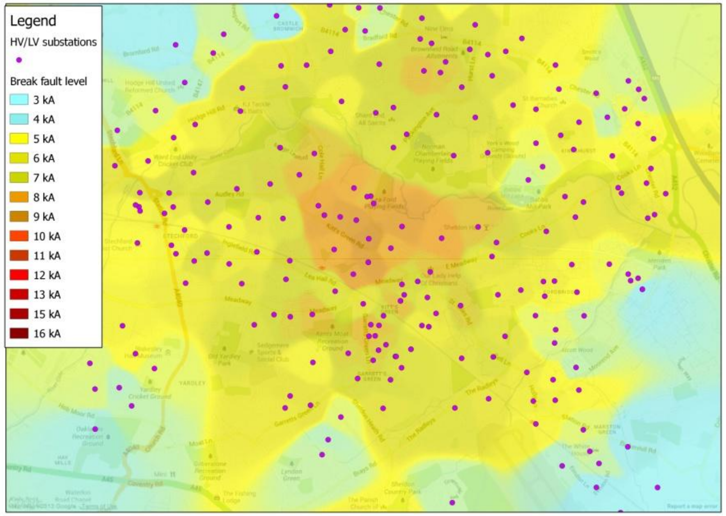


Each Method can be applied on its own whilst the integration of the three Methods combined will provide a system level solution to facilitate the connection of additional Generation.

