RESPOND

Learning event

17 May 2016

LCN Fund
Low Carbon Networks

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RESPOND

Paul Turner

Delivery Manager

Background

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Housekeeping

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Agenda

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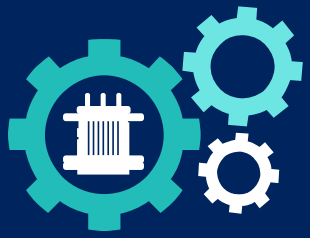
LCN Fund Low Carbon Networks	RESPOND		
Introduction 10:00 – 10:15	Project overview 10:15 – 10:30	Respond techniques 10:30 – 11:00	Trials & analysis 11:00 – 11:15
			
Break 11:15 – 11:30	Customer 11:30 – 12:20	Next steps and Q&A 12:20 – 12:30	Lunch 12:30 – 1:00

Introducing Electricity North West

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4.9 million

2.4 million

25 terawatt hours

£12 billion of network assets

56 000 km of network ● 96 bulk supply substations
363 primary substations ● 33 000 transformers

Our innovation strategy

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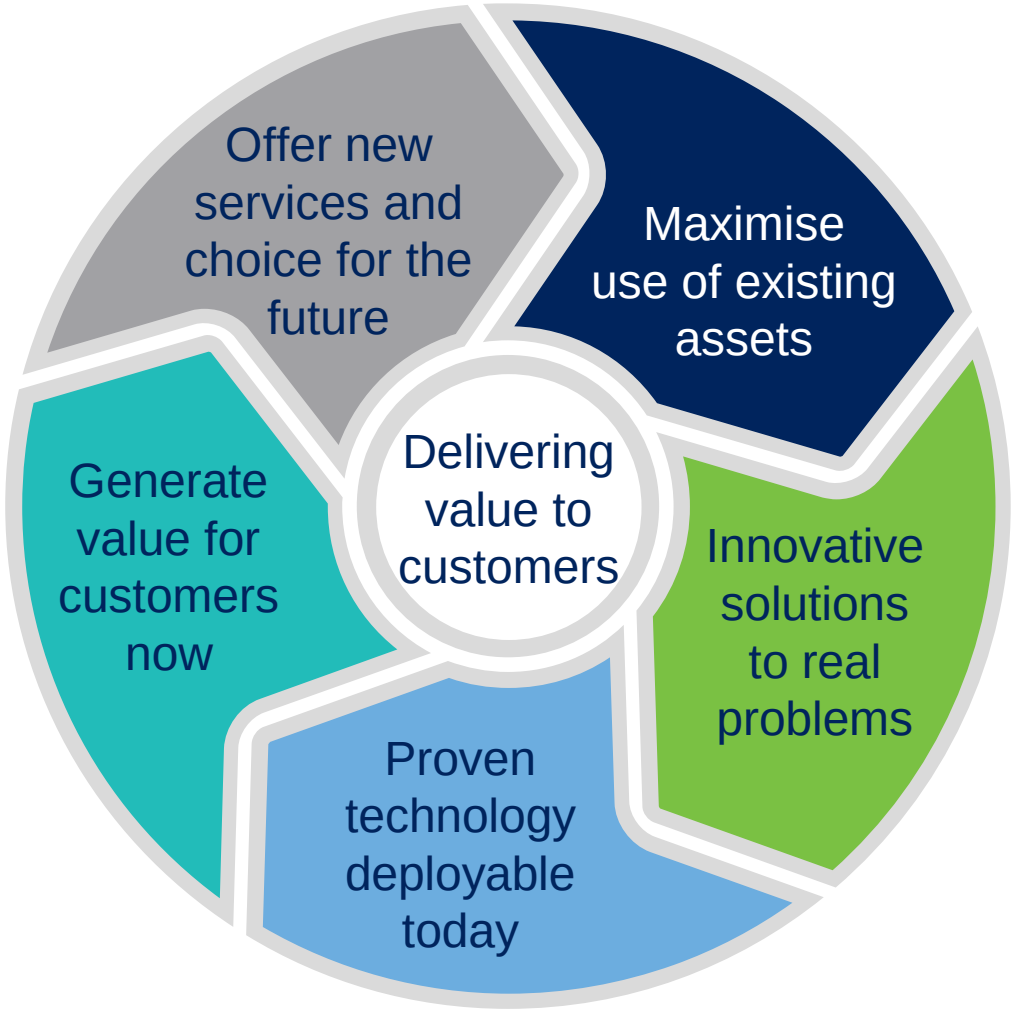

Our smart grid development

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Leading work on developing smart solutions

Deliver value from existing assets

Customer choice

LCN Fund Low Carbon Networks — Five flagship products (second tier/NIC) £42 million

C2C

SMART STREET

Celsius

CLASS

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Paul Marshall
Project Manager

Respond Overview

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What is fault current/fault level?

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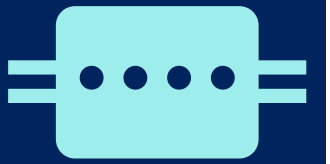
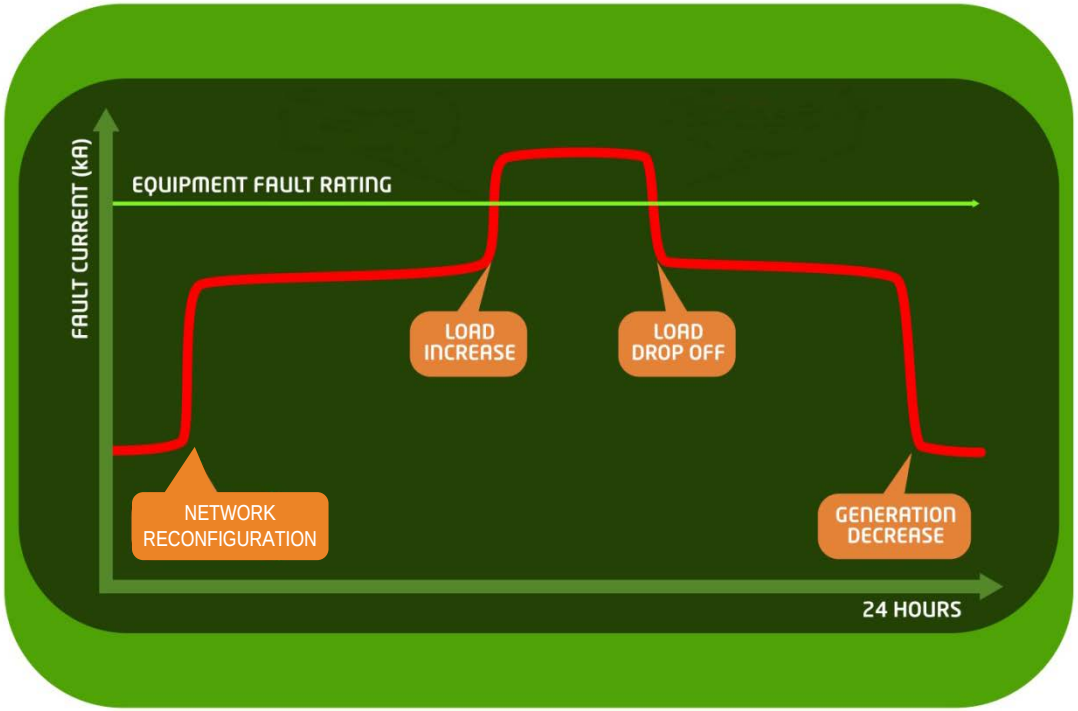
				
Our network is designed to handle normal current 24/7	Protected by fuses, switches and circuit breakers in key locations	These devices detect the fault current and disconnect the fault from the rest of the network	Fault current varies depending on type of fault, location, network configuration and generation 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.

Fluctuating fault level

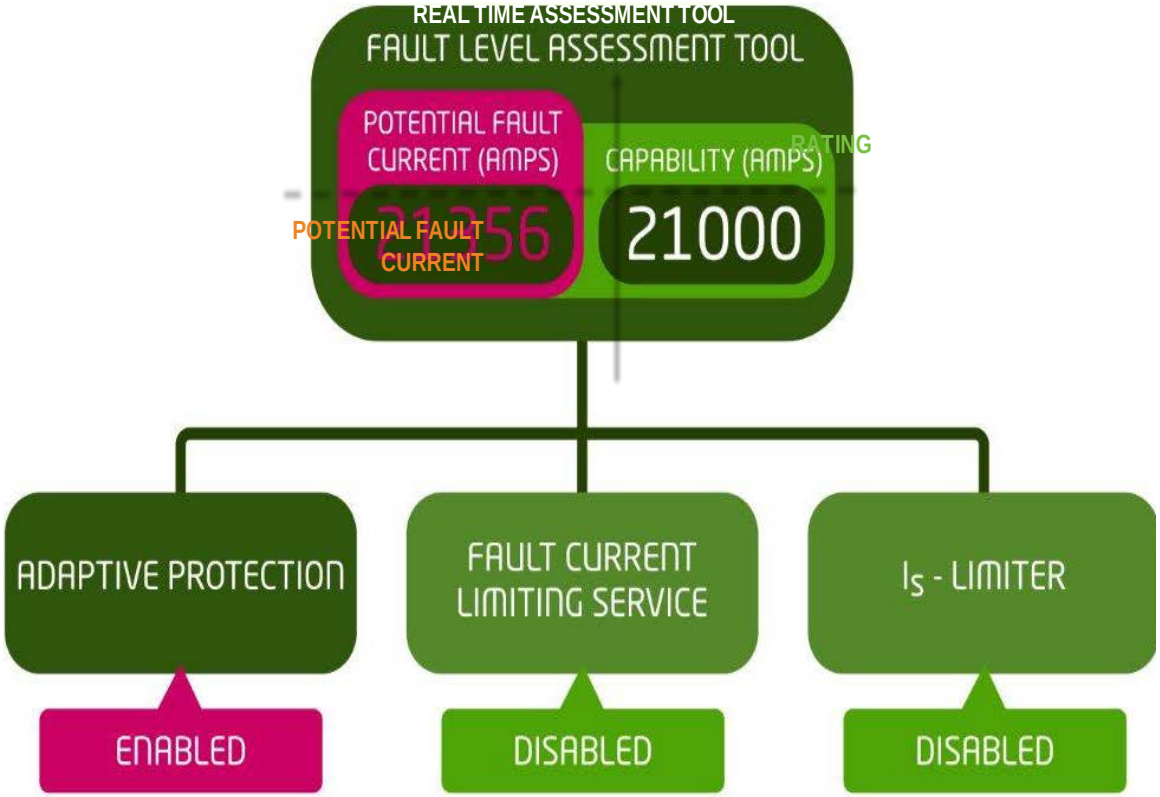


Fault level reinforcement is disruptive, lengthy and expensive which can discourage connection of new demand/generation

How can we manage these issues without expensive reinforcement ?

Respond

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



Respond overview

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Low Carbon Networks

Competitive competition

Funded by GB customers

Learning, dissemination & governance

Fourth of our five successful Tier 2 / NIC projects

Investment

£5.5 million

Project Starts **Jan 2015**	Site selection **May 2015**	Design **Nov 2015**	System installation & Go Live **May 2016**	Post fault analysis **Apr 2018**	Purchase FCL customer **Apr 2018**	Safety case **Sep 2018**	Closedown **Oct 2018**

Project partners

KELVATEK
WSP | PARSONS BRINCKERHOFF
ENER-G
ABB
Impact Research
United Utilities
ade

Financial benefits

Up to £2.3bn to GB by 2050

What Respond will prove and deliver

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Innovation themes	Affordable reliability	Customer service	Sustainability
Hypothesis	Respond is faster and cheaper to apply than traditional reinforcement	Respond facilitates the active management of fault current using retrofit technologies and commercial services	Respond uses existing assets with no detriment to asset health
	Respond will deliver a buy order of fault level mitigation solutions based on a cost benefit analysis	Respond enables a market for the provision of an FCL service	Respond reduces bills to all customers
Learning delivered	Proof of customer willingness, contractual requirements and price for FCL service	Specification, installation and application methodologies for each fault mitigation techniques. Functional specification, configuration and interface arrangements for Fault Level Assessment Tool	Revised fault level network design, planning and operational EPDs and CoPs
	How to actively manage distribution networks for fault level mitigation		Asset health study delivering updated health indices for circuit breakers and transformers
	Safety case for each fault level mitigation technique	Respond carbon impact assessment	Respond cost benefit analysis

● Transferable learning ● Regulatory changes ● New network design documents

Electricity North West delivery team

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Project Direction	Project Delivery					
						
Head of Engineering Steve Cox	**Innovation Team Delivery Manager** Paul Turner	**Project Manager** Paul Marshall	**Project Management Office** Andrew Howard **Project Office** Lucy Eyquem Jayne Ferguson	**Technology Workstream Lead** Steve Stott **Team** Roger Sumner	**Trials & Analysis Workstream Lead** Kieran Bailey	**Customer Workstream Lead** Kate Quigley **Team** Tracy Kennelly

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Steve Stott
Innovation Engineer
Respond Techniques

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Real time mitigation techniques

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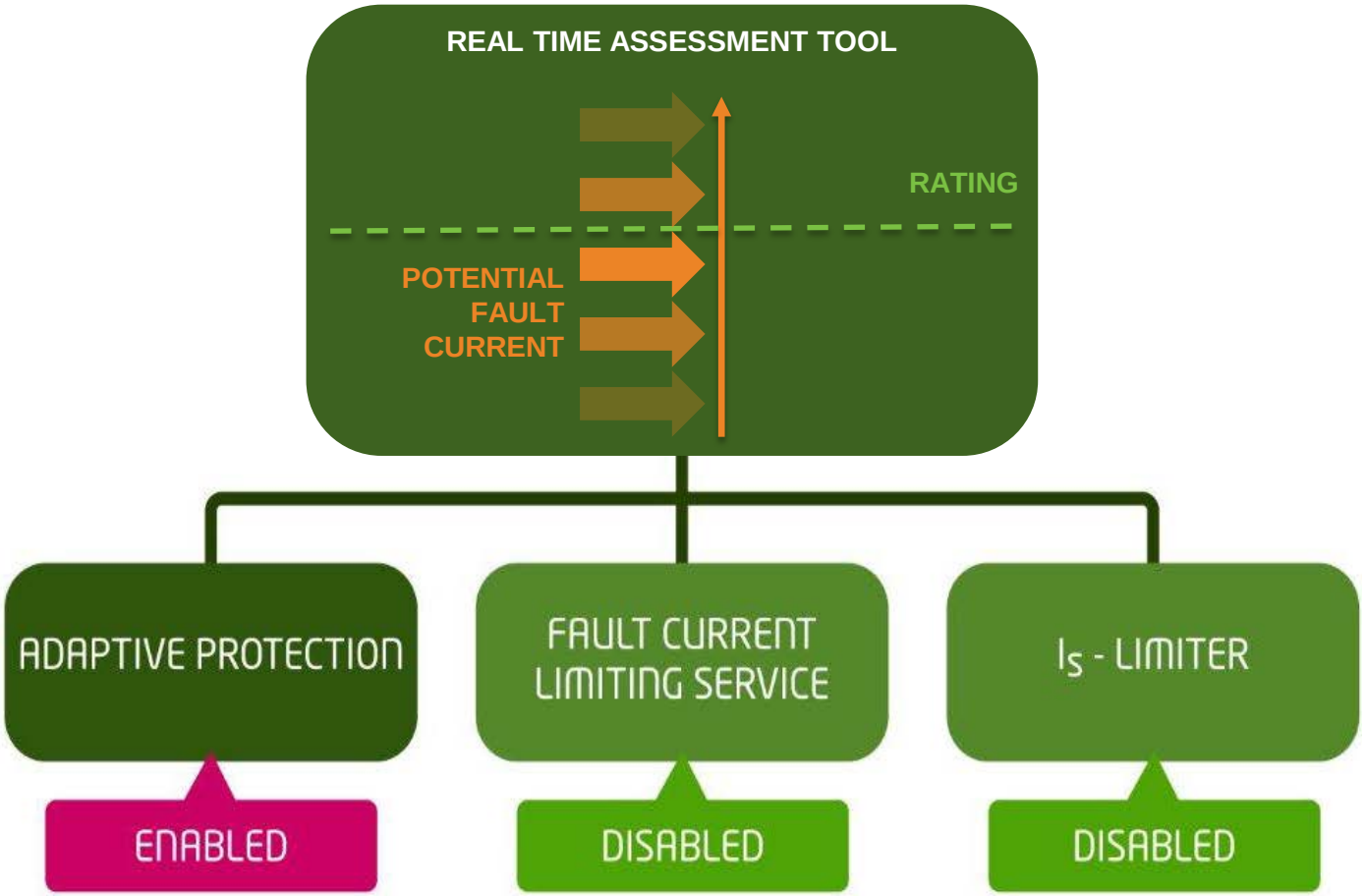

