

**electricity  
north west**

Bringing energy to your door



## Session 3.1 Innovative Fault Level Management

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Engineering & Technical Director

LCNI Conference  
Wednesday 12 October 2016

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**Respond**

**FLEXDGRID and Active  
Network Management**



Bringing energy to your door



**Steve Stott**

Innovation Engineer

**Jonathan Berry**

Innovation and Low  
Carbon Networks  
Engineer

**electricity  
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**RESPOND**

**Steve Stott**

Innovation Engineer

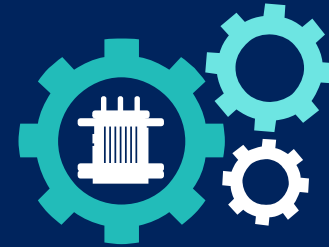
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# RESPOND



Introduction

Project overview

Respond techniques



Trials & analysis

Customer

Next steps



## Leading work on developing smart solutions



Deliver value from existing assets



Customer choice



Five flagship products (second tier/NIC)

£42 million

**C2C**

**SMART STREET**

**Celsius**

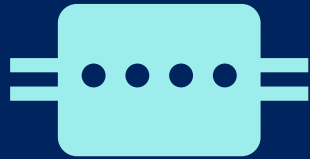
**CLASS**

**RESPOND**

# What is fault current/fault level?



Our network is designed to handle normal current 24/7



Protected by fuses, switches and circuit breakers in key locations



These devices detect the fault current and disconnect the fault from the rest of the network

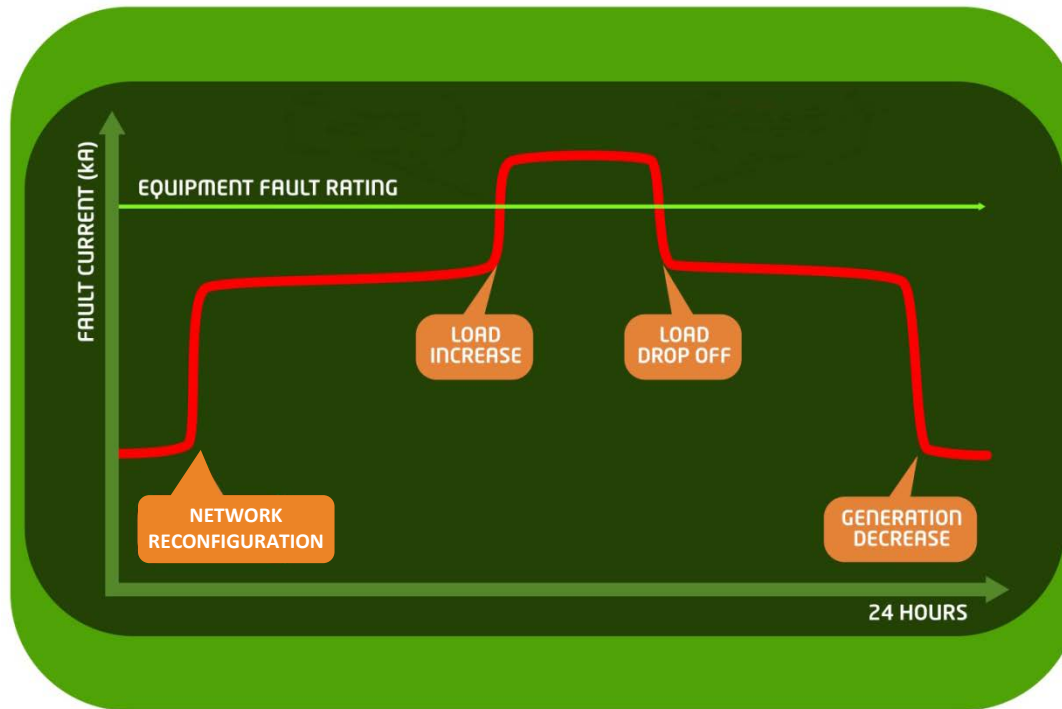


Fault current varies depending on type of fault, location, network configuration and generation sources



If unchecked fault current can damage equipment in a matter of seconds

***Fault current*** is the instantaneous surge of energy which flows under fault conditions  
***Fault level*** is the maximum potential fault current



Fault level reinforcement is disruptive, lengthy and expensive which can discourage connection of new demand/generation

How can we manage these issues without expensive reinforcement ?



Respond is the first UK demonstration of an active fault level management solution that avoids traditional network reinforcement



Competitive competition

Funded by GB customers

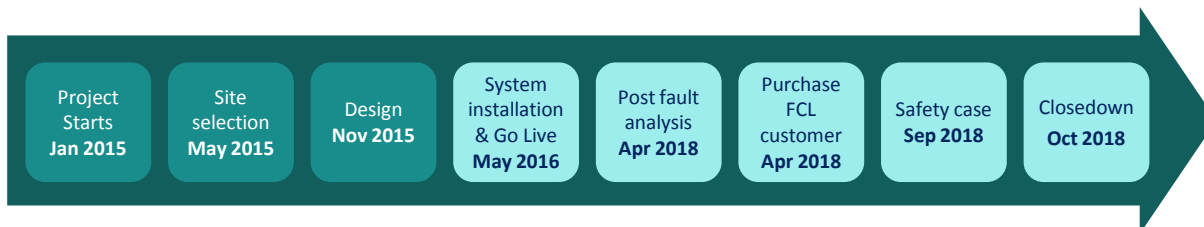
Learning, dissemination & governance

Fourth of our five successful Tier 2 / NIC projects



Investment

£5.5  
million



Project partners



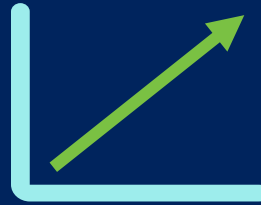
Financial  
benefits

Up to £2.3bn  
to GB by  
2050





Faster and cheaper to apply than traditional reinforcement



Will deliver a buy order of fault level mitigation solutions based on a cost benefit analysis