Effect on Fault Level

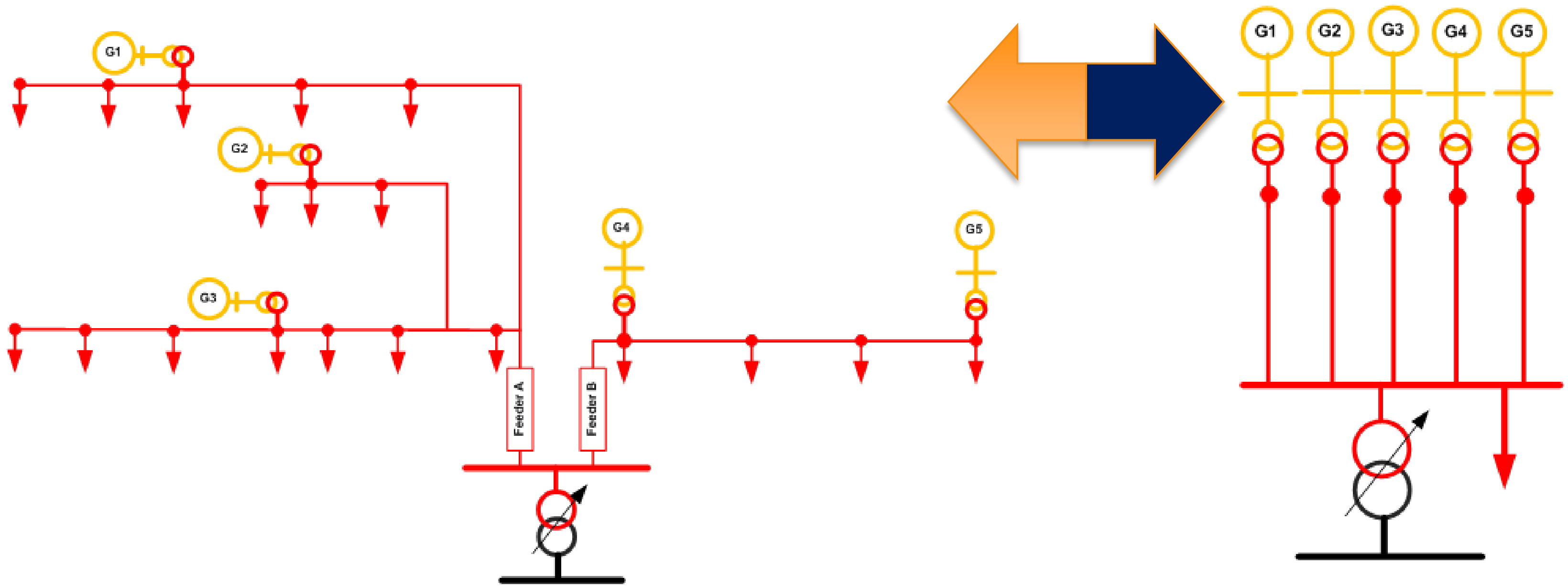






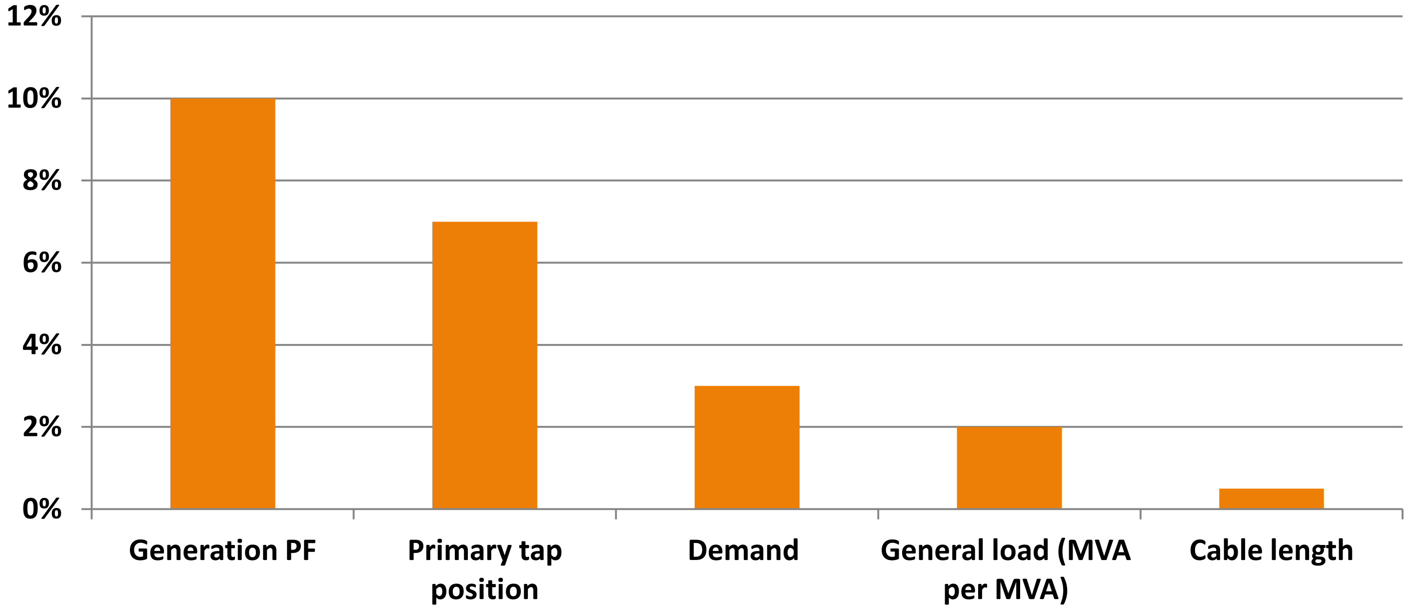
Fault Level Heat Maps

Modelling – Increased Granularity



	Unity PF		0.95 leading PF		Unity PF		0.95 leading PF		Gout=0	
	Make	Break	Make	Break	Make	Break	Make	Break	Make	Break
[kA]	6.76	2.50	6.26	2.23	7.13	2.60	6.71	2.43	7.05	2.57
[MVA]	128.8	47.6	119.3	42.5	135.8	49.5	127.8	46.3	134.3	49.0