● Real time fault current assessment ● Safe network operation ●

Adaptive protection
Five at 11kV sites & two at 33kV sites

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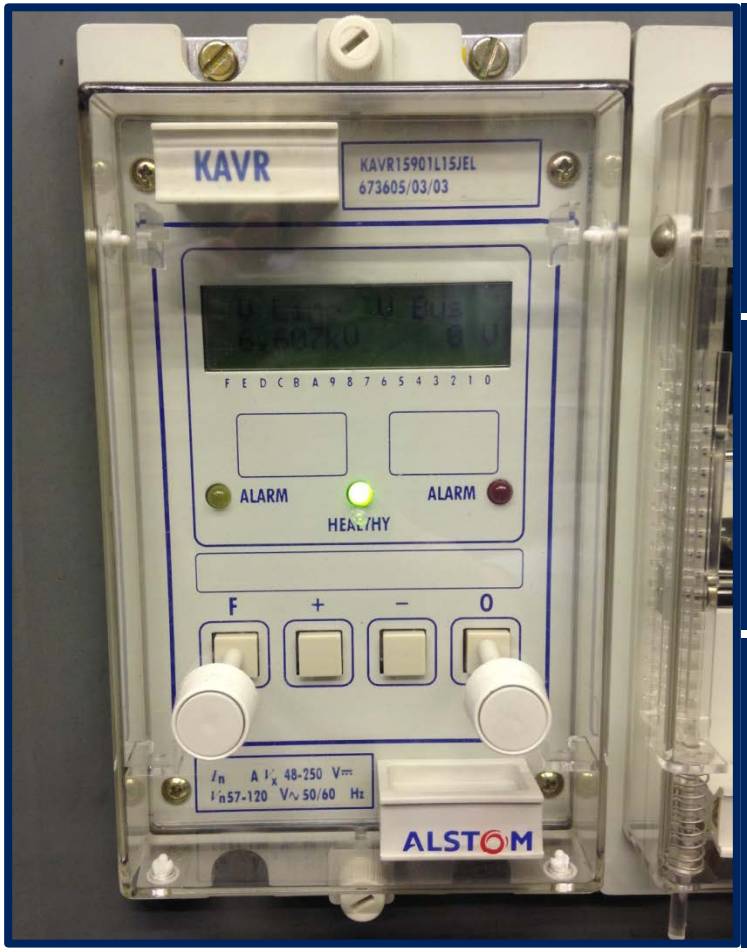
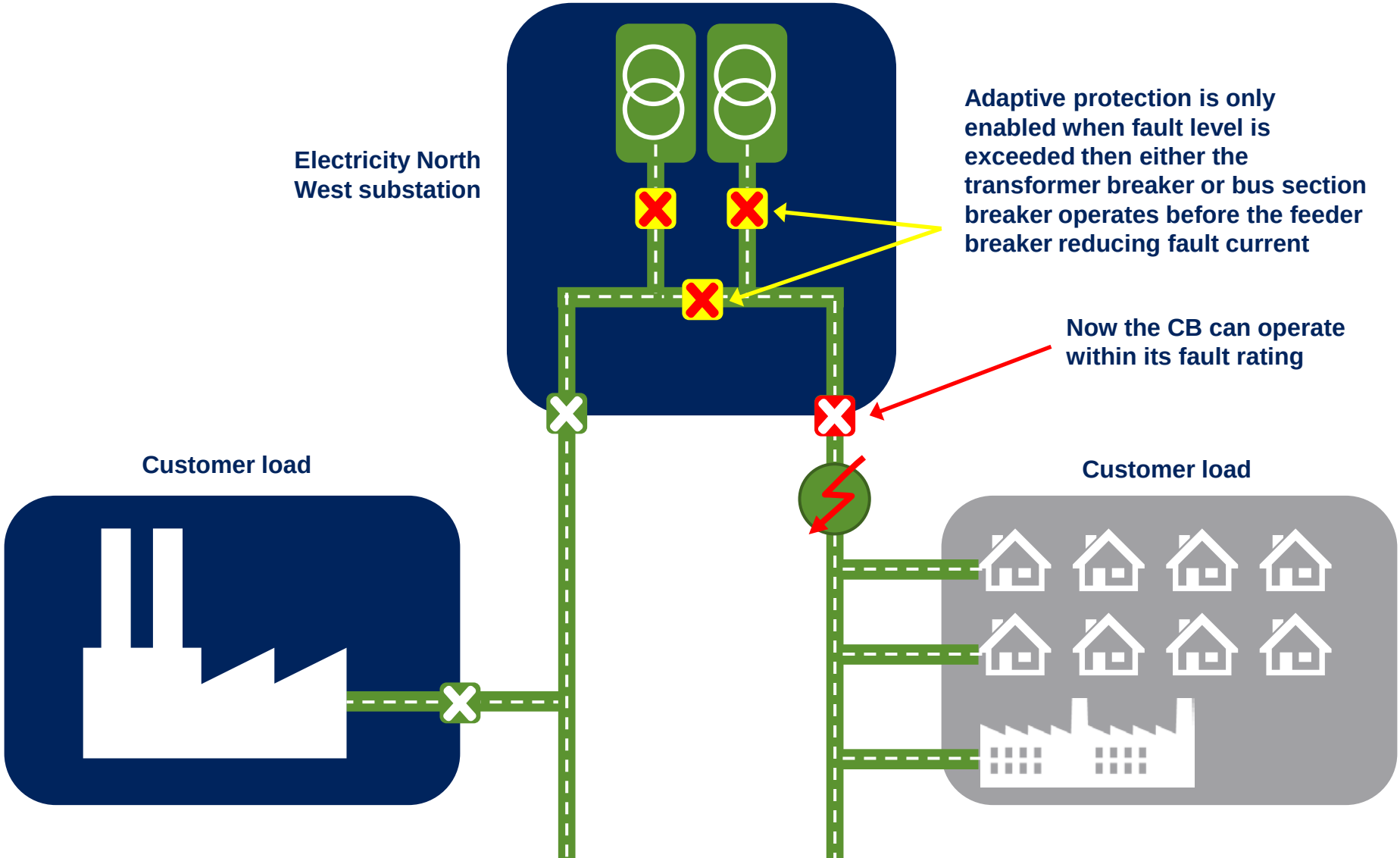


Network already designed to break fault current

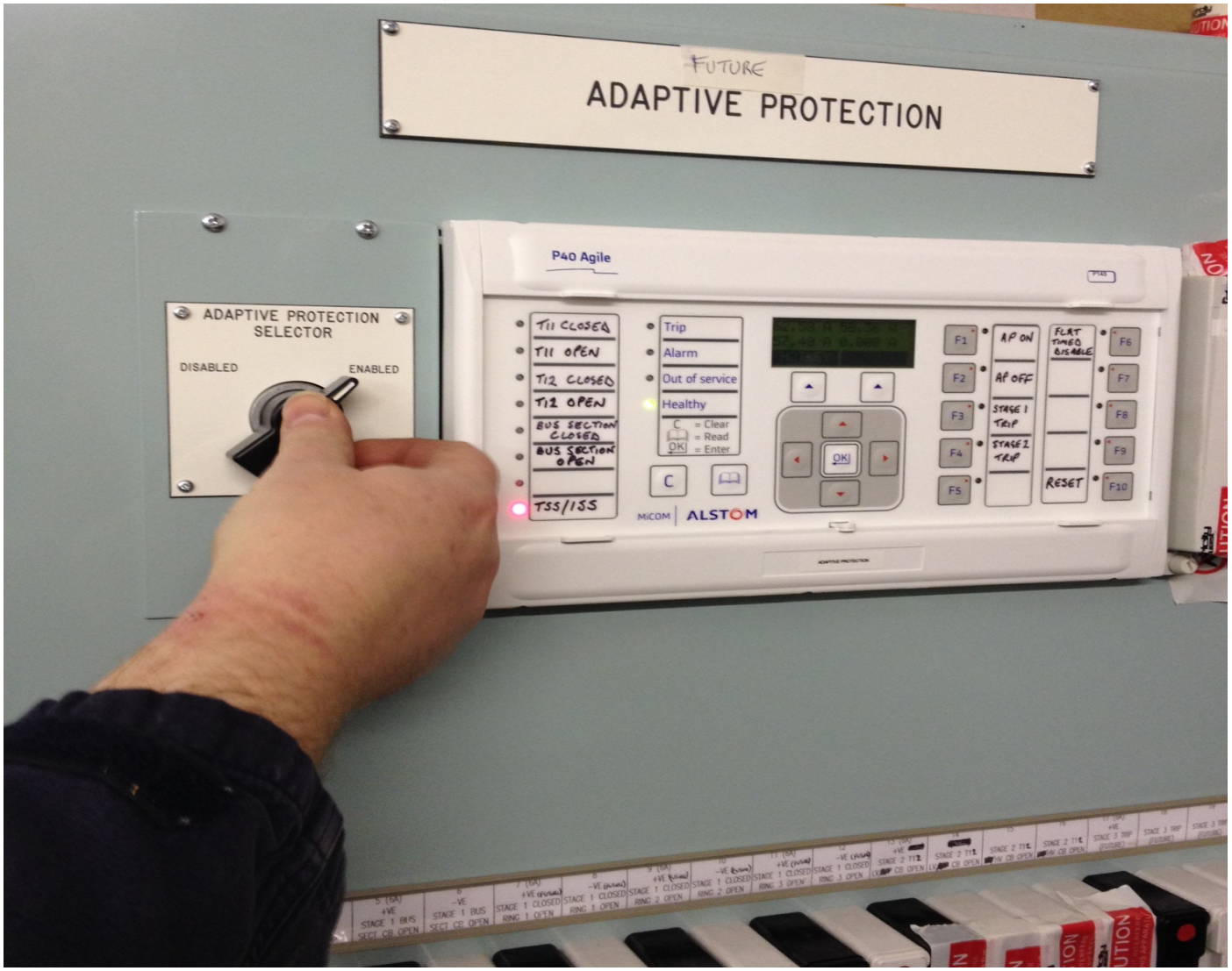
Adaptive protection changes the order in which circuit breakers operate to safely disconnect the fault

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

Adaptive protection



Adaptive Protection relay wall box



Adaptive Protection P40 agile relay

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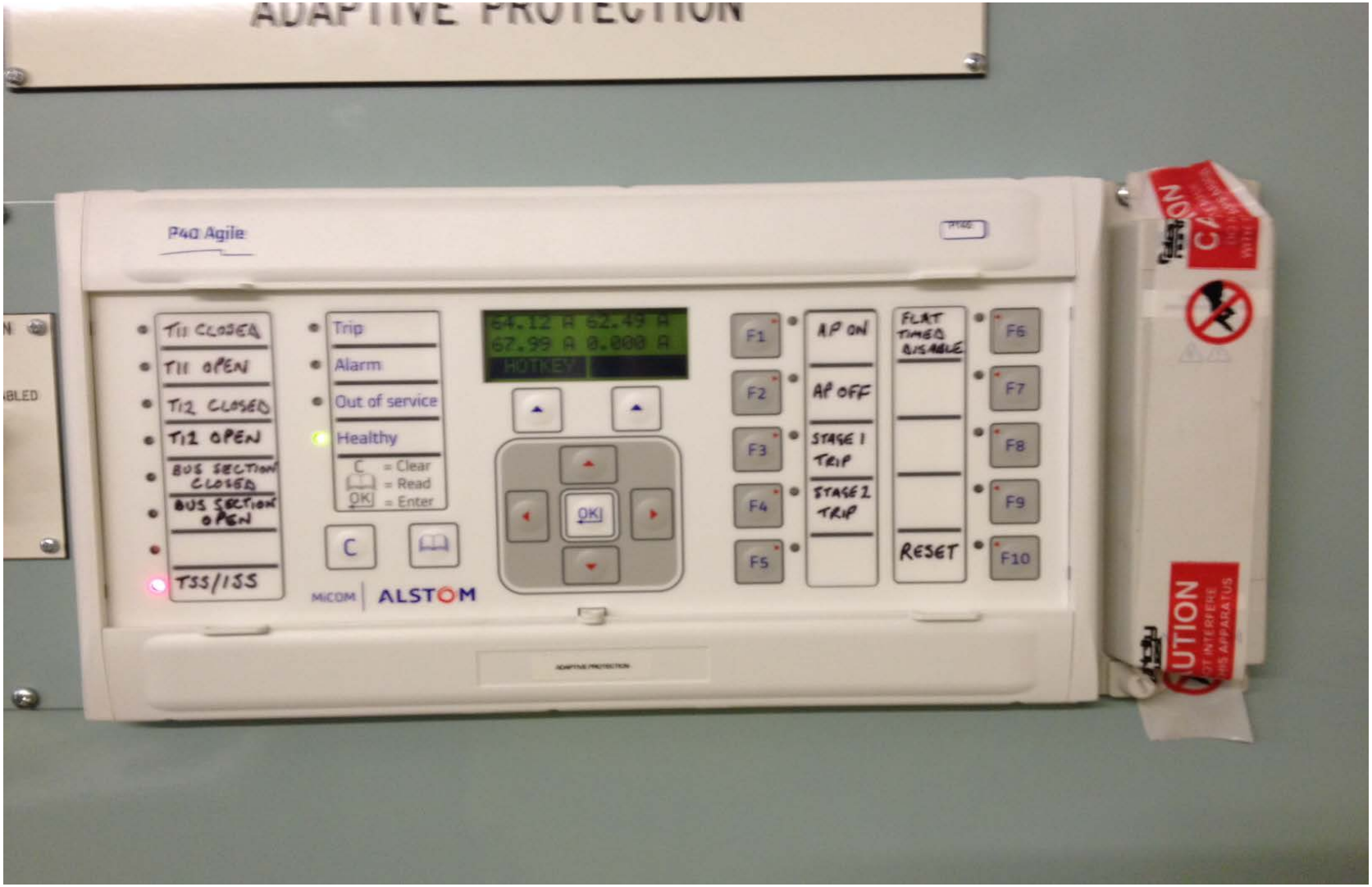

Denton West AP site pre-installation

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Denton West – 6.6kV B/S CB profiling

Profiler off-line timing connections

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Ultra TEV monitoring at Denton West

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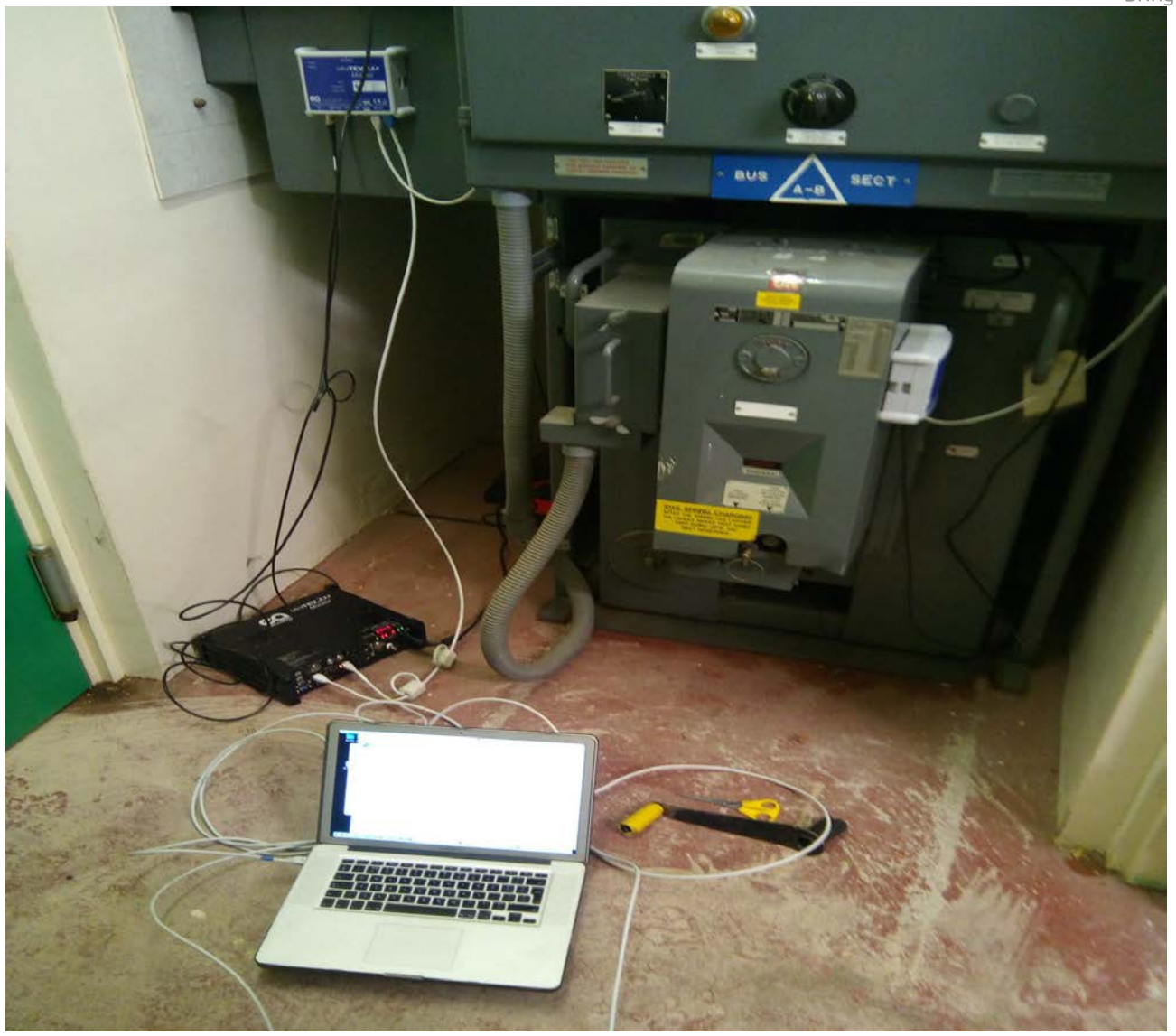