Facilitates active management of fault current, using retrofit technologies and commercial services



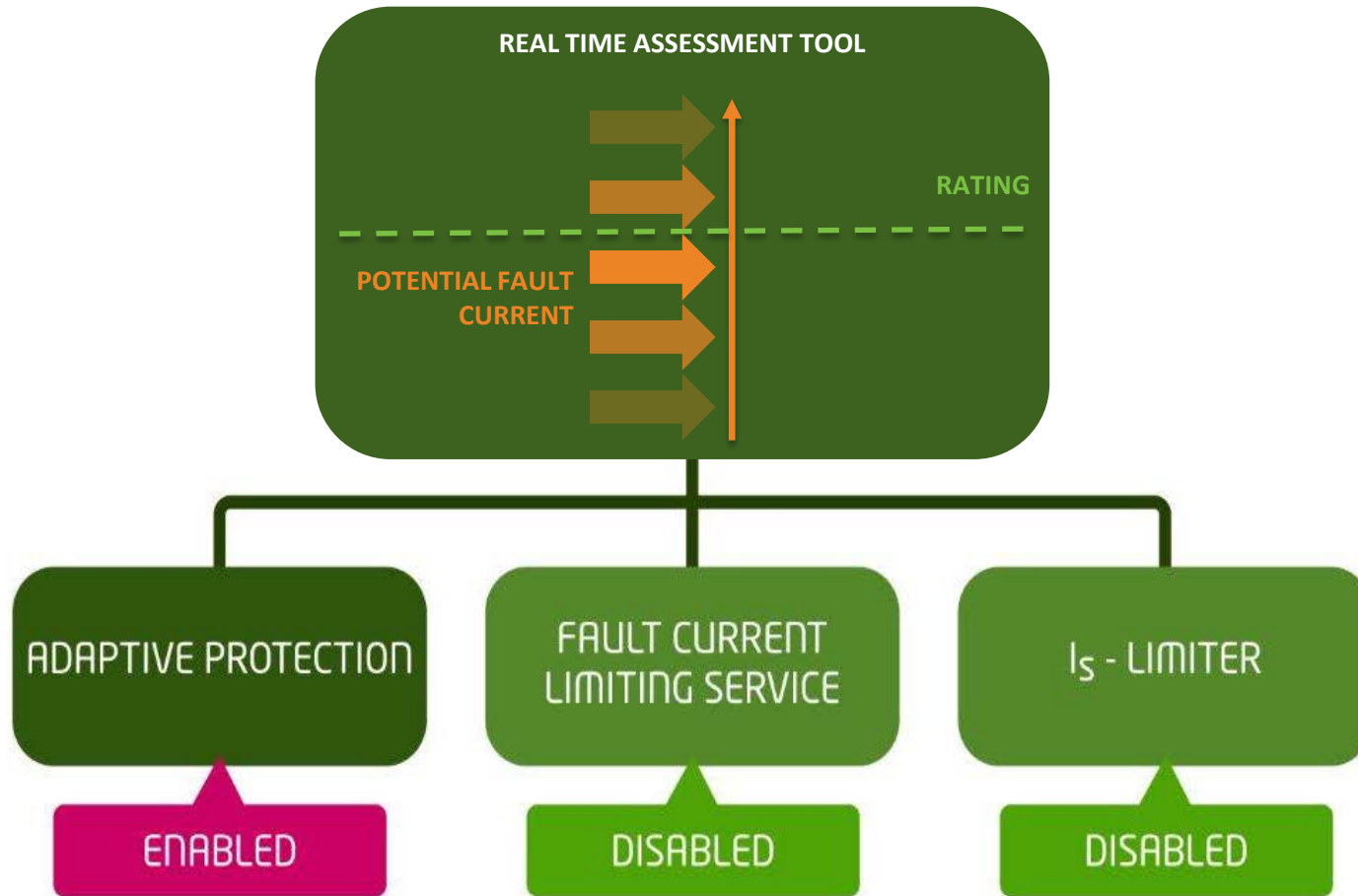
Enables a market for the provision of an FCL service