Difference (%)					5.5	4.0	7.2	9.0	-	-

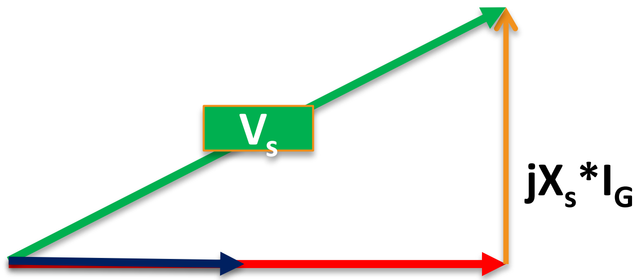
Modelling – Sensitivity Analysis



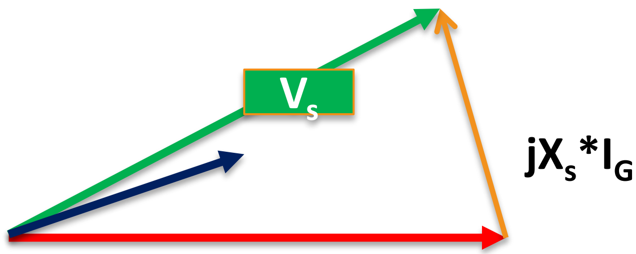
	Variation range	
Cable length	-5%	5%
Demand	-10%	10%
Generation PF	Unity, 0.95 leading, 0.95 lagging, Vset=1	
General load (MVA per MVA)	0	2
Primary tap position (voltage at HV busbars)	0.95 pu to 1.03 p.u	