I_S limiters – Two sites and five sensing sites

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Operates within 5 milliseconds or 1/200th 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

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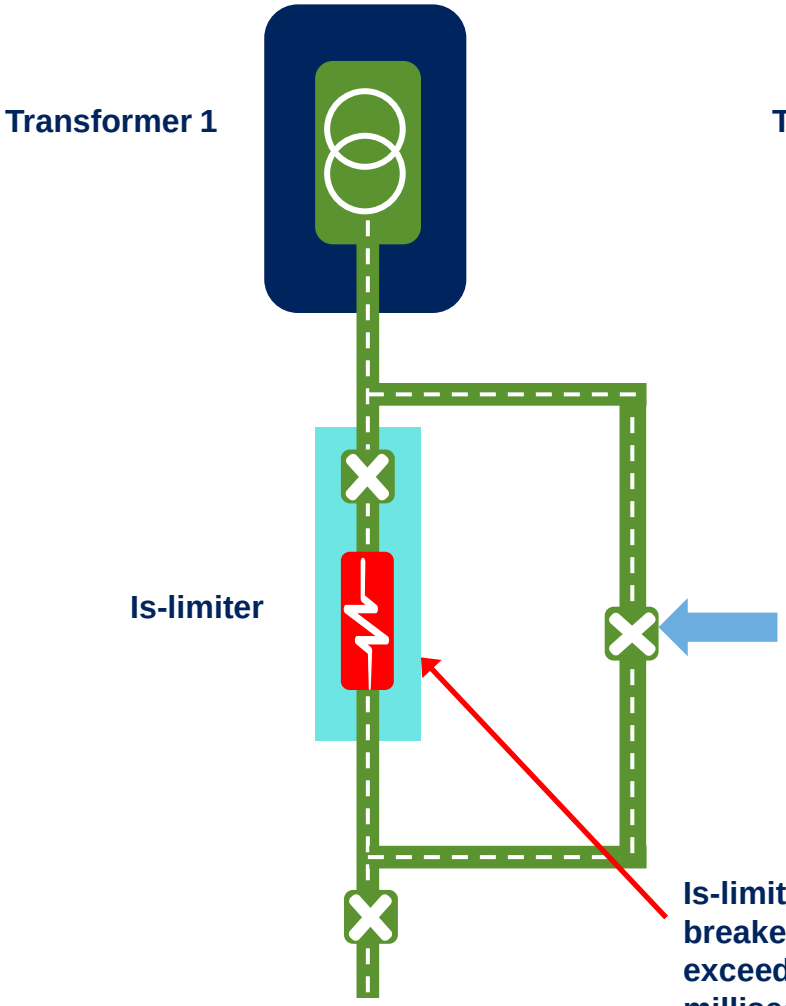
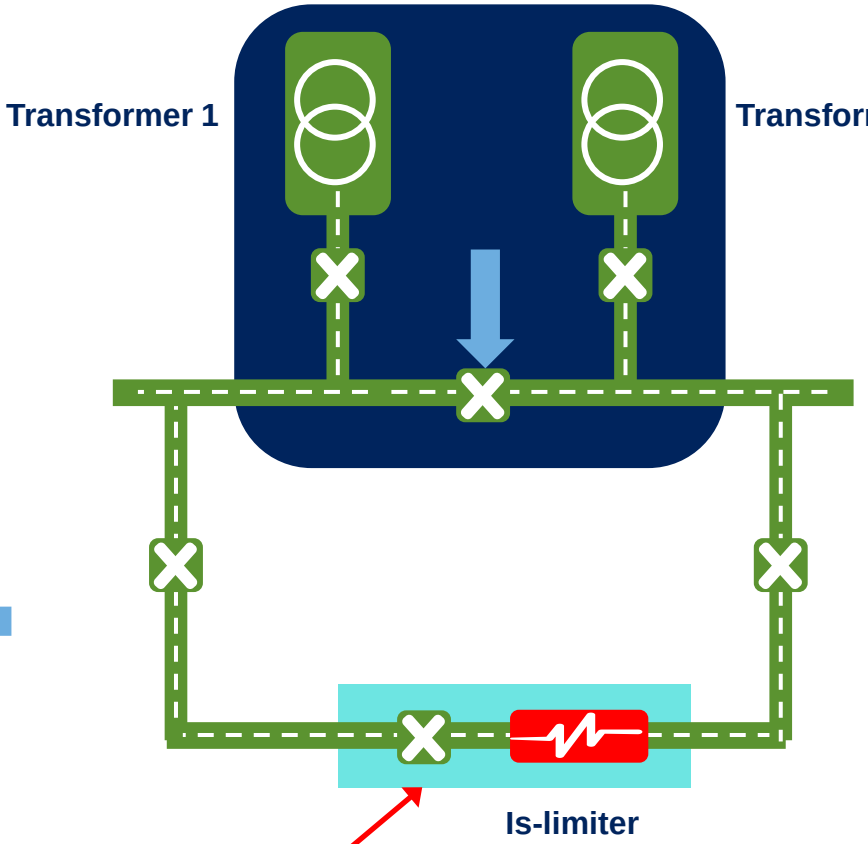
Broadheath



Bamber Bridge



Is-limiter acts like the bus section breaker or transformer breaker and is only enabled when fault level has been exceeded and then in the event of a fault operates in 2-3 milliseconds reducing fault current

I_S -limiter


ABB
UniGear
INTERCONNECTOR


ABB
UniGear
INCOMING FEEDER
OUTGOING FEEDER

Fault Current Limiting service

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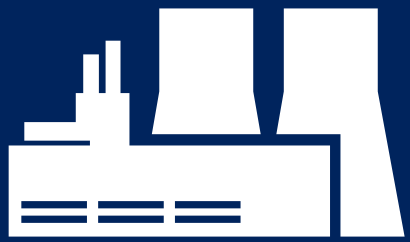
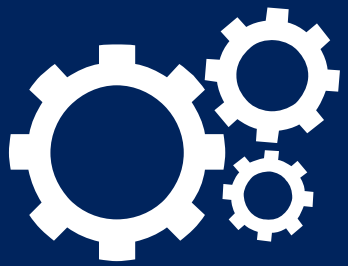
To reduce fault level we need to disconnect sources of fault current



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 & three external sites

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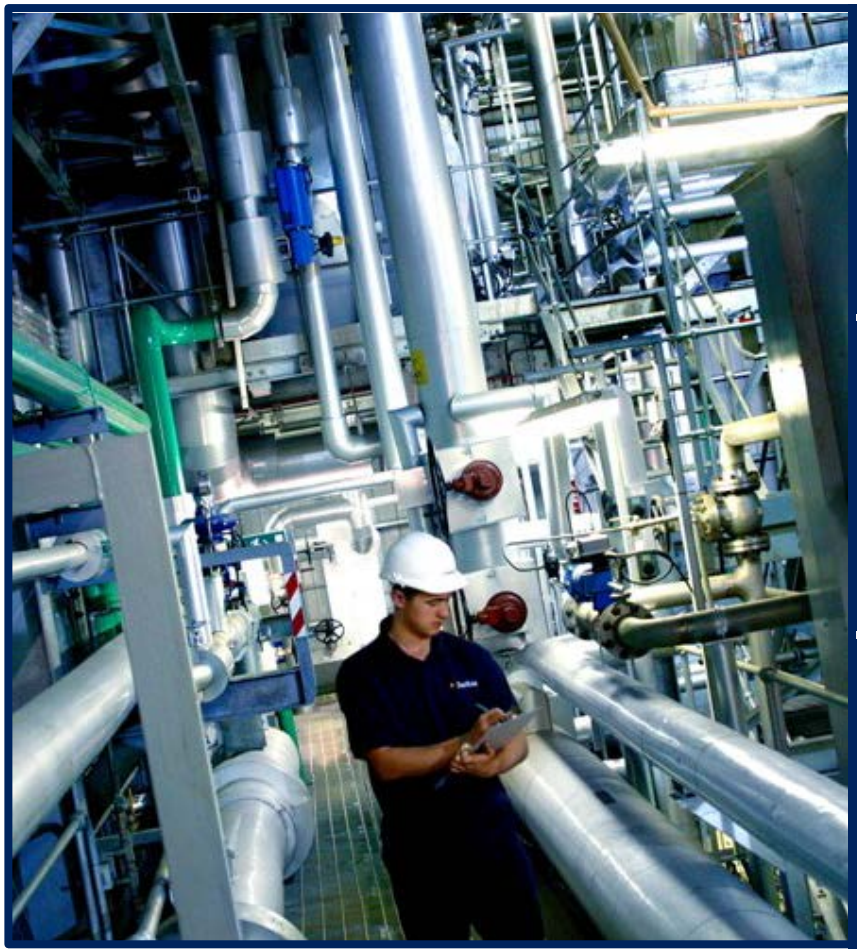
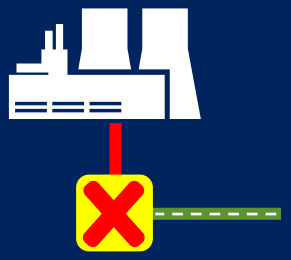




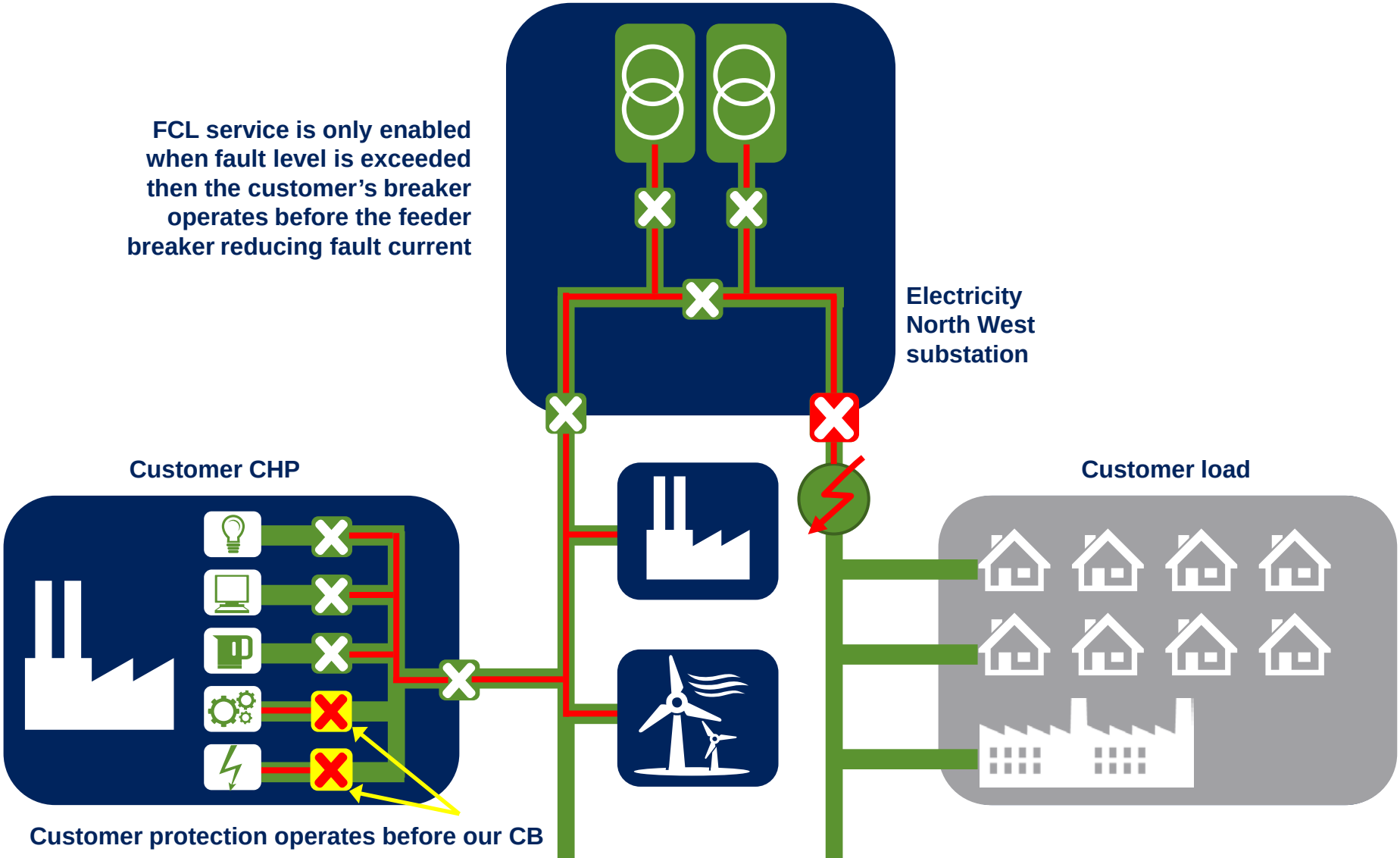
Fault current generated by customers can be disconnected using new technology

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



FCL service – customer proposition

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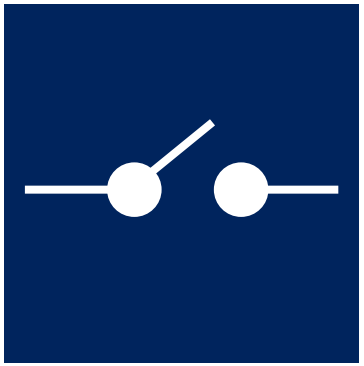
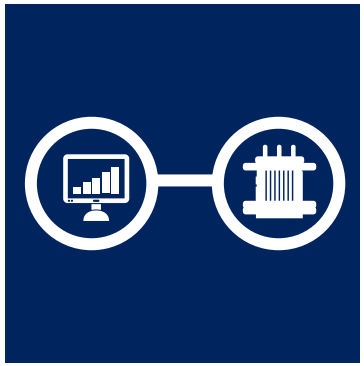
Do customers have equipment that can contribute to fault current?



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?

Respond sites

Substation	Worst performer feeder ranking	Number of faults in 2012/2013	Faults outside fault level	Technology to be deployed
Bamber Bridge	315	7	2.1	HV Is-limiter - bus section - 1
Broadheath	401	10	3	HV Is-limiter - Incomer - 2
Athletic St	294	28	8.4	EHV Is sensing equipment - 1
Wigan BSP	145	20	6	EHV Is sensing equipment - 2
Longridge	135	36	10.8	HV Is sensing equipment - 1
Hareholme	257	20	6	HV Is sensing equipment - 2
Nelson	131	17	5.1	HV Is sensing equipment - 3
Mount St	223	10	3	EHV adaptive protection - 1
Offerton	719		0	EHV adaptive protection - 2
Atherton Town Centre	7	29	8.7	HV adaptive protection - 1
Denton West				HV adaptive protection - 2
Blackbull	303	17	5.1	HV adaptive protection - 3
Irlam	275	7	2.1	HV adaptive protection - 4
Littleborough	336	13	3.9	HV adaptive protection - 5

Trial period – May 2016 to April 2018

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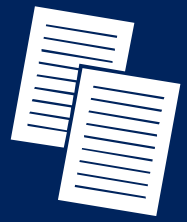
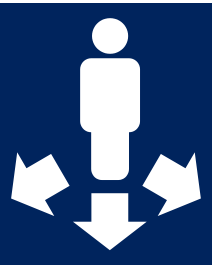
How accurate is the FLAT tool ?

Do the mitigation techniques work?

Fault	Analysis	Findings	Actions ?
			