Uses existing assets with no detriment to asset health

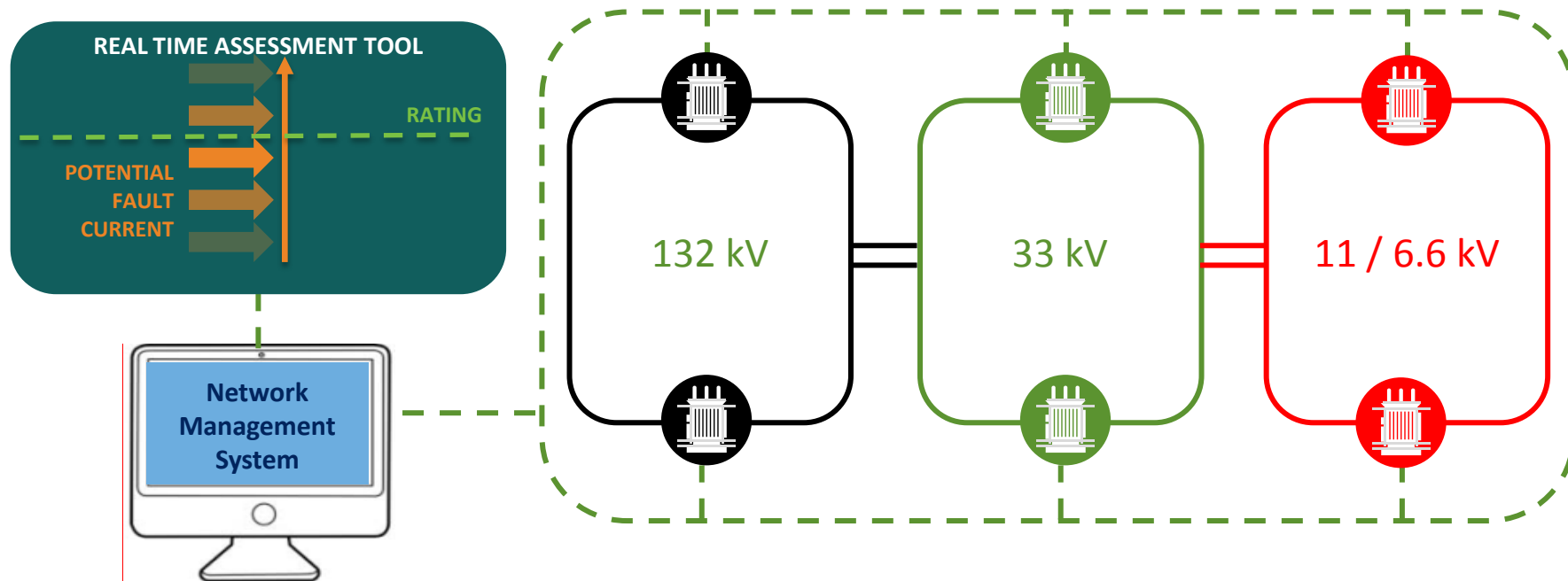


Reduces bills to customers through reduced network reinforcement costs



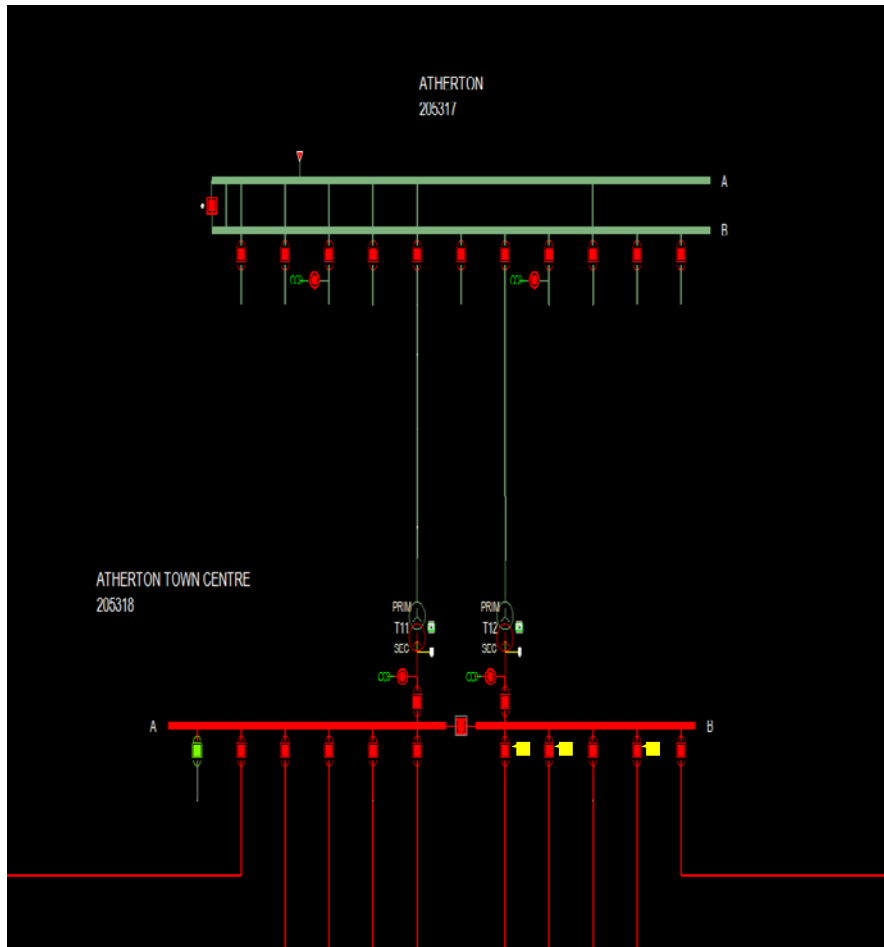
- Real time fault current assessment
- Safe network operation
-

# Respond network model



Real Time ● FL Calculation ● Comparison ● Action

# Fault Level Assessment Tool



Fault level calculation  
Trigger topology  
Change/time



Compares calculated FL  
with CB rating capacity.  
Symmetrical RMS break  
IEC606909