Modelling – Power Factor Effects

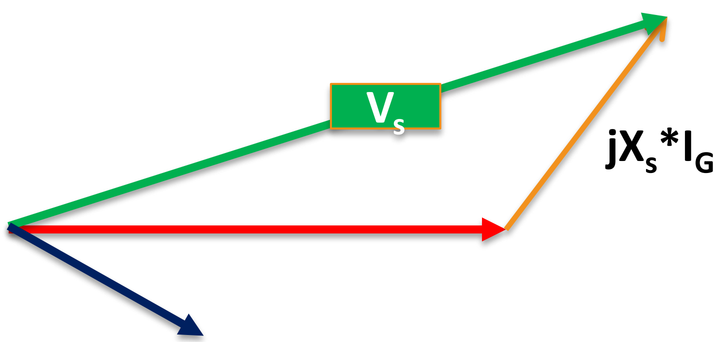
Unity PF

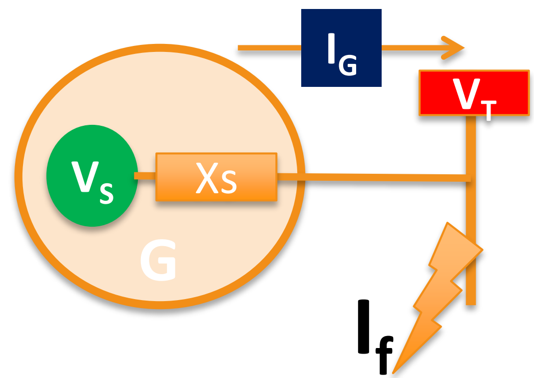


Leading PF



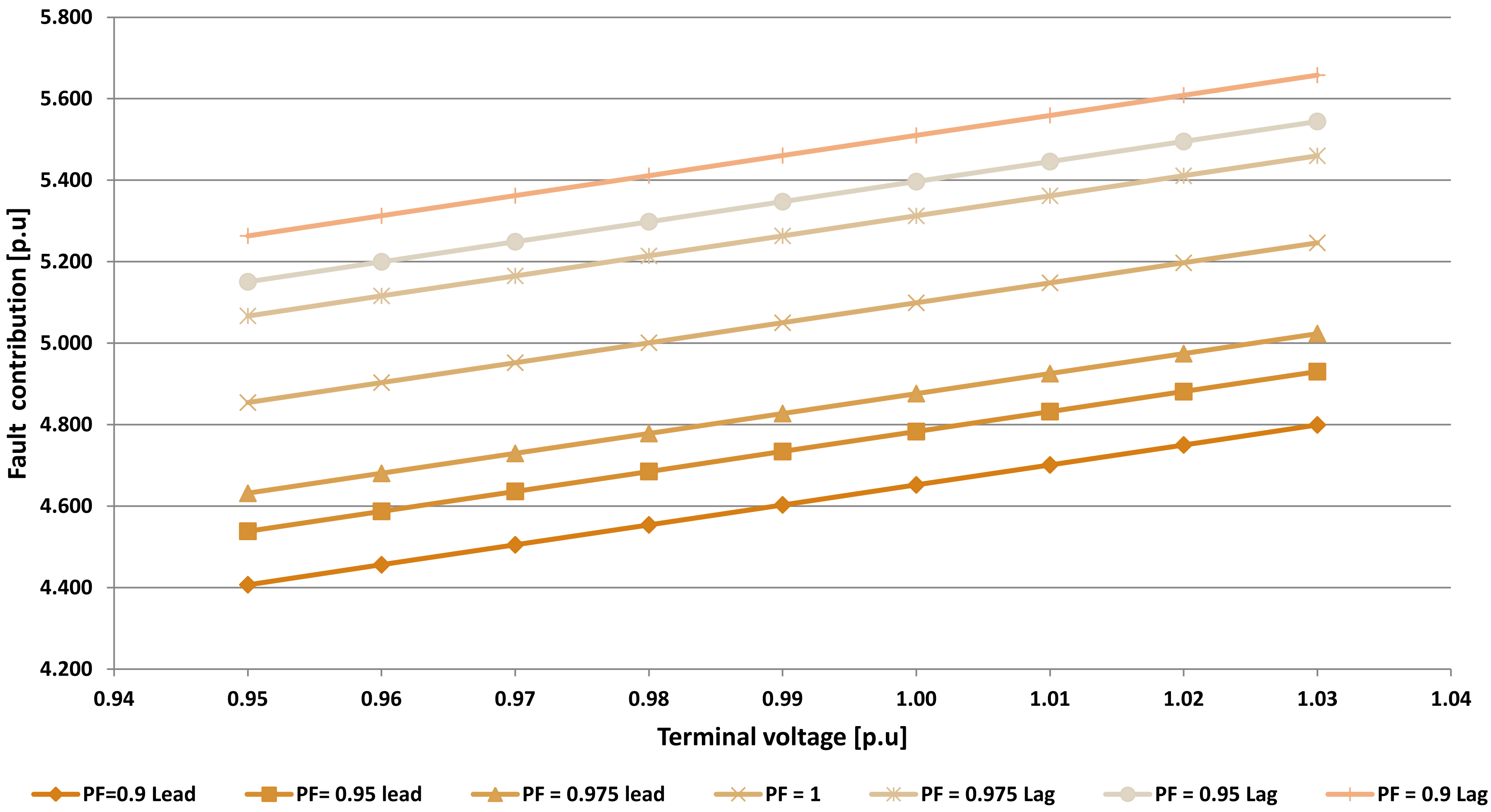
Lagging PF





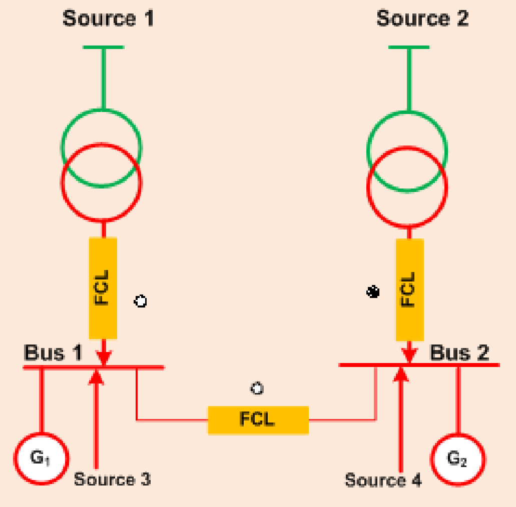
$$I_f = V_s / X_s$$

Modelling – Generation Fault Level



Modelling – Fault Level Mitigation Tech Model

Fault Current Limiter model
Substation Test



Fault current limiter technology

- Pre-Saturated Core FCL (PCFCL)
- Resistive Superconducting FCL (RSFCL)
- Solid-State FCL (SSFCL)

Substation Name	Substation Test				
Firm capacity	78	MVA	Generation fault contribution [MVA/MVA]	4.5	-
Switchgears rating (Break)	13.1	kA	Base power	100	MVA
Switchgears rating (Make)	33.4	kA	Base voltage	11	kV