Respond networks monitored for all faults System snapshot at every fault	Fault current experienced calculated Actual operation assessed	What fault current flowed? Did mitigation operate correctly?	Data availability Data quality Settings Performance

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Kieran Bailey
Trials & Analysis
Workstream Lead
Trials & Analysis

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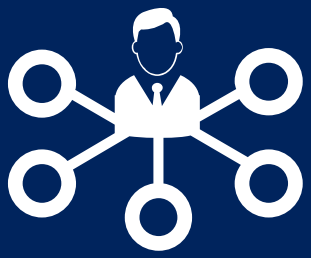
Trials and analysis workstream

Scope	Team	Dependency
		
Tool built into the new Electricity North West network management system (NMS) Calibration against IPSA models and on site fault level monitoring Post fault analysis and monitoring during trial period May 2016 to April 2018	Trials and Analysis lead Electricity North West IT team Schneider PB (TNEI) (Outram)	Electricity North West NMS replacement project Initiation of alternative response

Fault Level Assessment Tool

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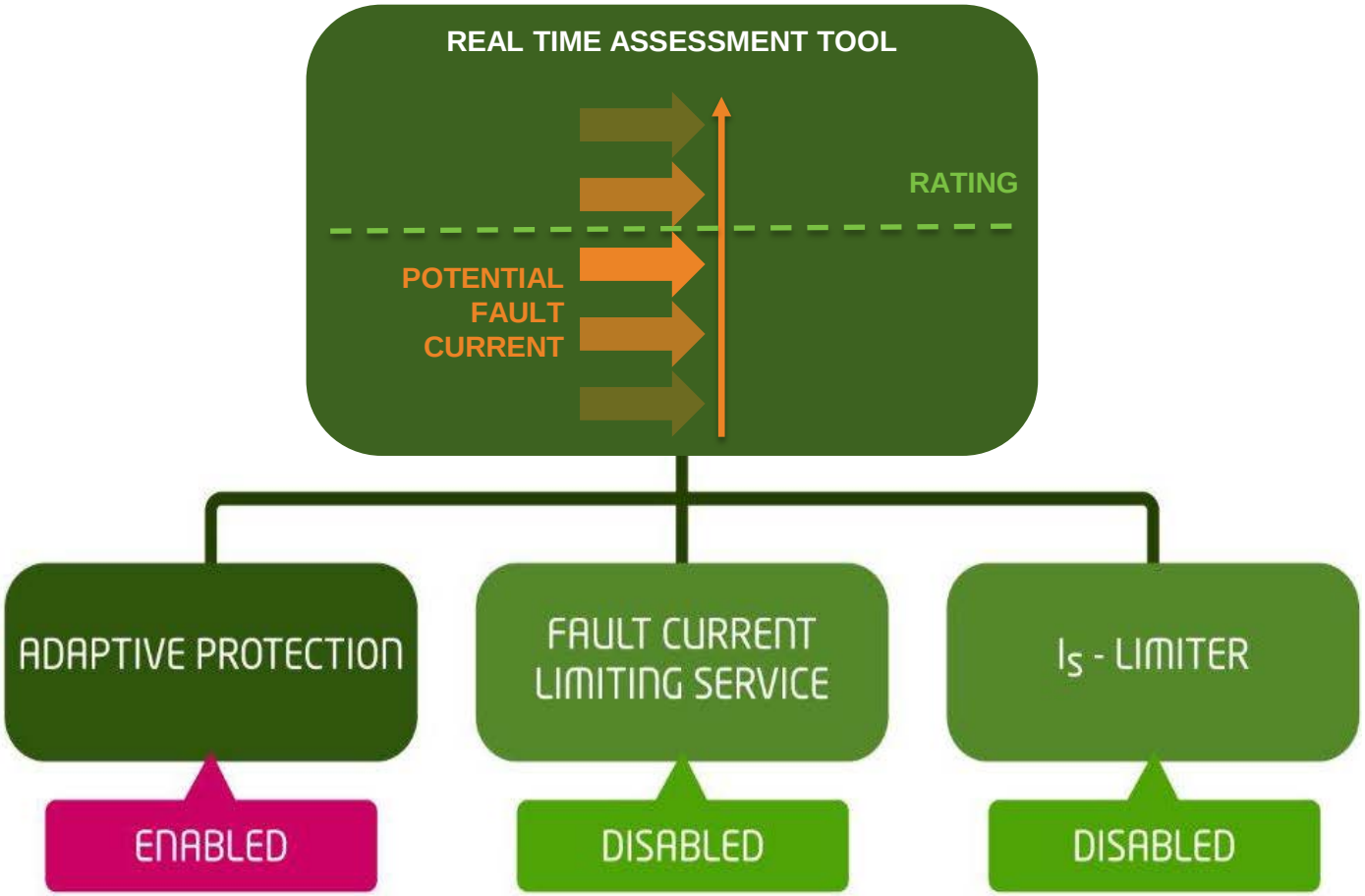
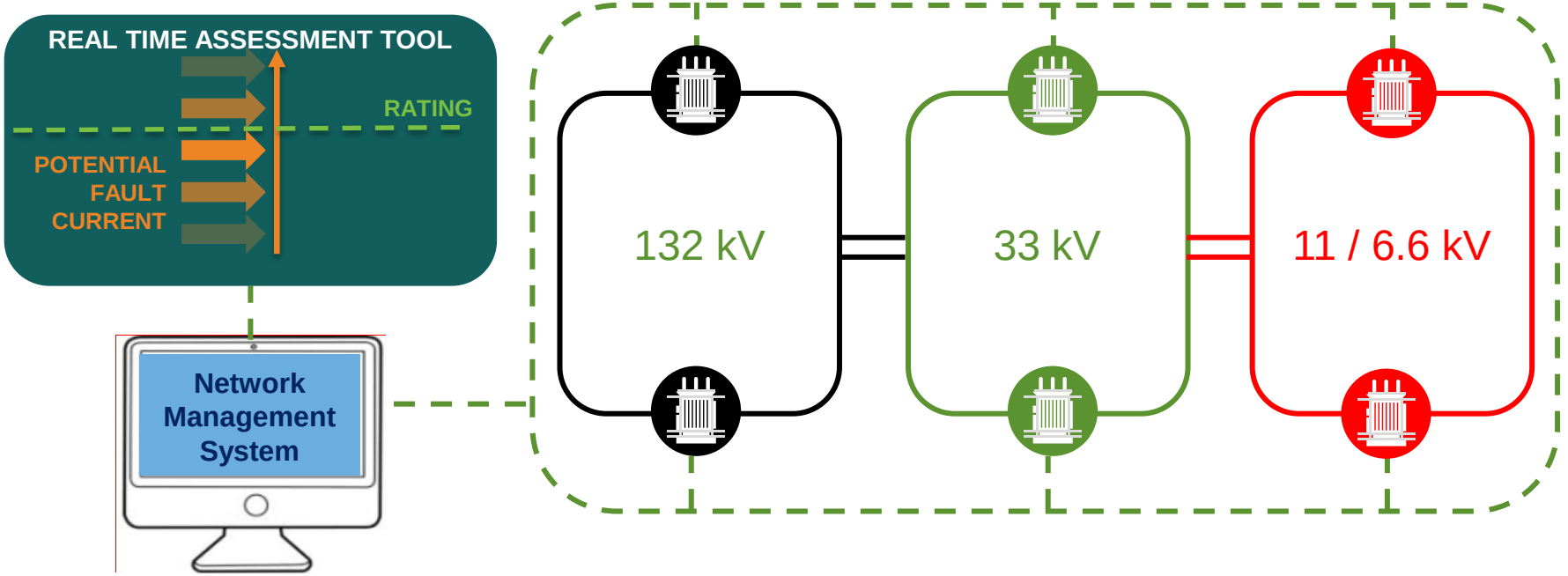


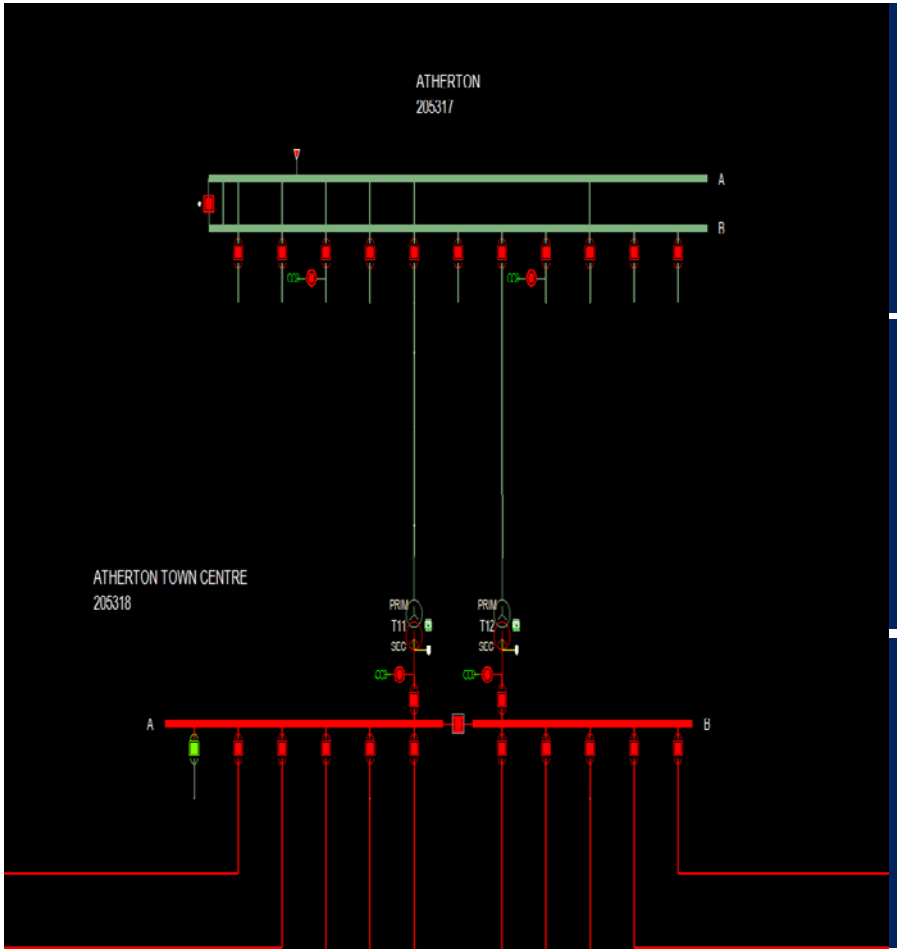
● Real time fault current assessment ● Safe network operation ●

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

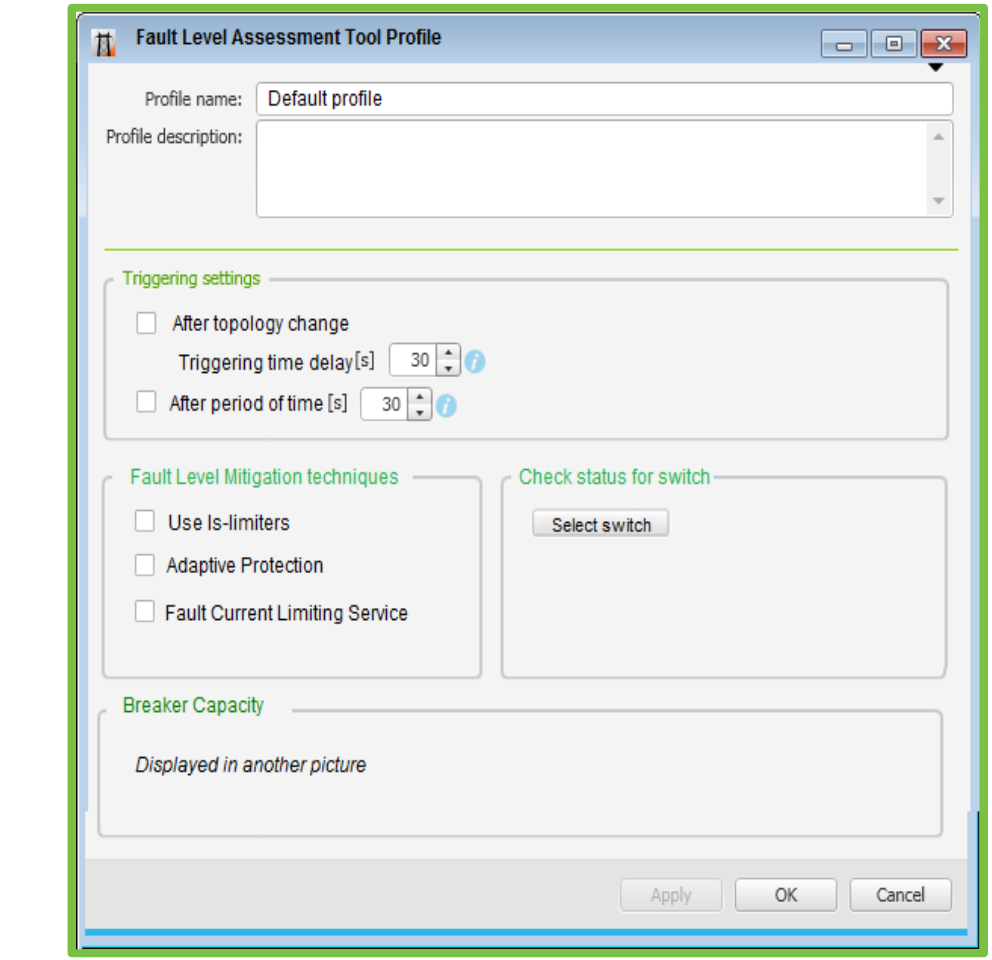
IEC606909

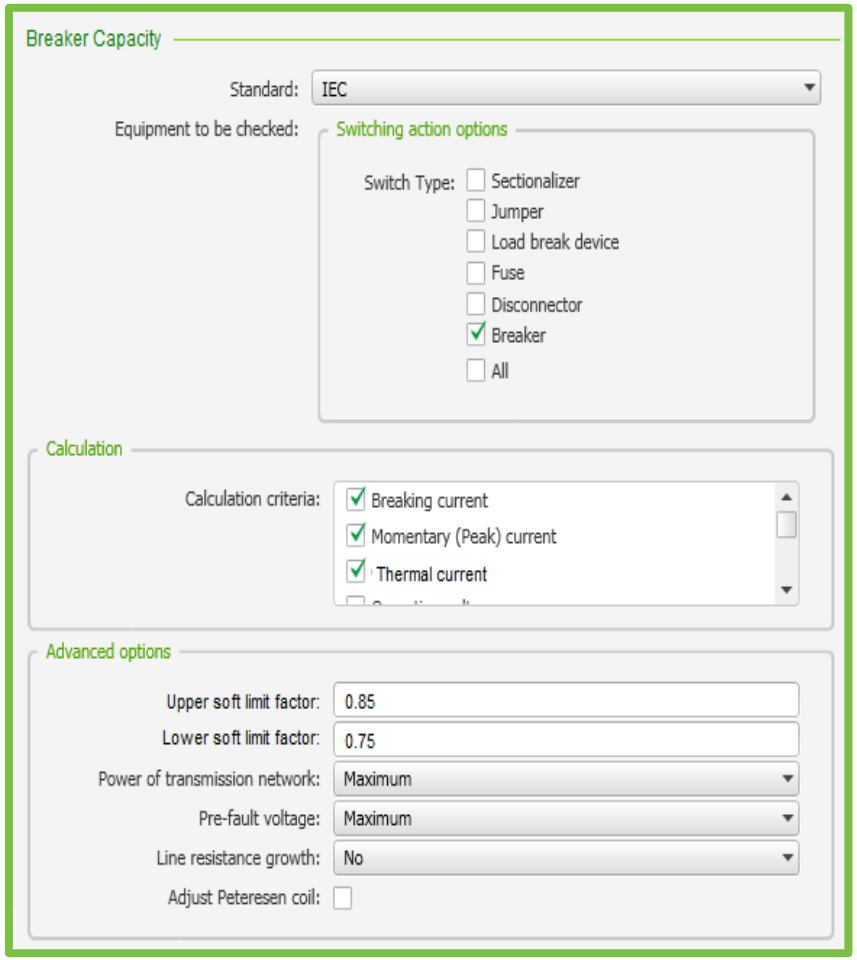
DISABLE

ENABLE

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

Fault level profiles – execution parameters





Respond dashboard

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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

Fault level report

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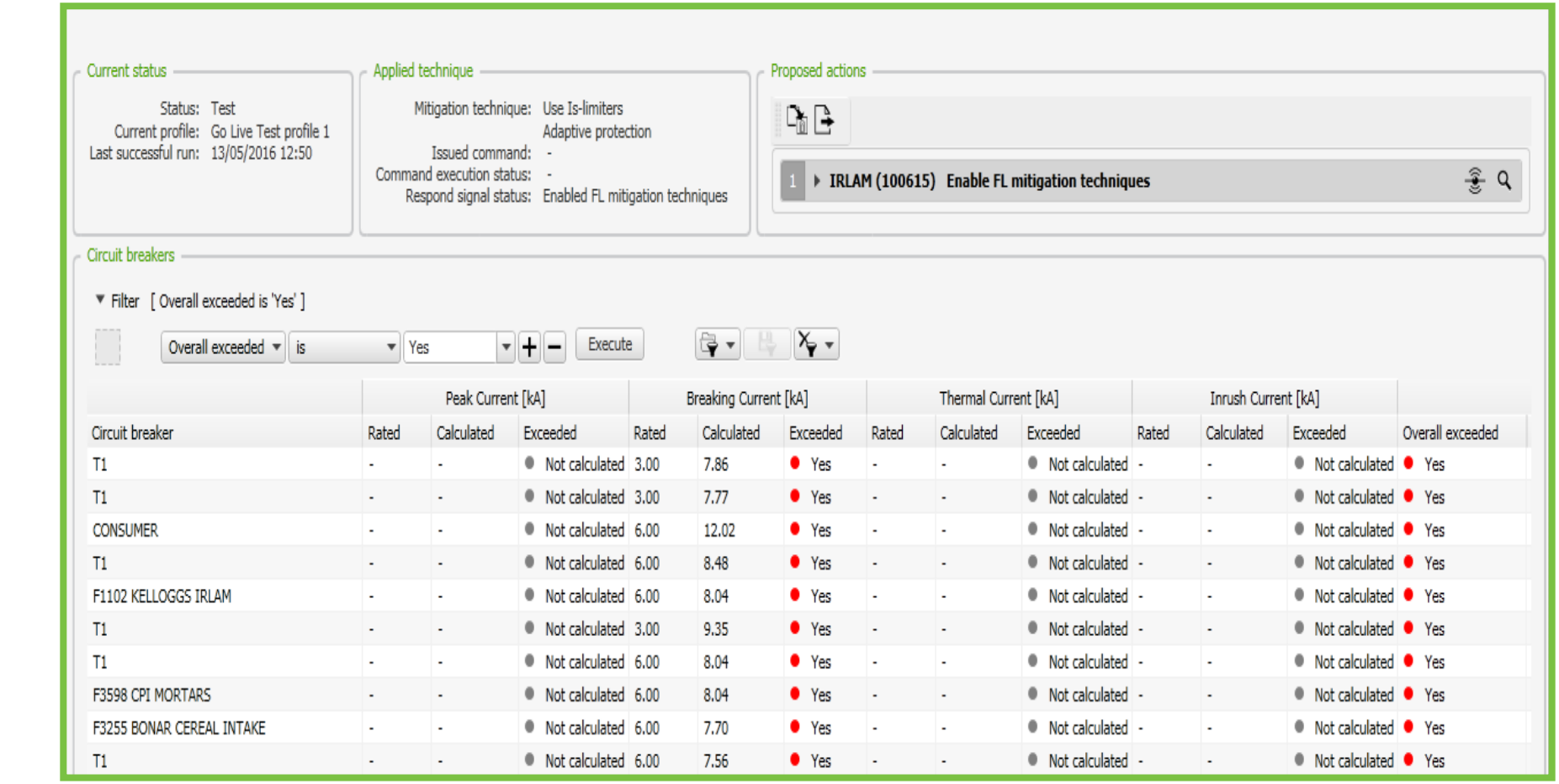