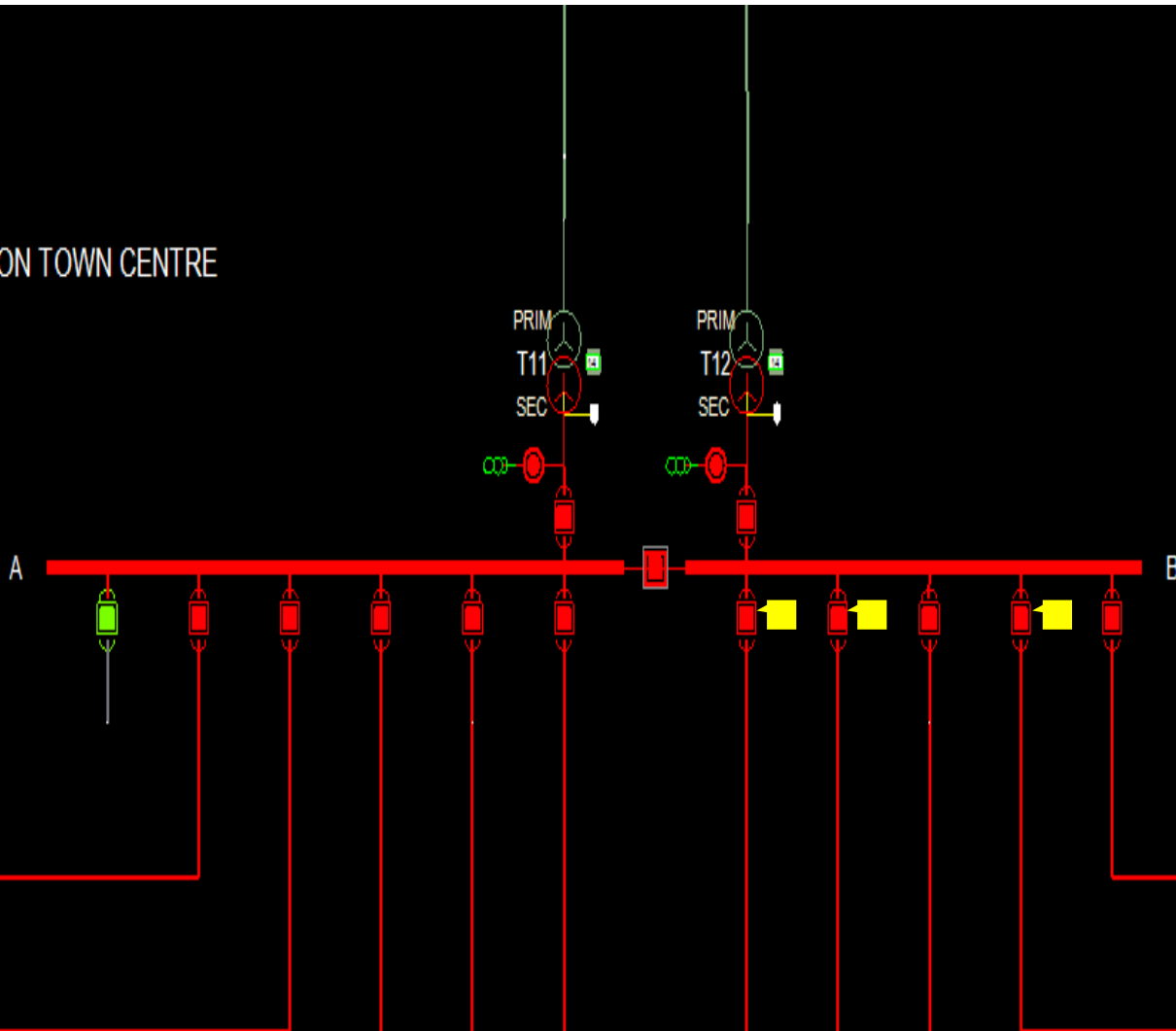
DISABLE

Enable or disable fault  
level mitigation technique  
signal issued to respective  
site

ENABLE



ATHERTON TOWN CENTRE  
205318





## Respond dashboard

Substation	FLAT Status	Active Profile	Respond Signal Status	Last Run	Messages
Bamber Bridge (400201)	On	BB1	Enabled FL mitigation Technique	05/05/2016 17:49	
Broadheath (100134)	On	BH1	Enabled FL mitigation Technique	05/05/2016 17:49	
Athletic St (400052)	On	AST1	Enabled FL mitigation Technique	05/05/2016 17:49	
Wigan (200421)	On	WIG1	Enabled FL mitigation Technique	05/05/2016 17:49	
Longridge (400416)	On	LON1	Enabled FL mitigation Technique	05/05/2016 17:49	
Hareholme (400092)	On	HAR1	Enabled FL mitigation Technique	05/05/2016 17:49	
Nelson (400044)	On	NEL1	Enabled FL mitigation Technique	05/05/2016 17:49	
Mount St (100622)	On	MST1	Enabled FL mitigation Technique	05/05/2016 17:49	
Offerton (302872)	On	OFF1	Enabled FL mitigation Technique	05/05/2016 17:49	
Atherton Town Centre (205318)	On	ATC1	Enabled FL mitigation Technique	05/05/2016 17:49	
Denton West (100111)	On	DWT1	Enabled FL mitigation Technique	05/05/2016 17:49	
Blackbull (400403)	On	BBL1	Enabled FL mitigation Technique	05/05/2016 17:49	
Irlam (100615)	On	IRL1	Enabled FL mitigation Technique	05/05/2016 17:49	
Littleborough (304884)	On	LIT1	Enabled FL mitigation Technique	05/05/2016 17:49	