De-rating factor	10	%	Base current	5.25	kA
Switchgear policy rating (Break)	11.8	kA	Base impedance	1.21	ohm

Source 1 - Upstream Fault Contribution			Source 2 - Upstream Fault Contribution		
Upstream breaking fault contribution	7	kA	Upstream breaking fault contribution	8	kA
Upstream making fault contribution	19	kA	Upstream making fault contribution	20	kA
Upstream X/R ratio	20	-	Upstream X/R ratio	10	-
Voltage at Source	1	p.u	Voltage at Source	1	p.u

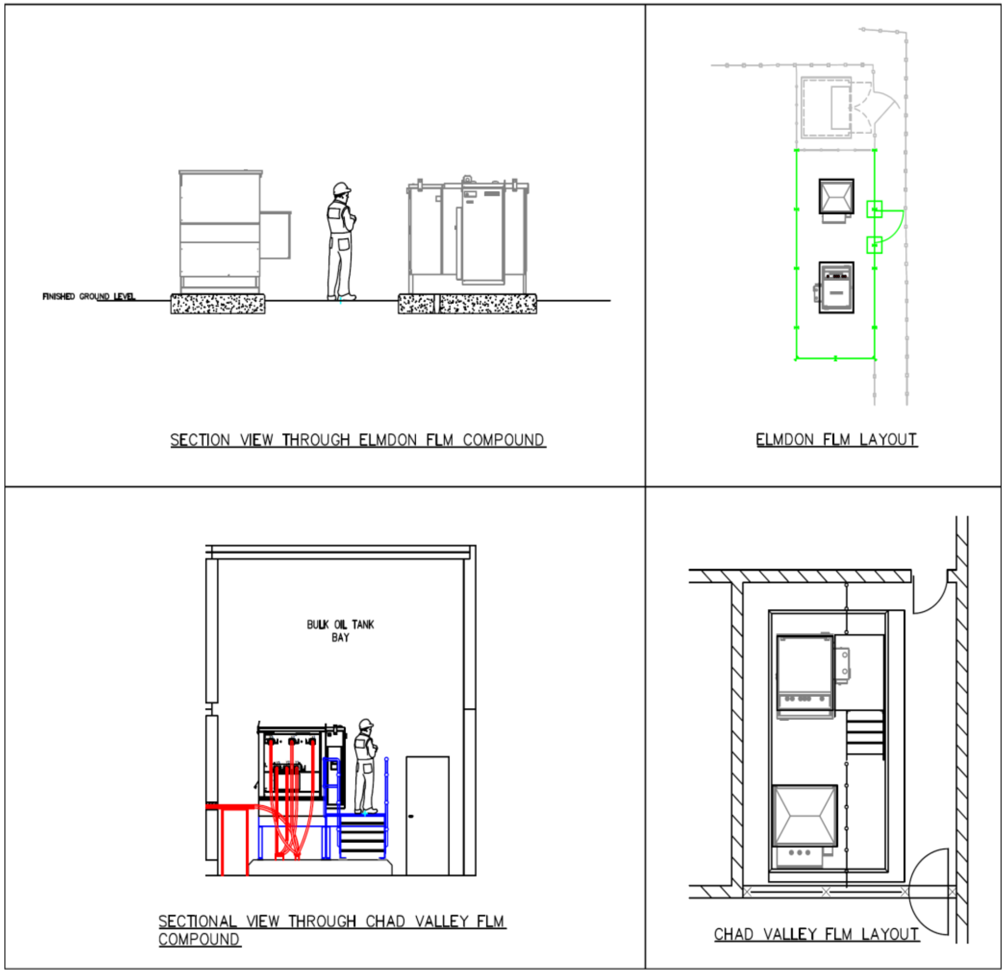
Source 3 - Downstream Fault Contribution			Source 4 - Downstream Fault Contribution		
Breaking fault contribution	2	kA	Breaking fault contribution	1	kA
Making fault contribution	3	kA	Making fault contribution	2	kA