Current status

Status: Test
Current profile: Go Live Test profile 1
Last successful run: 13/05/2016 12:50

Applied technique

Mitigation technique: Use Is-limiters
Adaptive protection
Issued command: -
Command execution status: -
Respond signal status: Enabled FL mitigation techniques

Proposed actions

1 IRLAM (100615) Enable FL mitigation techniques

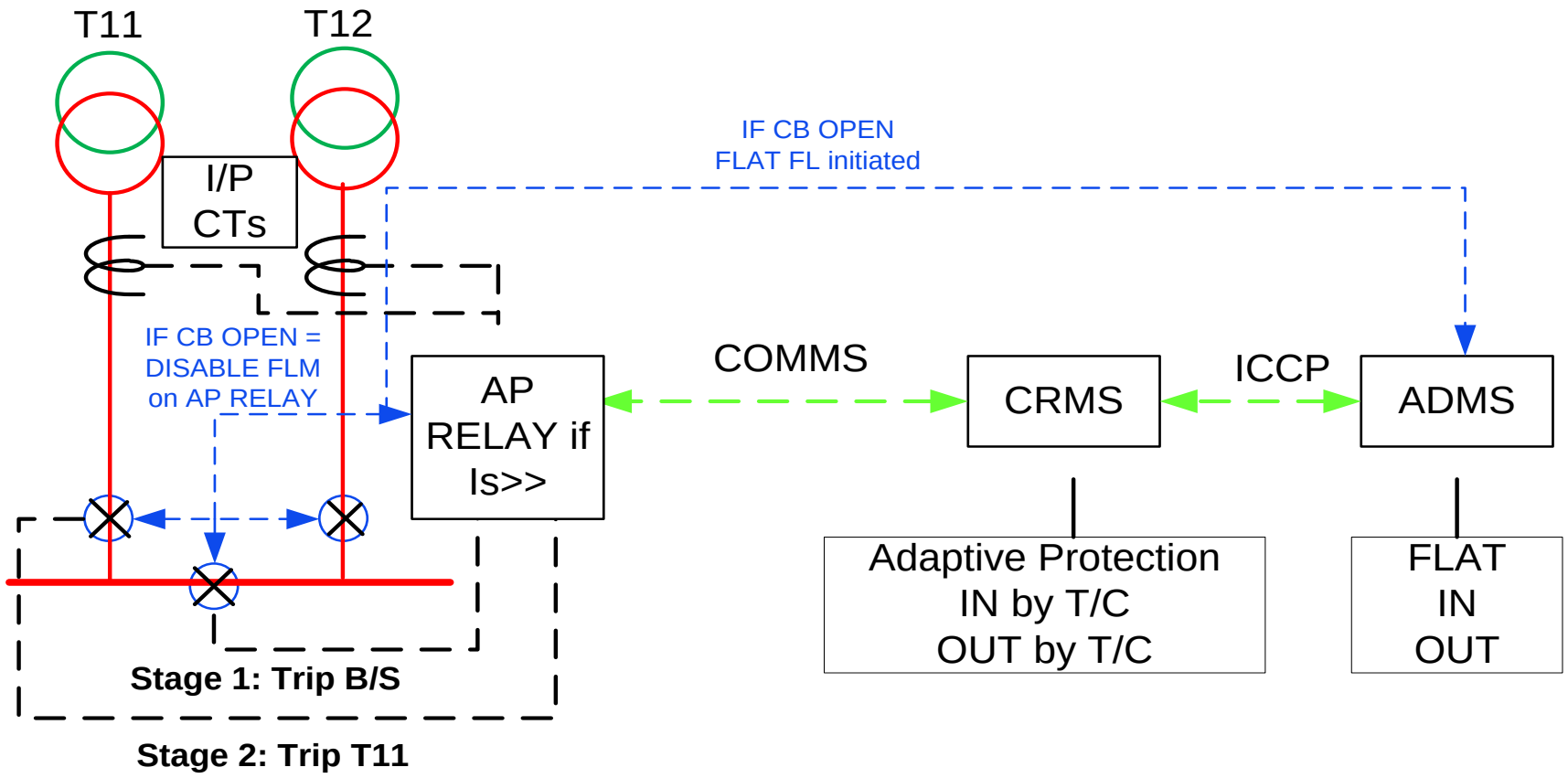
Circuit breakers

Filter [Overall exceeded is 'Yes']

Overall exceeded | is | Yes | Execute

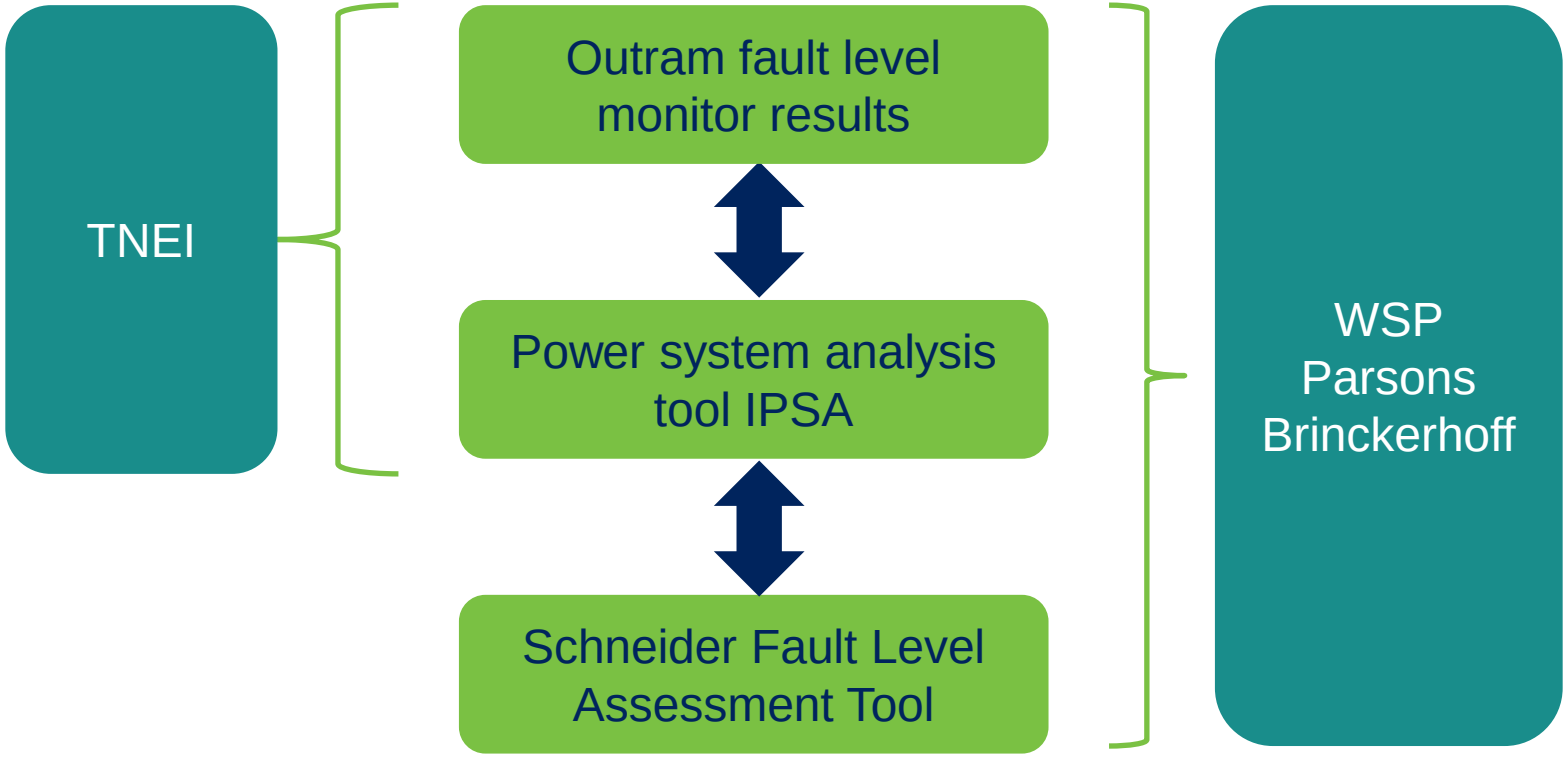
	Peak Current [kA]			Breaking Current [kA]			Thermal Current [kA]			Inrush Current [kA]			
Circuit breaker	Rated	Calculated	Exceeded	Rated	Calculated	Exceeded	Rated	Calculated	Exceeded	Rated	Calculated	Exceeded	Overall exceeded
T1	-	-	Not calculated	3.00	7.86	Yes	-	-	Not calculated	-	-	Not calculated	Yes
T1	-	-	Not calculated	3.00	7.77	Yes	-	-	Not calculated	-	-	Not calculated	Yes
CONSUMER	-	-	Not calculated	6.00	12.02	Yes	-	-	Not calculated	-	-	Not calculated	Yes
T1	-	-	Not calculated	6.00	8.48	Yes	-	-	Not calculated	-	-	Not calculated	Yes
F1102 KELLOGGS IRLAM	-	-	Not calculated	6.00	8.04	Yes	-	-	Not calculated	-	-	Not calculated	Yes
T1	-	-	Not calculated	3.00	9.35	Yes	-	-	Not calculated	-	-	Not calculated	Yes
T1	-	-	Not calculated	6.00	8.04	Yes	-	-	Not calculated	-	-	Not calculated	Yes
F3598 CPI MORTARS	-	-	Not calculated	6.00	8.04	Yes	-	-	Not calculated	-	-	Not calculated	Yes
F3255 BONAR CEREAL INTAKE	-	-	Not calculated	6.00	7.70	Yes	-	-	Not calculated	-	-	Not calculated	Yes
T1	-	-	Not calculated	6.00	7.56	Yes	-	-	Not calculated	-	-	Not calculated	Yes

System overview



Fault level validation

Peak asymmetrical make and symmetrical RMS break short circuit levels at 33kV and 11kV substations and along circuits



Fault level validation objectives

Outram FLM v IPSA

Establish how representative the IPSA results based on G74 assumptions are for each monitoring location, understanding the range of monitored results

Period of monitoring
network configuration during period
loading range during that period
IPSA modelling to be reflective of system conditions

FLAT v IPSA

Objective is to establish if the IEC calculation is conservative relative to the IPSA results and inform the tolerance needed in the trigger for supplementary fault level action.

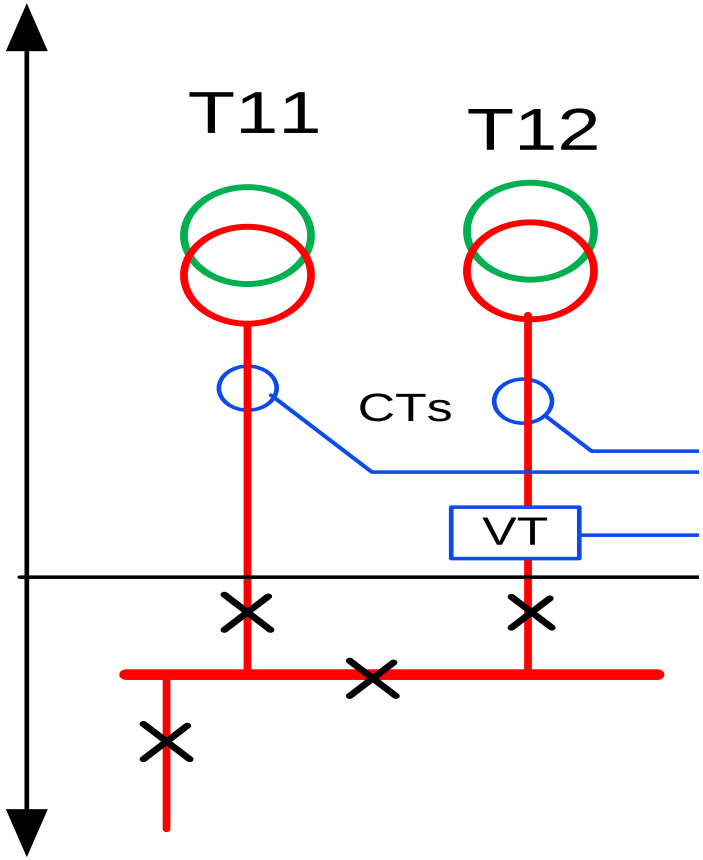
Fault calculation method
Model parameters
consider a range of short circuit locations at substations and along circuits.

Fault level monitor

Outram Power Master 7000 fault level monitor

Fault level monitor – connection

Upstream Event – Peak Fault level contribution from Down Stream



Down Stream Event – Peak and RMS fault contributions from Upstream

Fault level monitor

Fault level estimation for three phase and single phase systems on radial or interconnected networks

The fault level predictive results are based on disturbances occurring on the network during normal operation

Can measure events with voltage disturbances as low as 0.15%

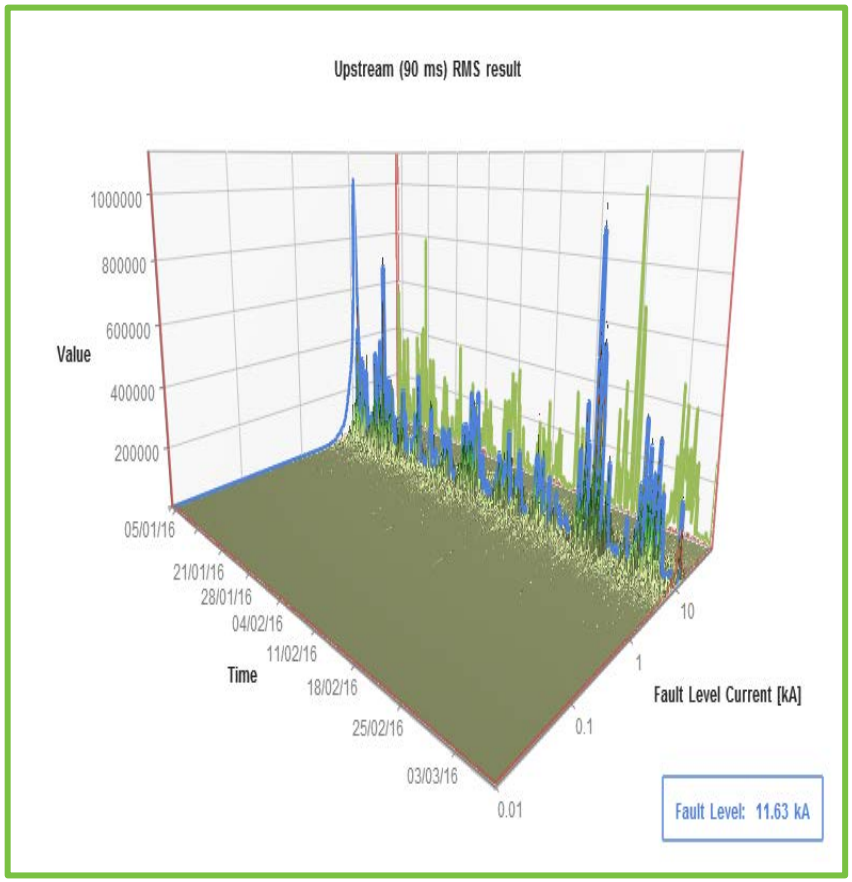
- Peak upstream fault level at ½ cycle (10 ms)
- RMS upstream fault level at, typically 90 ms (selectable)
- Peak downstream (motor) contribution at ½ cycle (10 ms)