Respond specific dashboard within NMS

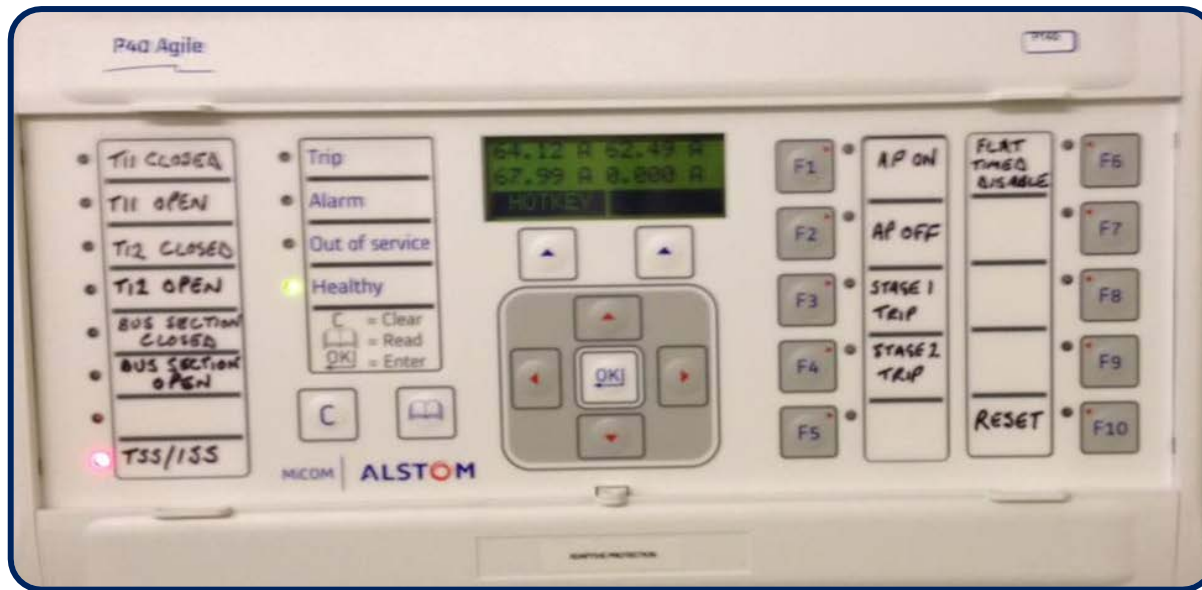
Locate each site from dashboard

FL report for each site following activation

Unique profile

Change FLAT status for individual sites or globally

# Adaptive protection at five sites



Network already designed to break fault current

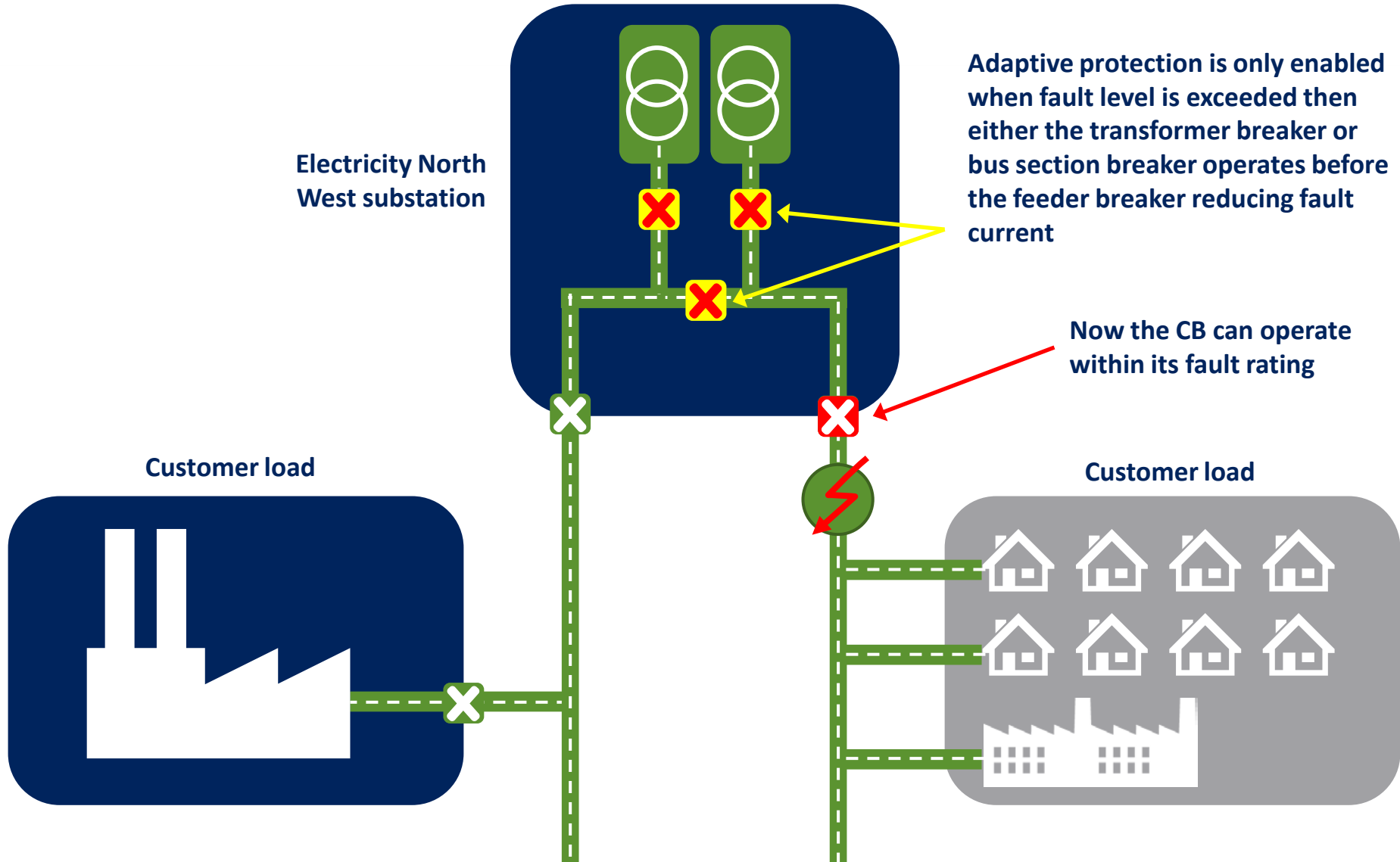


Adaptive protection changes the order in which circuit breakers operate to safely disconnect the fault