Pre-Fault FCL loading	50	A

Without FCL	Bus 1	Bus 2	With FCL	Bus 1	Bus 2
Breaking fault current [kA]	18.0	18.0	Breaking fault current [kA]	10.0	10.0
Making fault current [kA]	44.0	44.0	Making fault current [kA]	24.0	24.0
Generation headroom at Bus 1 (G1) [MVA]	0.0	-	Generation headroom at Bus 1 (G1) [MVA]	7.6	-

Excel Based FLMT Model

Fault Level Monitor Installations

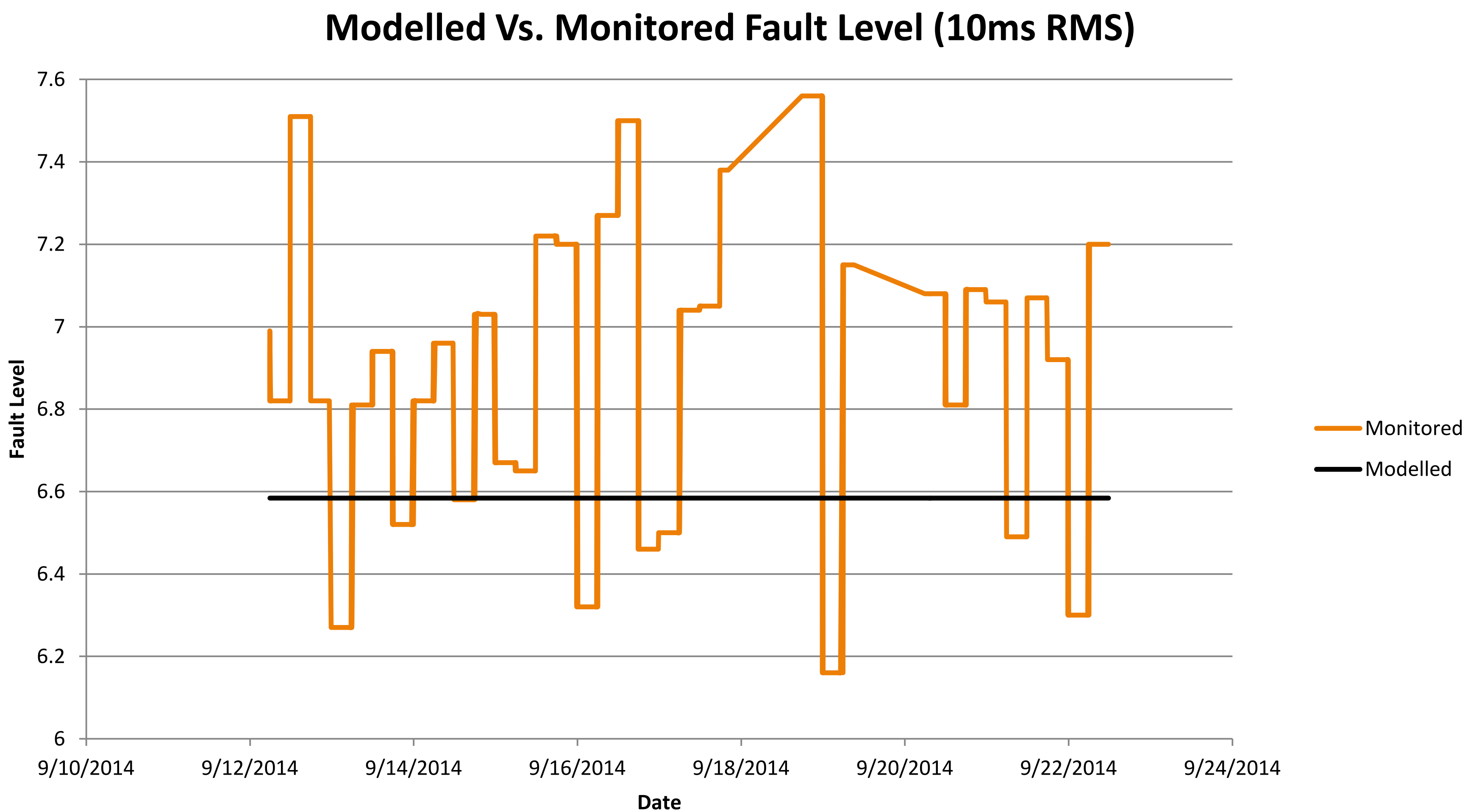


FLM Site Designs

Fault Level Monitor Installations

Ladywood FLM Installation

Fault Level Results from Installation

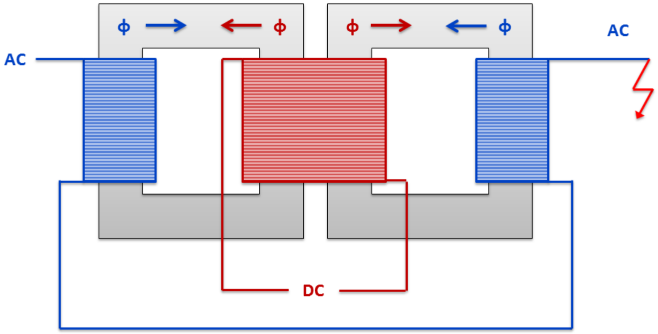


Fault Level Mitigation Technology Installations

Substation	Technology	Manufacturer	Delivery Date
Castle Bromwich	Pre-Saturated Core FCL	GridON	Q4 2014
Chester Street	Resistive Superconducting FCL	Nexans	Q2 2015
Bournville	Resistive Superconducting FCL	Nexans	Q3 2015
Kitts Green	Power Electronic FCL	Alstom	Q4 2015
Sparkbrook	Power Electronic FCL	Alstom	Q1 2016