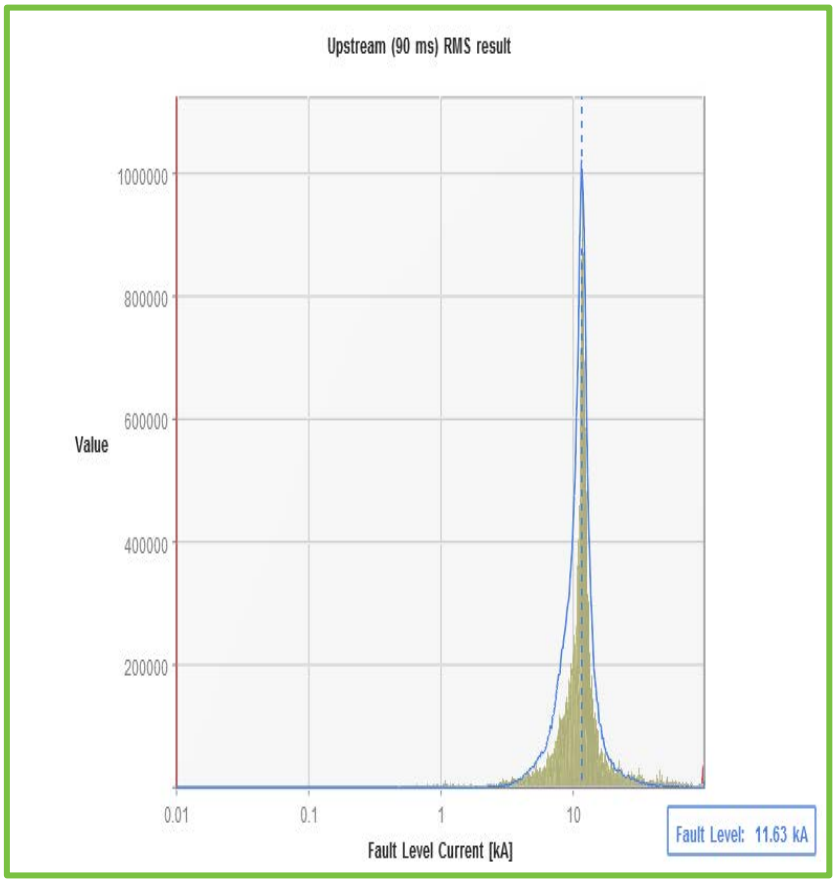
Portable, passive and easy to install

Initial fault level results for validation

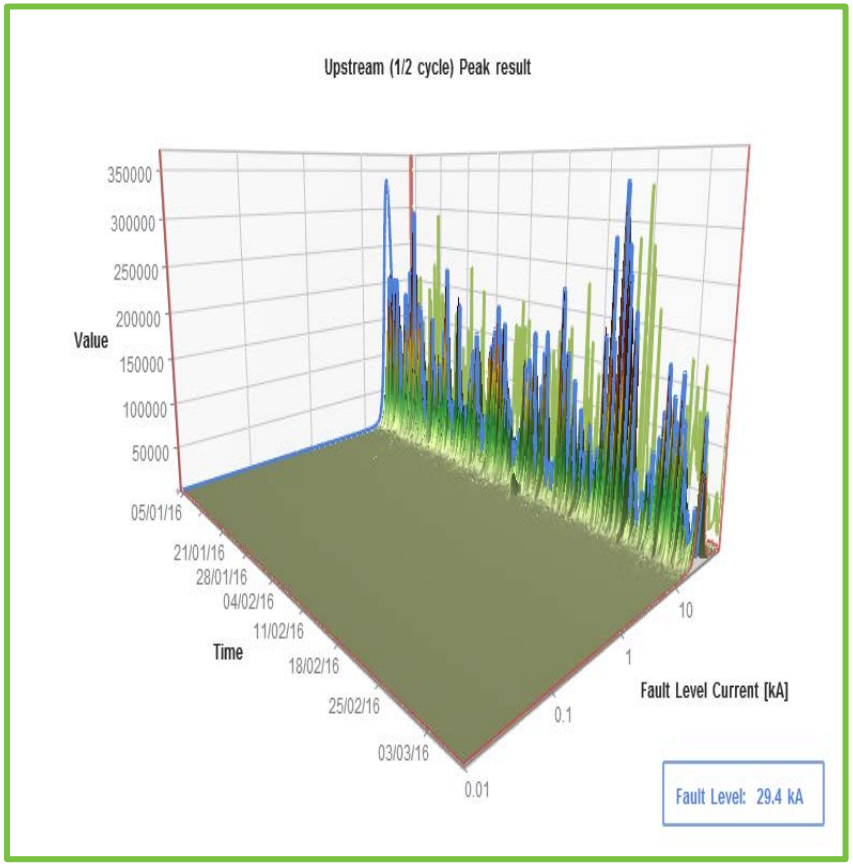
Substation	Outram FLM				IPSA+		Difference %	
	10ms peak upstream (kA)	10ms peak down-stream (kA)	90ms RMS upstream (kA)	Combined 10ms peak (kA)	10ms peak (kA)	90ms RMS upstream (kA)	10ms peak (%)	90ms RMS (%)
Wigan BSP	16.83	1.6	7.51	18.43	29.9	8.28	9.30	62.24
Broadheath	N/A	N/A	N/A	N/A	38.9	11.2	-	-
Irlam Primary	29.4	4.27	11.63	33.67	34.64	11.94	2.60	2.88
Denton West	34.84	3.47	14.08	38.31	39.51	13.65	-3.15	3.13

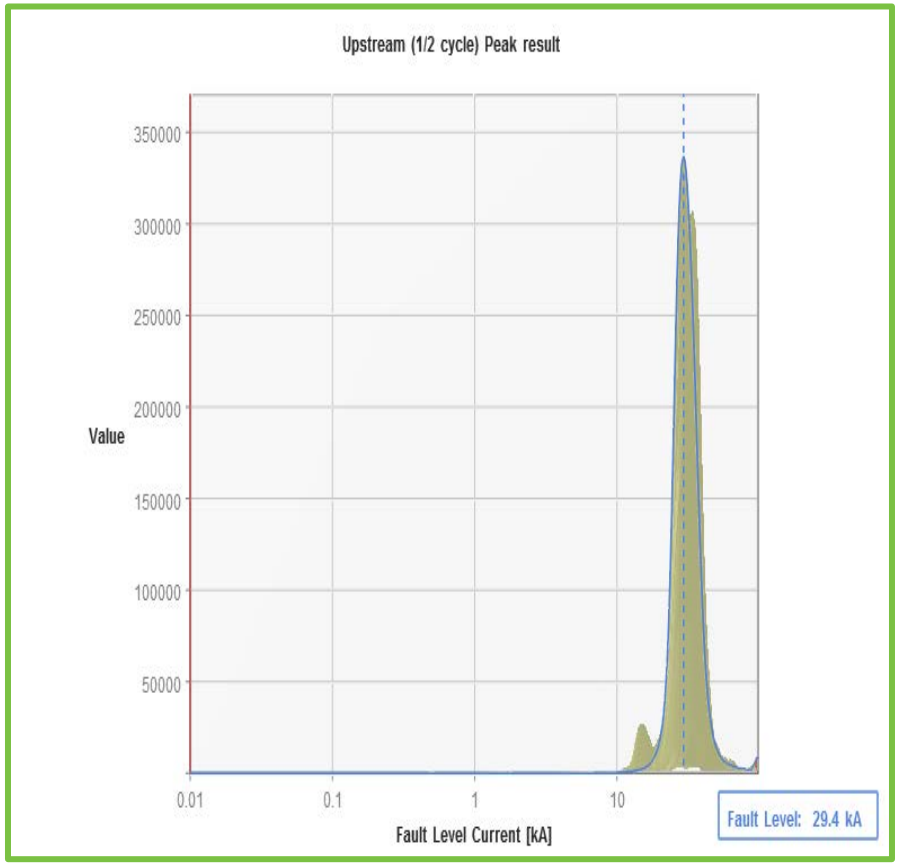
Irlam – 90ms RMS for downstream event



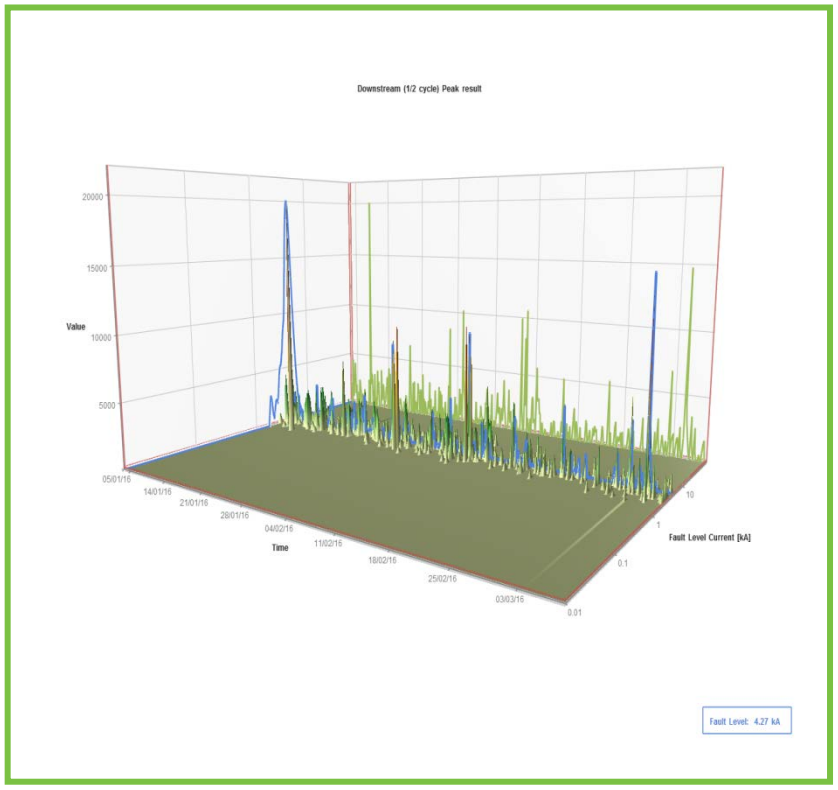


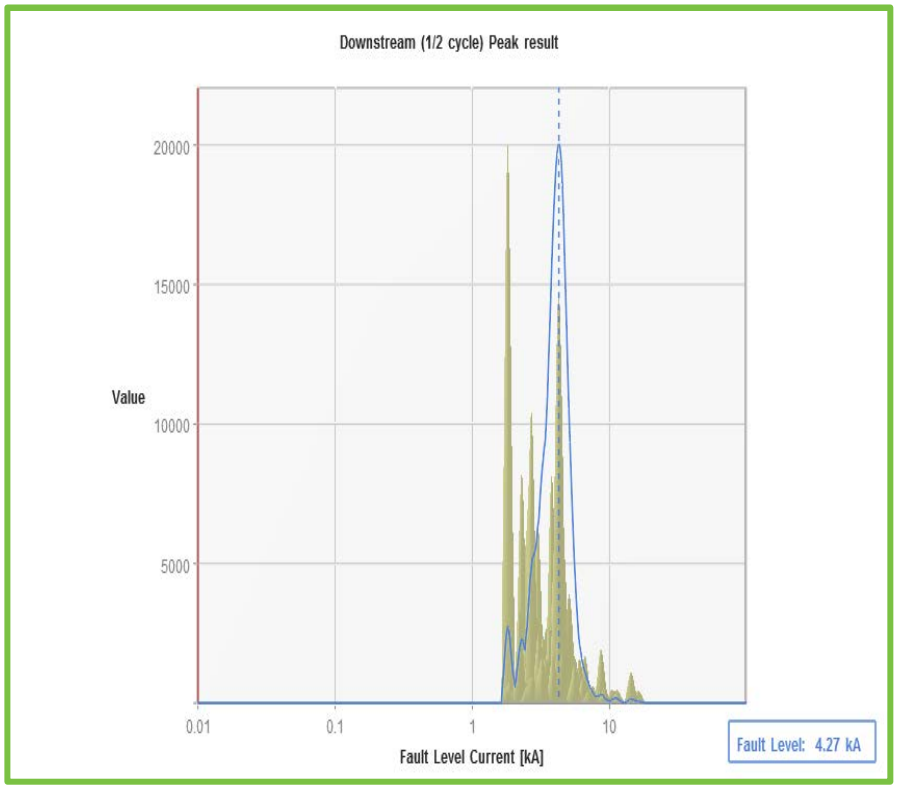
Irlam –10ms peak for downstream event





Irlam –10ms peak for upstream event





Progress to date

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Schneider Electric	Outram Research Limited	Outram Research Limited	tnei enterprise with energy	WSP Parsons Brinckerhoff
Fault Level Assessment Tool in operation and trials in progress	Fault level monitoring completed at four sites and installed at a further four location	Fault level report from Outram Research	Fault level monitoring and modelling report	Post fault monitoring and analysis procedure

RESPOND

Kate Quigley
Customer
Delivery Manager
Customer Engagement

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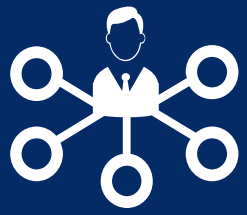
Customer engagement hypothesis

"The Method enables a market for the provision of an FCL service"

Engaged customer panel



Formulate engagement materials

Customer survey (Pre-trial)

Establish appeal of the commercial proposition

Customer survey (monitoring)

Qualify customer experience

Completed

Completed

2016

Engaged customer panel methodology

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Cross-section of I&C demand and generation customers

Usually organisation already owned or operated generators or motors with a capacity between 500kW and 15MW

Two meetings: 16 September 2015 and 7 October 2015

Eight customers recruited to attend ECP meetings in Manchester

Purpose of engaged customer panel

Review and test FCL service communication materials and survey instrument

Three key questions

1. Which materials are most effective in engaging customers about Respond?
2. Which key components of the FCL service need to be communicated?
3. How can learning from the ECP be utilised to design a customer survey?

Purpose of engaged customer panel

Review and test FCL service communication materials and survey instrument

Three key questions

1. Which materials are most effective in engaging customers about Respond?
2. Which key components of the FCL service need to be communicated?
3. How can learning from the ECP be utilised to design a customer survey?

Which materials are most effective in engaging customers about Respond?

Water analogy	A good introduction to the project, especially those without a technical or engineering background
Concept board	A succinct summary of the problem, solution, method and benefits, especially for those at board level
FCL service video	Useful to disseminate more technical detail. Visuals enhanced to indicate fluctuations in fault level and why and when the FCL service may be utilised
FAQ	Created to satisfy the ECP's request for more detailed written information regarding the FCL service

Purpose of engaged customer panel

Review and test FCL service communication materials and survey instrument

Three key questions

1. Which materials are most effective in engaging customers about Respond?
2. Which key components of the FCL service need to be communicated?
3. How can learning from the ECP be utilised to design a customer survey?

Which key components of the FCL service need to be communicated to customers?

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Objective	Need to communicate the objective of the survey so that it is not perceived as a pure sales and marketing exercise
Differentiate	Need to differentiate the FCL service from other commercial load shedding, STOR or DSR arrangements
Technical information	Need to satisfy an appetite for more detailed technical information such as how many times a year motors or generators would be constrained
Reward	Set expectations regarding financial rewards

Purpose of engaged customer panel

Review and test FCL service communication materials and survey instrument

Three key questions

1. Which materials are most effective in engaging customers about Respond?
2. Which key components of the FCL service need to be communicated?
3. How can learning from the ECP be utilised to design a customer survey?

How can learning from the ECP be utilised to design a customer survey?

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Accessibility	IT restrictions (eg video, devices) Pause and re-enter
Navigation	Progress bar Technical vs commercial questions
Content	Superfluous questions Language used eg MW/ kW

Customer survey conjoint exercise

Scenario 10

Which of these contracts do you prefer?

	Contract 1	Contract 2
Maximum number of events (constraints to equipment) in one year	8	5
Length of contract (years)	2 years	2 years
Duration of interruptions	10 minutes	10 minutes
An annual payment regardless of the number of events (constraints to equipment)	£2820 per year	£2041 per year
Payment per event	None	None

…and if the contract you chose was available now, how likely would you be to actually take it up?

- ☐ Very likely
- ☐ Fairly likely
- ☐ Neither likely nor unlikely
- ☐ Fairly unlikely
- ☐ Very unlikely

ECP lessons learned

- An ECP is a suitable forum for testing and refining complex communication materials
- Materials must be tailored to meet the diverse requirements of different customers
- Allow sufficient discussion time in ECP to capture feedback on survey instrument
- Special consideration should be given to the type and role of I&C participants
- Consider testing the requirement for, and the content of, customer videos earlier on in the process
- Obtain participants' explicit consent for the use of audio/visual soundbites in dissemination activities

RESPOND

Dawn Mulvey
Research Director
Impact Research

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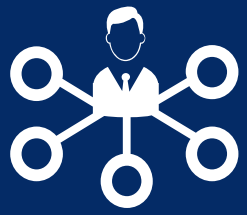
Customer engagement hypothesis

"The Method enables a market for the provision of a FLC service"

Engaged customer panel



Formulate engagement materials

Customer survey (Pre-trial)

Establish appeal of the commercial proposition

Customer survey (monitoring)

Qualify customer experience

Completed

Completed

2016

Good news!