Using redundancy in the network ensures no other customers go off supply

# Adaptive Protection





# $I_S$ limiters – Two sites and five sensing sites



Operates within  
5 milliseconds or 1/200<sup>th</sup>  
of a second

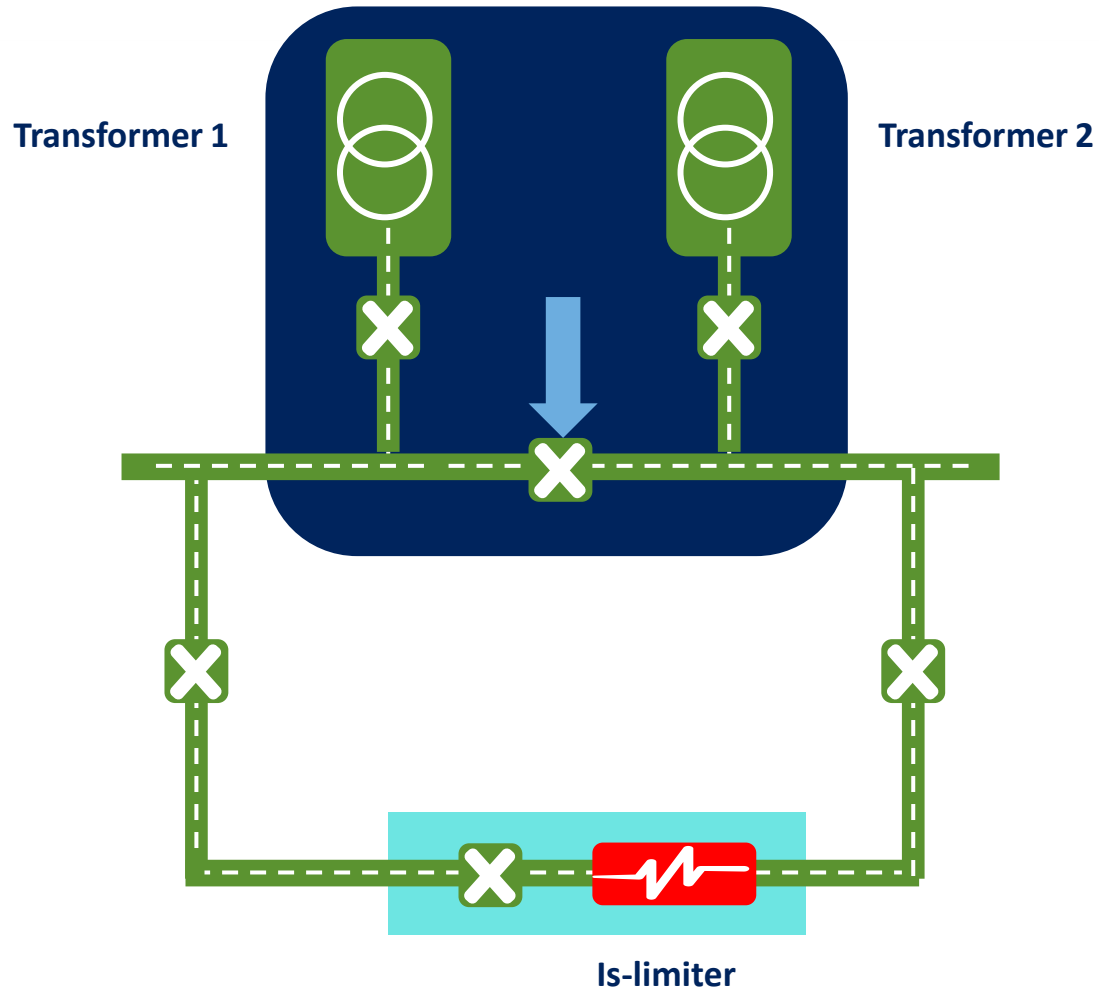


Detects rapid rise in  
current when a fault  
occurs and responds to  
break the current



Respond will prove the  
technology, review  
safety case and deploy at  
two sites