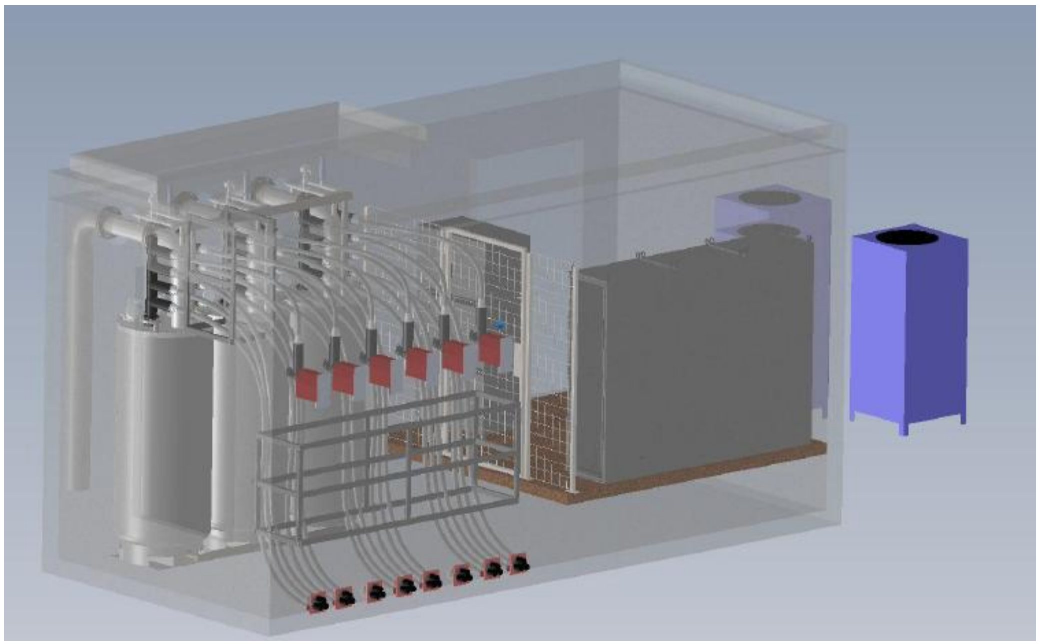
Pre-saturated Core FCL

GridON FCL – During Factory Acceptance Testing

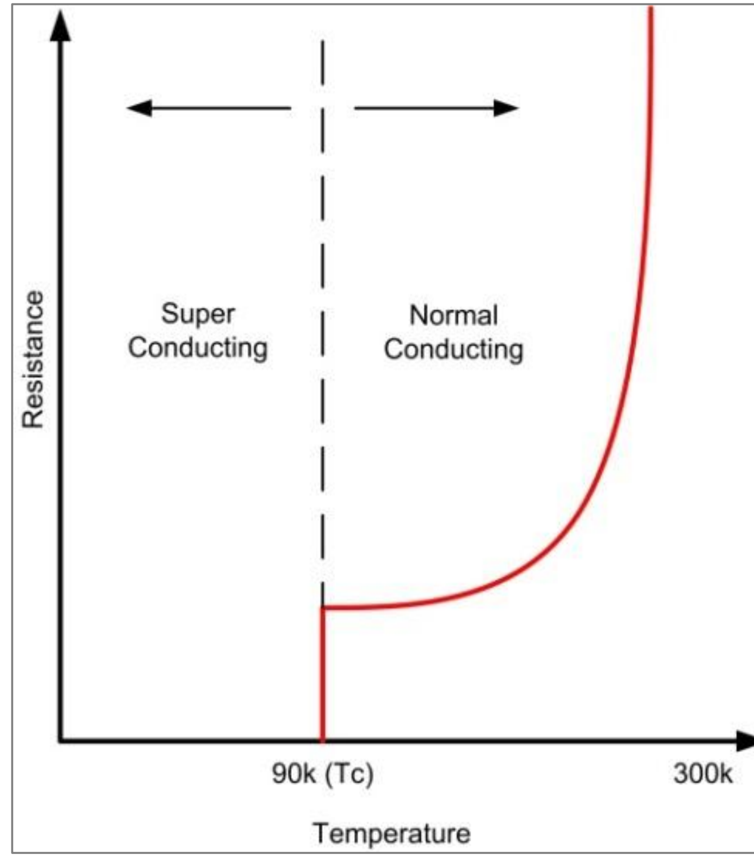


Design

Resistive Superconducting FCL

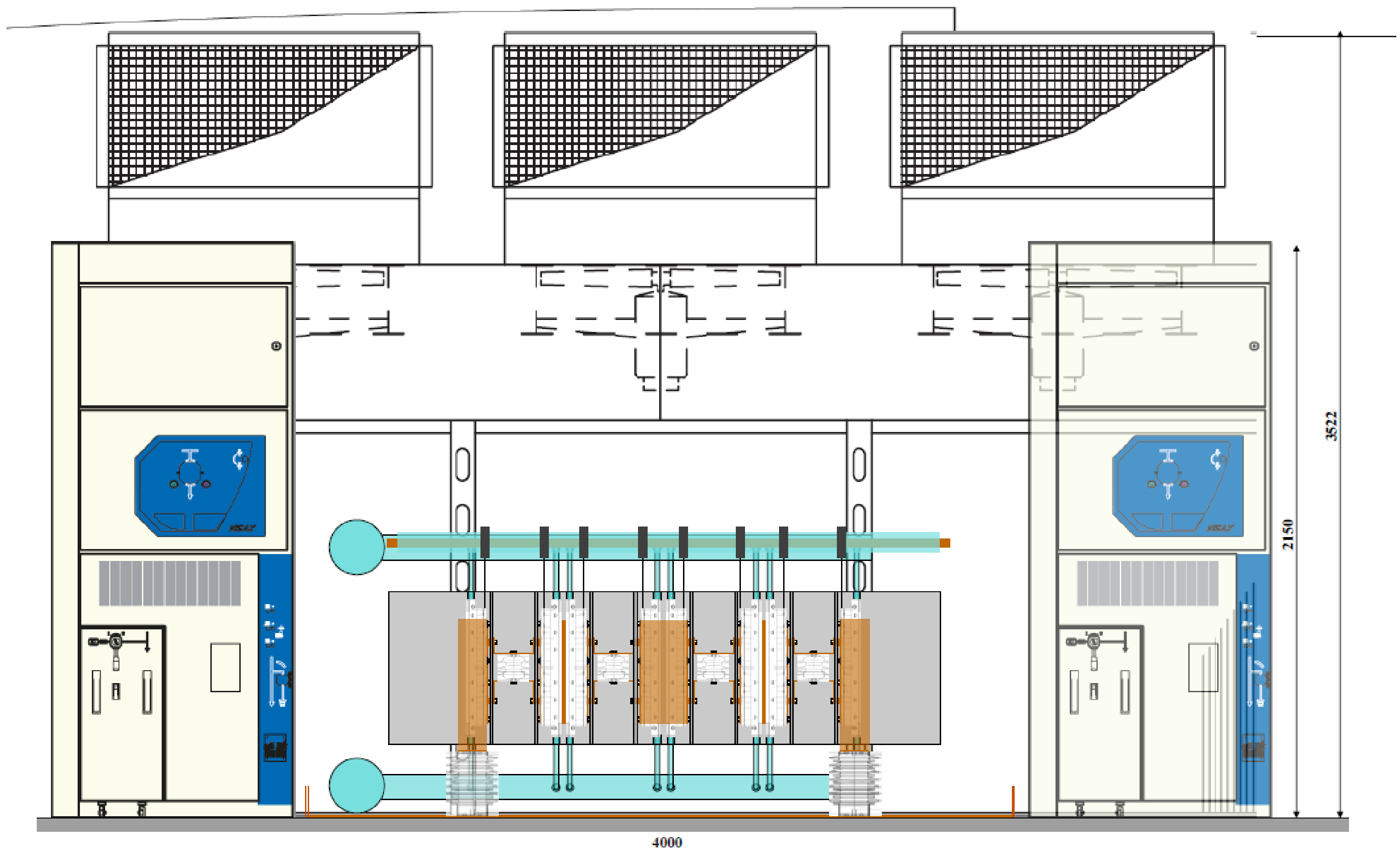


Nexans FCL



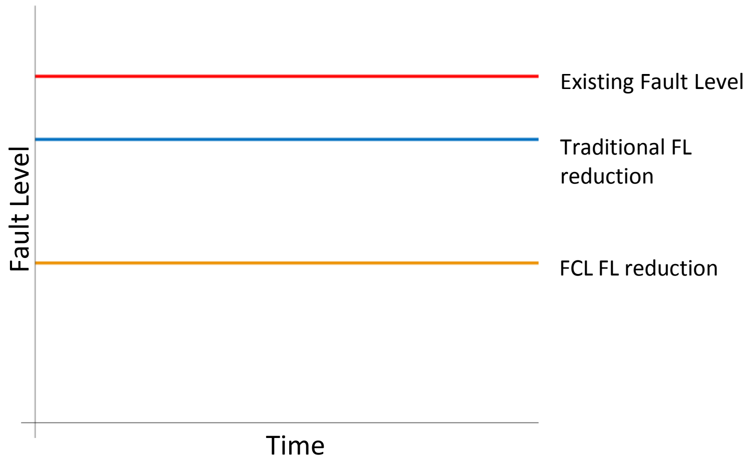
Design

Power Electronic FCL



Alstom Design

FCL Benefits



FlexDGrid Requirements

Following the installation of an FCL be able to:

- Operate the 11kV network in parallel
- Increase the level of generation on the network by 10% of a substation's firm load capacity

Faster Connections

- Installation of an FCL can be carried out quicker than traditional reinforcement

Reduced Costs

- Installation of an FCL can be completed cheaper than traditional reinforcement

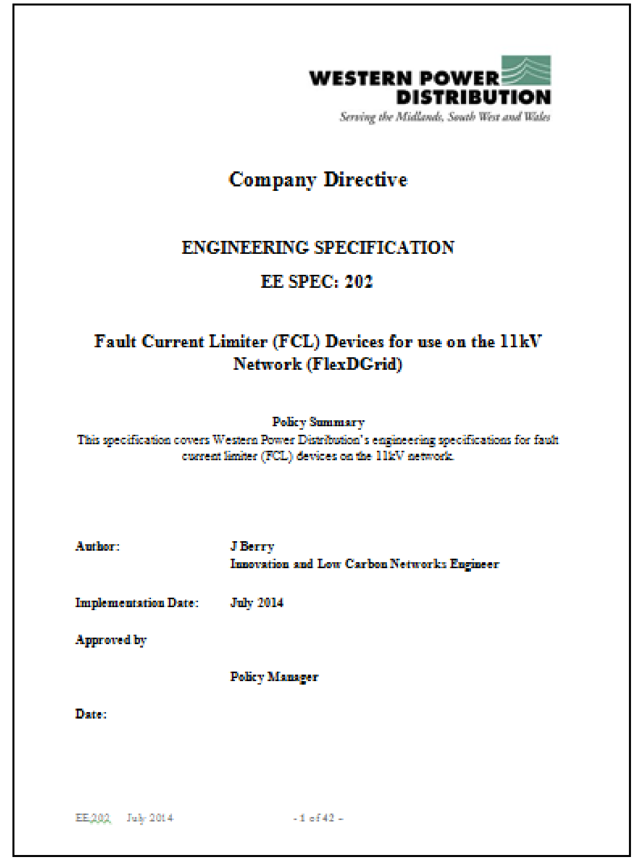
Greater Benefits

- Increased fault level reduction over traditional solutions
- Security of supply improvement through parallel network operation

Policies

Now in Place:

- EE201 – FLM Engineering Specification
- EE202 – FCL Engineering Specification
- ST_SD4R – Application and Connection of 11kV FLMs
- ST_SD4S – Application and Connection of 11kV FCLs



WESTERN POWER DISTRIBUTION
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Company Directive

ENGINEERING SPECIFICATION

EE SPEC: 202

Fault Current Limiter (FCL) Devices for use on the 11kV Network (FlexDGrid)

Policy Summary
This specification covers Western Power Distribution's engineering specifications for fault current limiter (FCL) devices on the 11kV network.

Author:	J Berry Innovation and Low Carbon Networks Engineer
Implementation Date:	July 2014
Approved by	
	Policy Manager
Date:	

EE202 July 2014 - 1 of 42 -

THANKS FOR LISTENING

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