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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

Customer survey

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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

Customer survey purpose

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

Customer survey participants

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50% manufacturing

50% other industries

76% ENW

20% rest of GB

52% high capacity (>1MW)

46% low capacity (<1MW)

49% motor

24% generator

27% generator and motor

Customer survey participants

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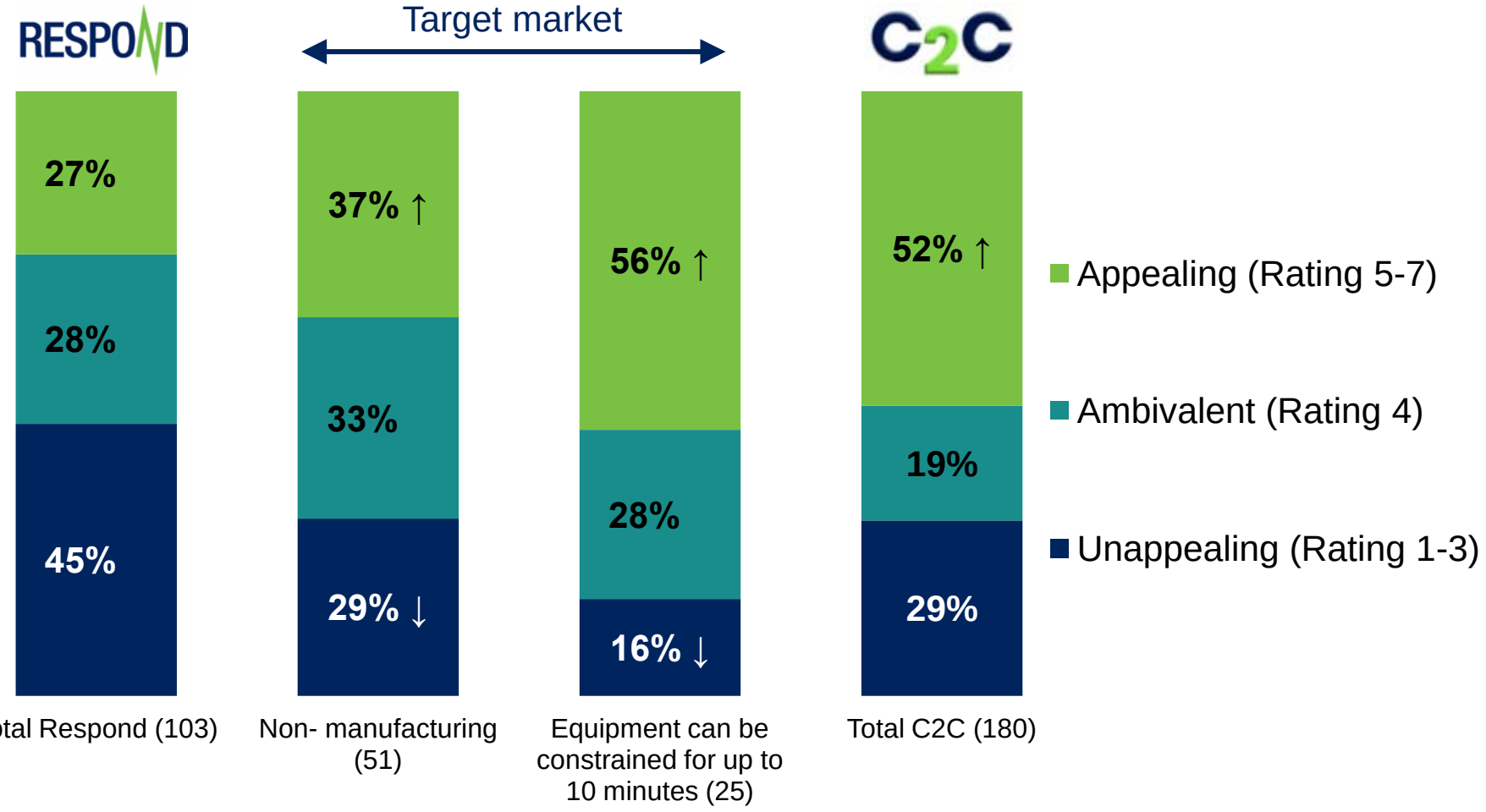
43% **Essential** to have electricity available **24/7**

25% 10 minute constraint **significant impact**

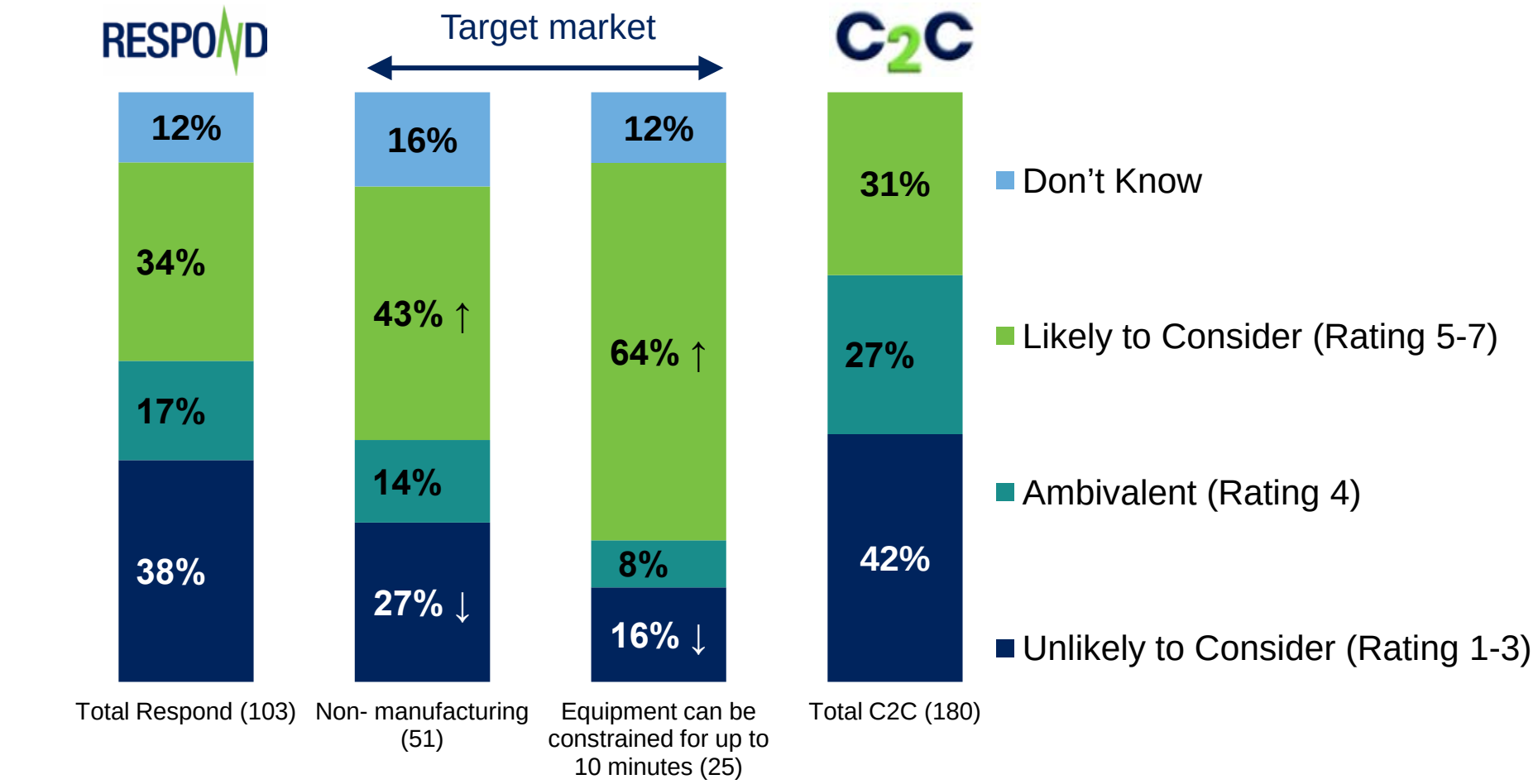
24% 10 minute constraint **no significant impact**

Appeal of the FCL service



Overall <u>appeal</u> of the FCL service is relatively low at a total level… however significantly higher among the 'target market'

Recommending the FCL service



34% indicated that they would recommend their organisation consider an FCL service agreement (prior to financial reward information)

Benefits of signing up to an FCL service

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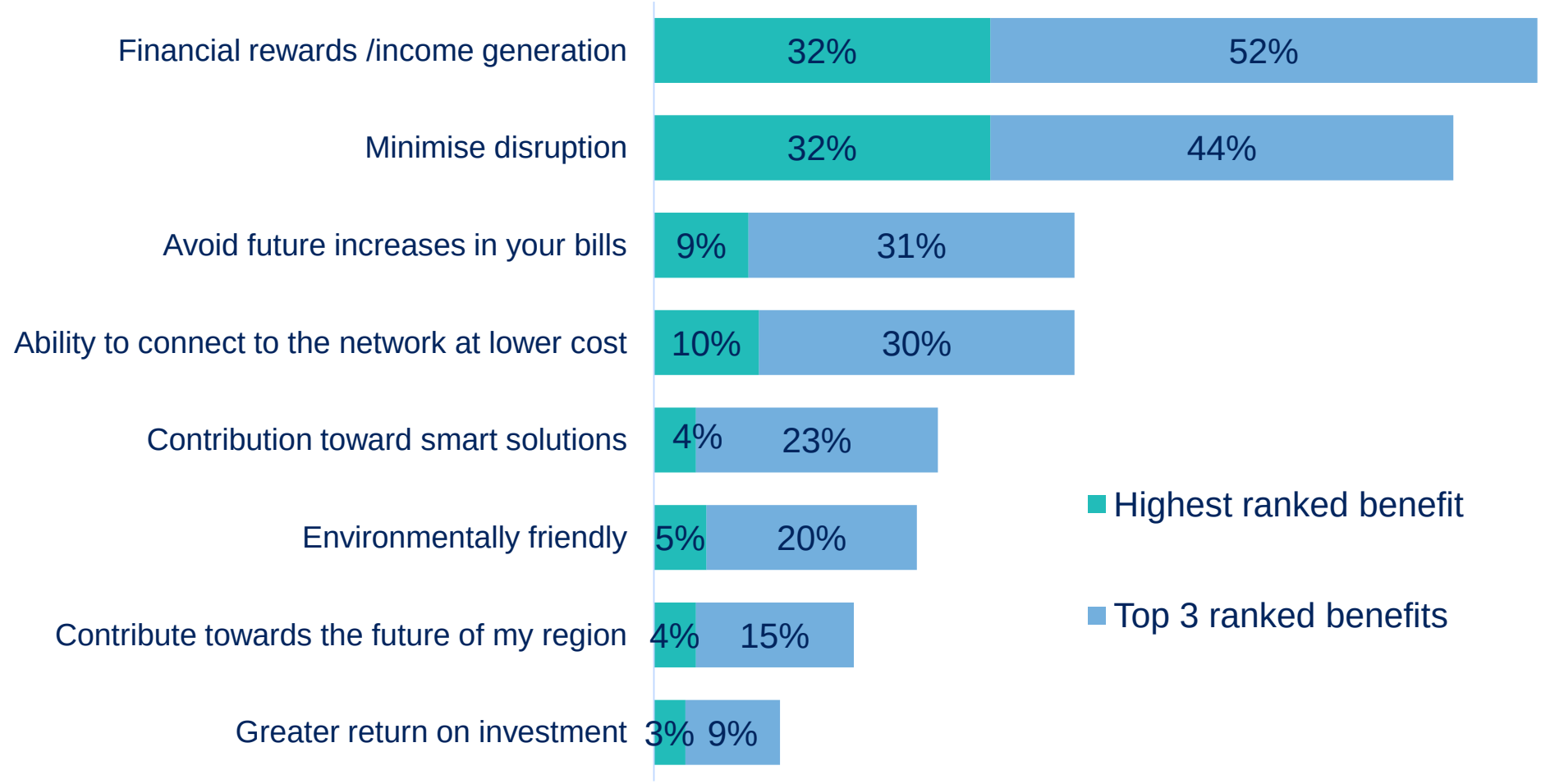

Financial rewards are the most influential driver of indicative take up, with minimised disruption to the electricity network also very important

Risks of providing an FCL service

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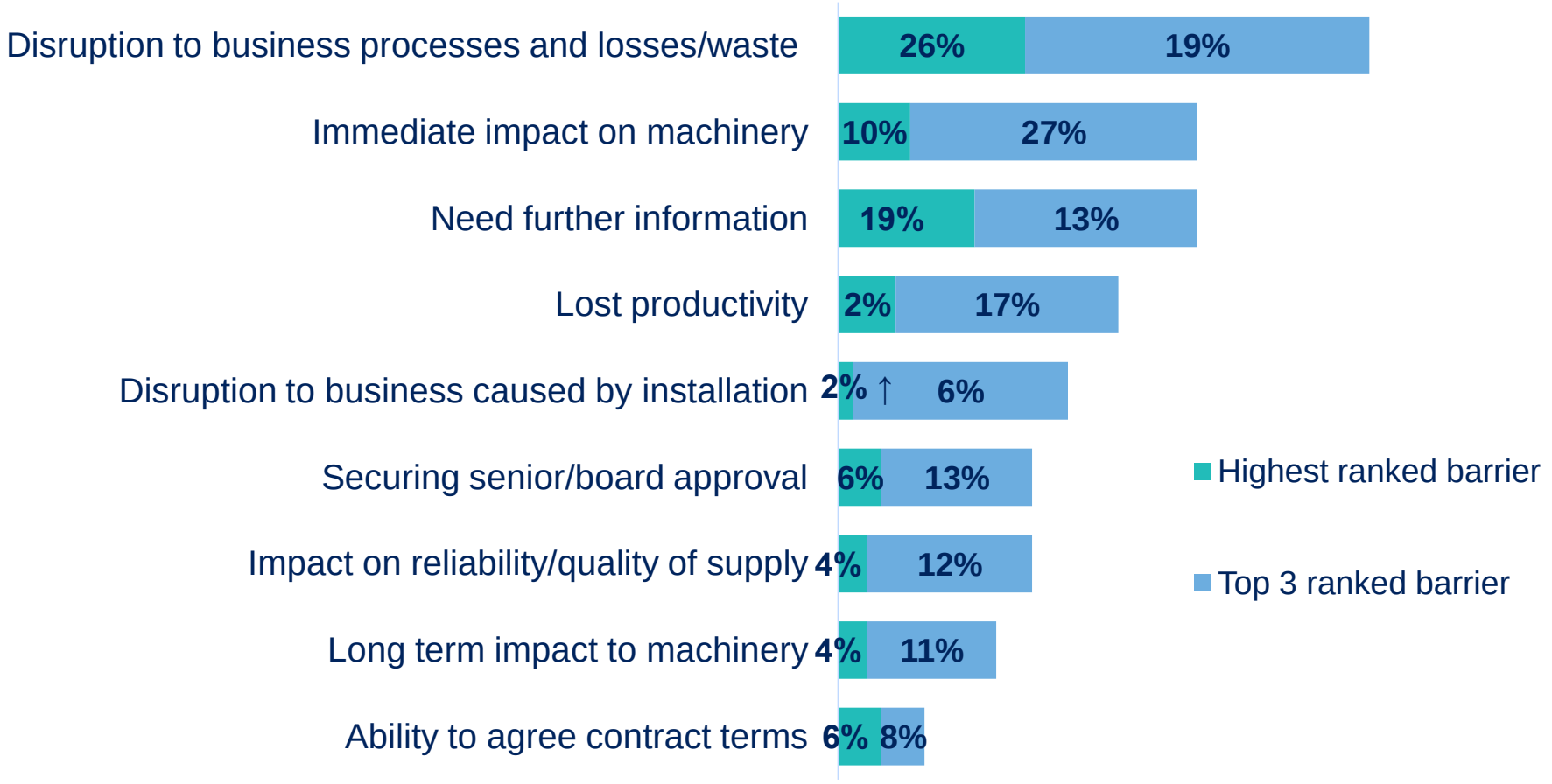

Concern over losses/waste arising from the constraint of a generator or motor is the biggest barrier to providing an FCL service

Pricing structures and contract options

The Respond FCL service 'contracts' were constructed from the following components:

Type of contract	PPE (pay per event)	Pre-paid					
Maximum number of events (constraints to equipment) in one year	1	2	3	4	5	6	7	8
Length of contract (years)	1 year	2 years	3 years					
Level of financial reward	90%	95%	100%	105%	110%			

To evaluate the appeal of different contract options, a base case scenario was applied, against which all variants could be benchmarked:

Base case scenario
• One year contract • Maximum of one of event per year • Rate paid by contract – 100% • Pre-paid (fixed per contract retainer, paid in advance)/Pay as you go - payment per event PPE payment methods

Calculating FCL service financial rewards

Technical factor	Figures
Number of Electricity North West customers	2.4m
Electricity North West winter max demand	4.2GW
Max demand per customer	1.75kW
One customer interruption	£12.34
One customer hour lost	£17.81