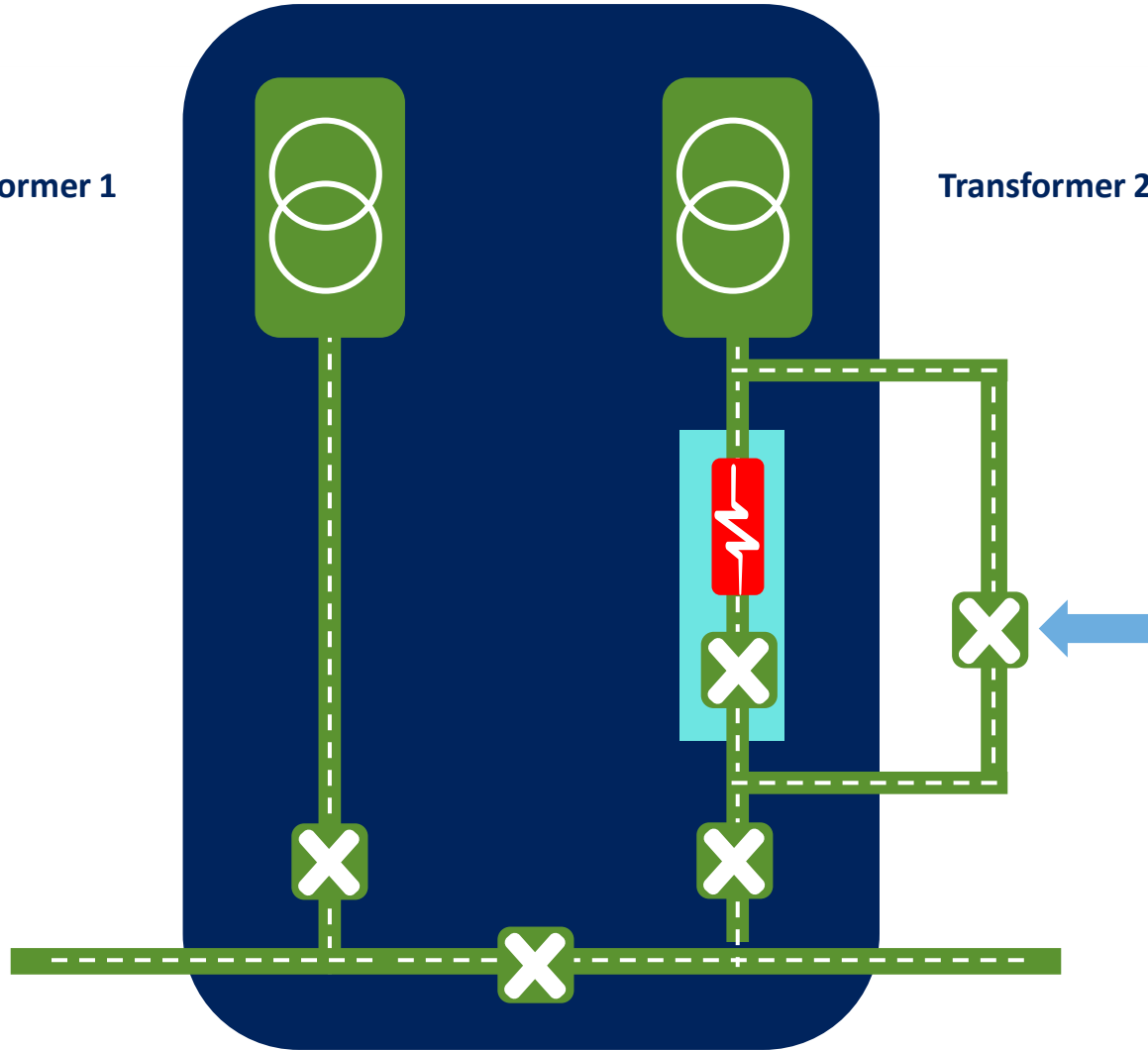
# $I_s$ -limiter – Bamber Bridge





Transformer 1

Transformer 2



# I<sub>s</sub>-limiter sites



# $I_s$ -limiter



# $I_s$ sensing unit



# Asset health monitoring



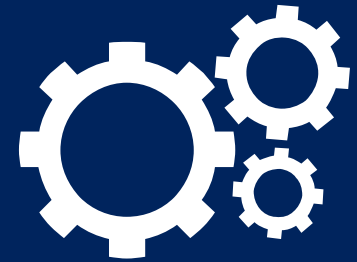


To reduce fault level we need to disconnect sources of fault current



Generator

Motor



Designed for generation of electricity

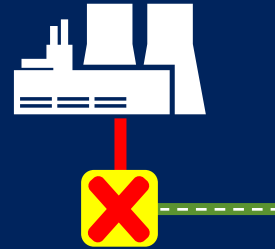
If spinning when a fault occurs, momentum of motor and magnetic field cause electricity to flow towards the fault

- Every source will contribute to the fault current ●
  - Larger sources will contribute more ●
- Generators will contribute more than similar rated motors ●



# Fault Current Limiting (FCL) service

## Two UU sites and three external sites



Fault current generated by customers can be disconnected using new technology



Financial benefits to customers taking part and long term to all customers

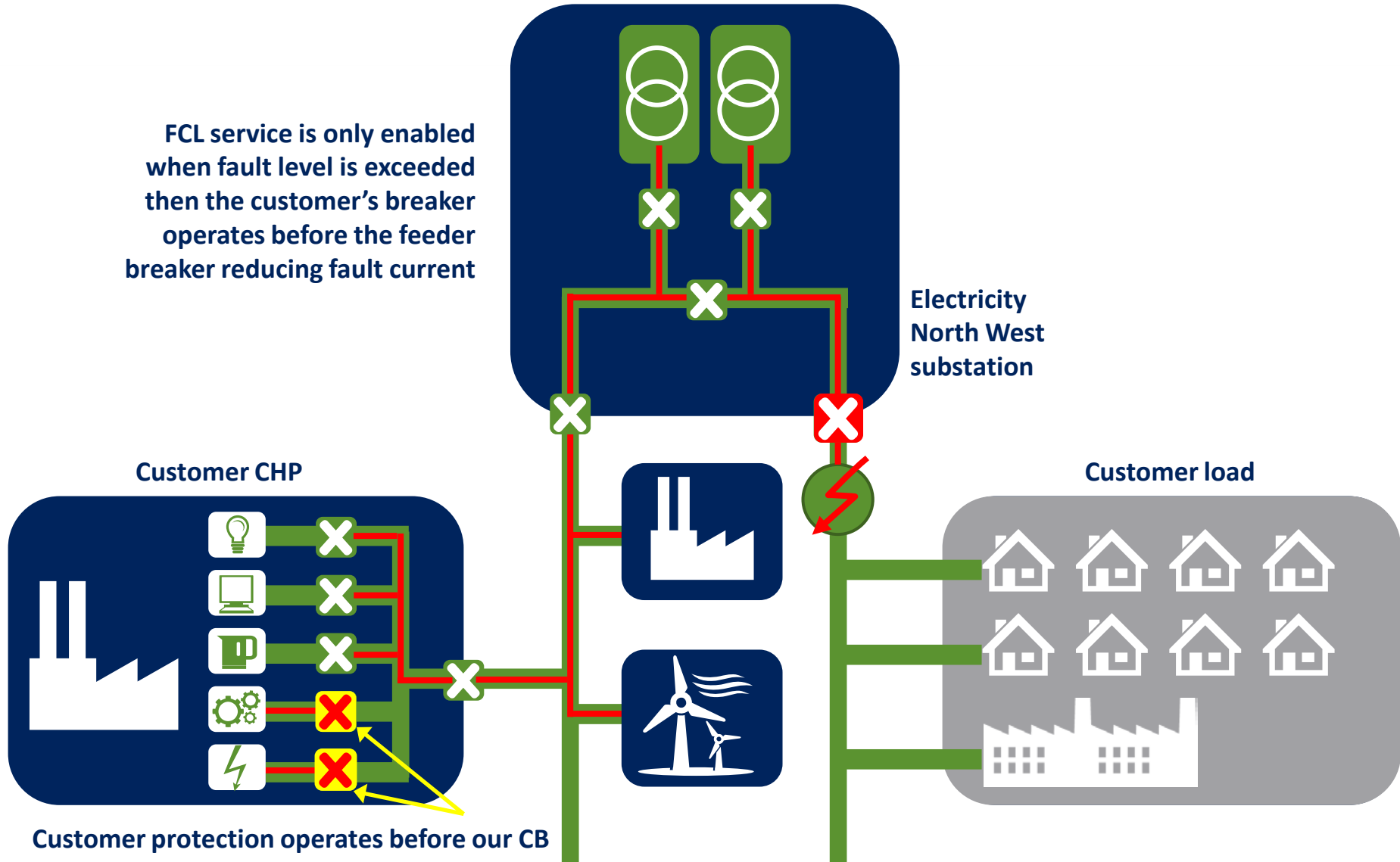


Challenge is to identify customers to take part in a trial of the FCL service

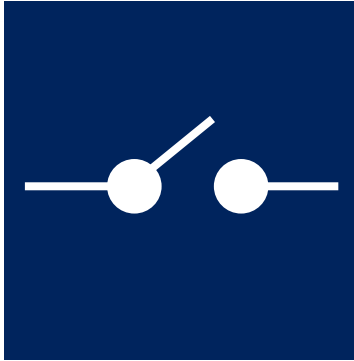
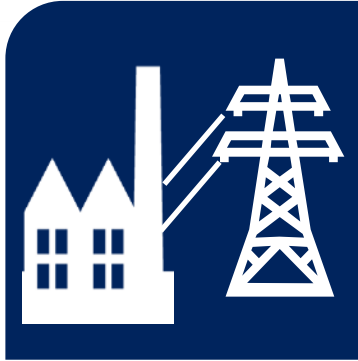
# Fault Current Limiting service



FCL service is only enabled when fault level is exceeded then the customer's breaker operates before the feeder breaker reducing fault current



Customer protection operates before our CB



Do customers have equipment that can contribute to fault current?

Are customers willing for equipment to be disconnected if required?

What commercial arrangements need to be in place?

What technical arrangements need to be in place?

Is there a long-term benefit to all GB customers?  
What is the scale of the benefit?



*“The Method enables a market for the provision of an FCL service”*

Engaged customer panel



Formulate engagement materials



**Completed**

Customer survey (Pre-trial)

Establish appeal of the commercial proposition



**Completed**

Customer survey Completed



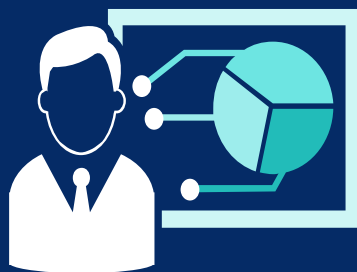
Qualify customer experience



**Completed**



Electricity North West provided customer data (1,639 in total)



Data screened to ensure organisation met key criteria to provide an FCL service



A suitable individual was identified and emailed the survey (303 in total)



103 interviews completed

103 I&C demand and DG customers across GB participated in the customer survey during October 2015 to February 2016



The customer survey assessed appetite to engage in an FCL service contract, and at what price



## Background

Industry classification

Largest single AC rotating machine

Implications of the equipment being constrained



## Introduction to FCL service

Video, analogy, FAQ document and concept board

Perceptions, appeal, likelihood to consider take-up of the FCL service, drivers and barriers



## Stated preference exercise

Customers selected a preferred option from a pair of possible FCL service contract scenarios (x12)

Optimum price point, payment method and contract length derived



**43%**

**Essential** to have electricity  
available **24/7**



**25%**

10 minute constraint  
**significant impact**



**24%**

10 minute constraint  
**no significant impact**





Initial analysis **proves** the hypothesis that the **Respond method enables a market for an FCL service**

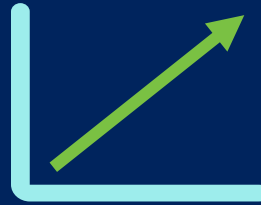


A target market has been identified of customers from **non-manufacturing industries** and those who are **able to constrain their motor or generator** without significant impact for up to 10 minutes





Deployed the FLAT and the three techniques



Trial ongoing for next two years with three successful operations of the techniques so far



Examining the key questions and hypothesis



Customer recruitment phase for FCL Service



Build safety cases for each of the techniques



What is the relative benefits versus financials for the fault level mitigation solutions



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