Take-up of FCL service – base scenario

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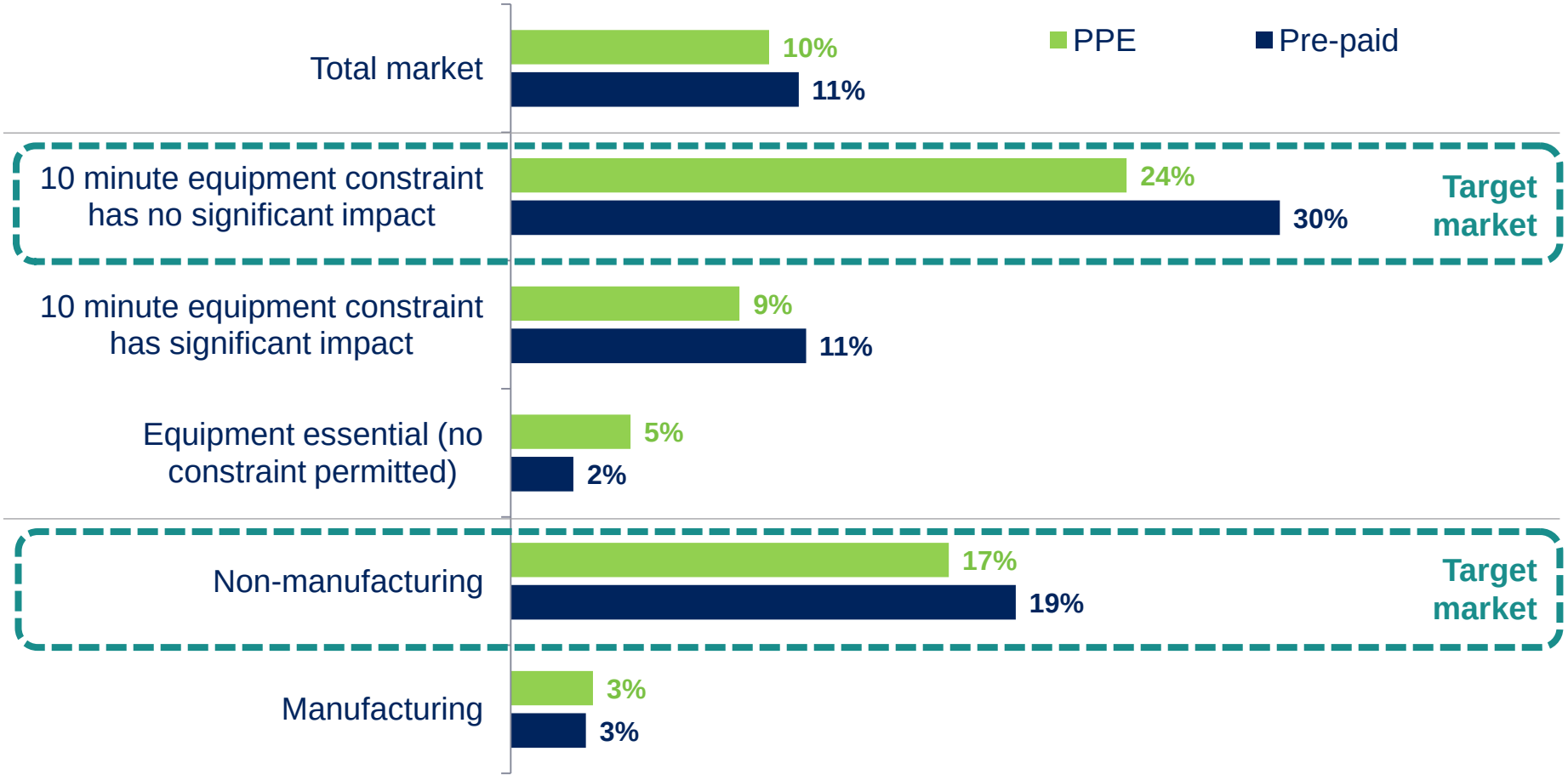
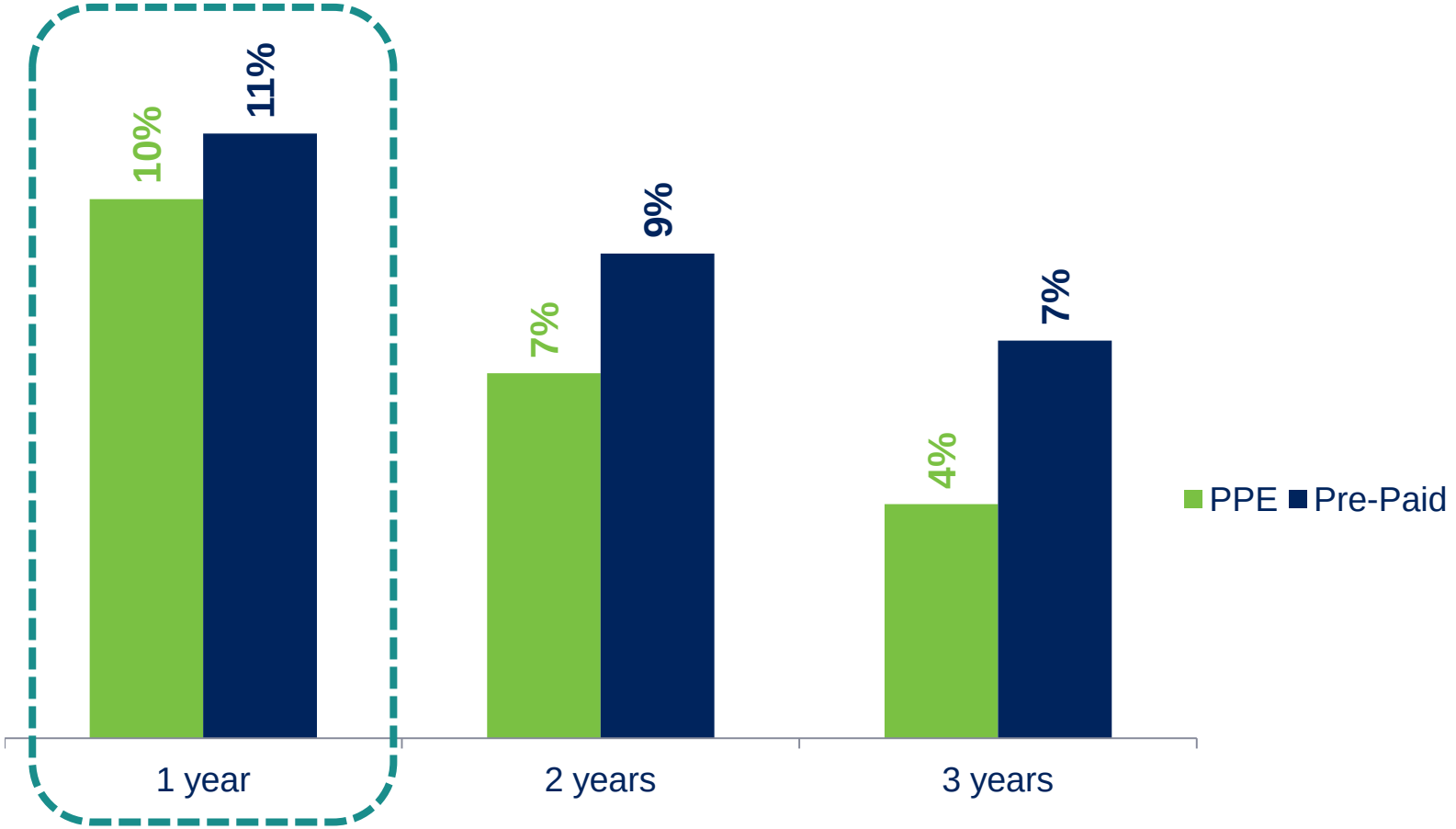


Take-up of the FCL service is significantly higher among the target market and pre-paid contract options

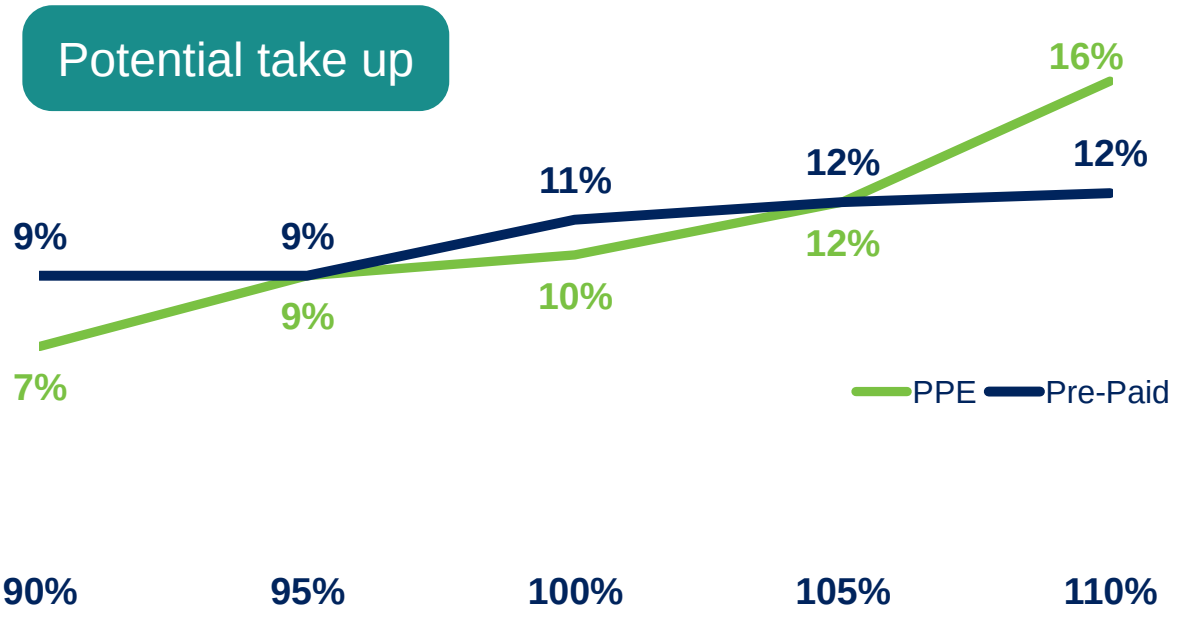
Take-up of FCL service by length of contract



The optimal duration for an FCL service contract is likely to be one year

Sensitivity to value of payment

Significant gains in take-up can be achieved by offering increased PPE financial rewards (+10%)



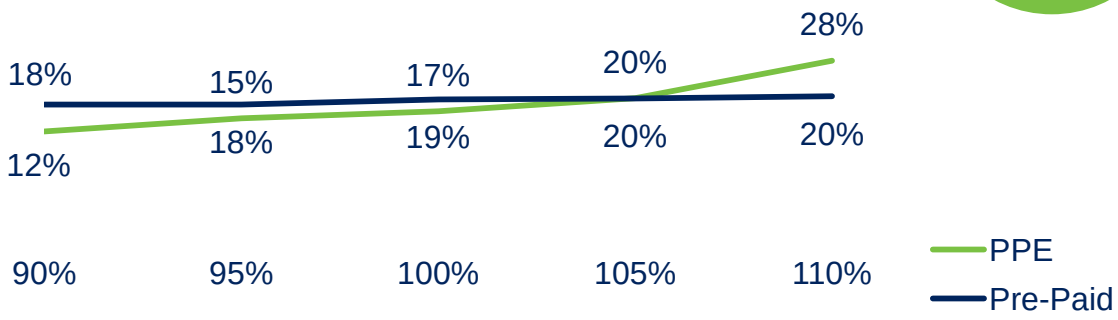
PPE (per event per annum)	£3,026	£3,194	£3,362	£3,531	£3,699
Pre Paid (per event per annum)	£1,513	£1,597	£1,681	£1,765	£1,849

Central value

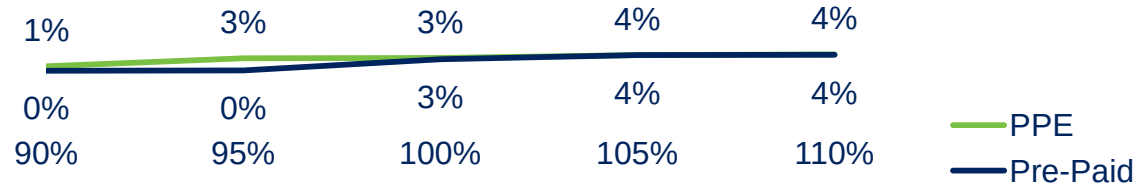
Sensitivity to value of payment

Target market

Non-manufacturing potential take up (51)



Manufacturing potential take up (52)

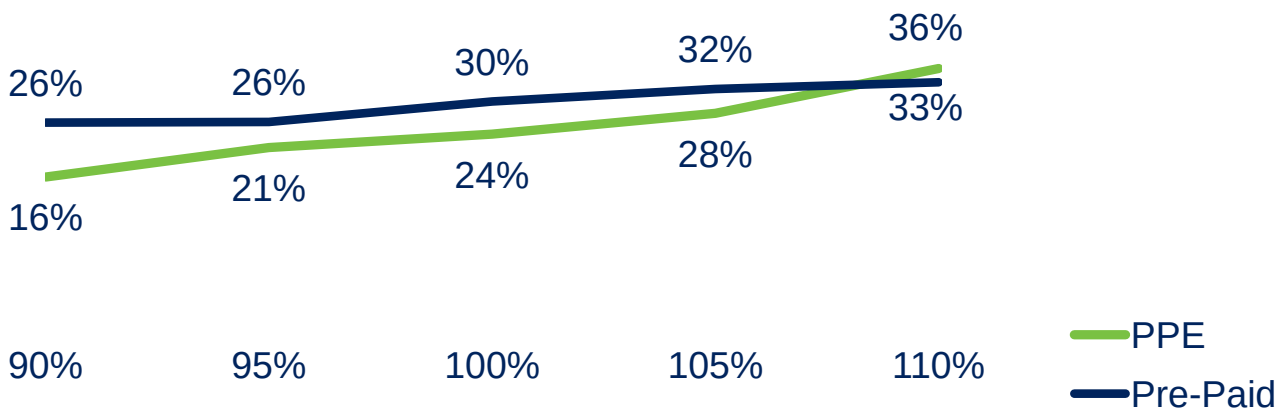


Significant gains in take-up can be achieved by offering increased PPE financial rewards to the non-manufacturing segment (+10%)

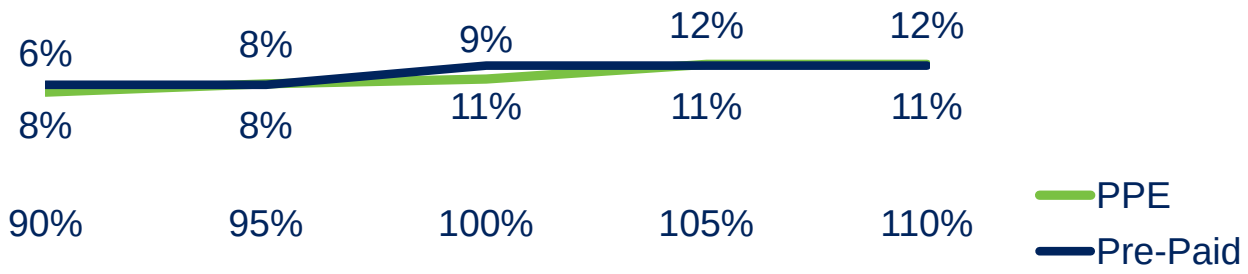
Sensitivity to value of payment by sector

Target market

Potential take up if 10 minute constraint IS acceptable (26)



Potential take up if 10 minute constraint is NOT acceptable (26)

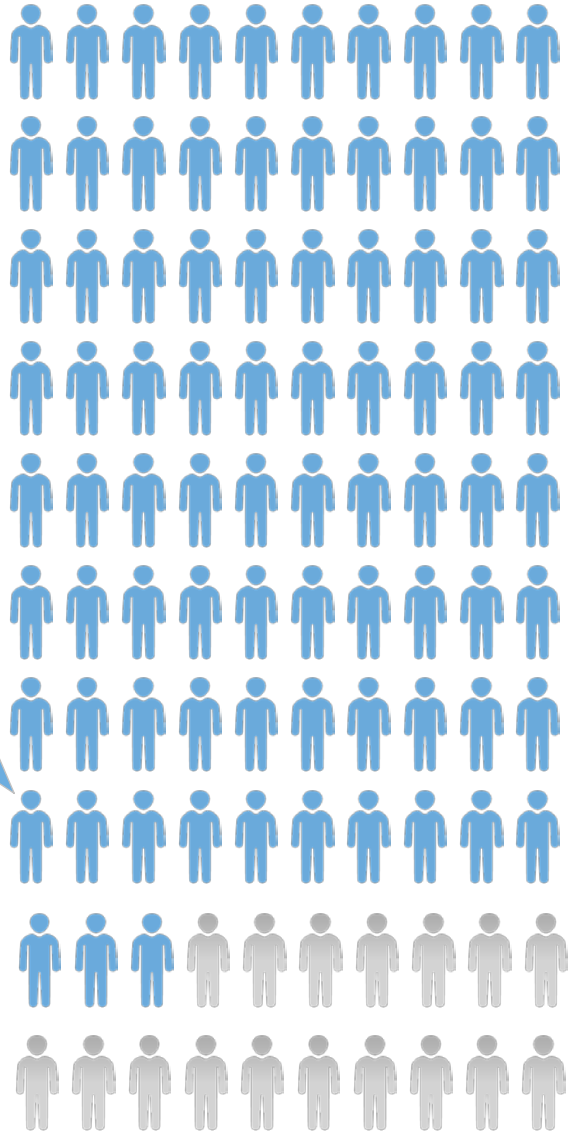


Take-up reaches 36% amongst the target market if offered PPE at 110% for one year

Interest in finding out more about the trial

57%
would like to know more about participating in the FCL service trial

83%
of the overall sample would like to be informed of the results of the survey



Further information requirements

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Tailored information	Site specific and equipment specific information is needed for potential users to come to a conclusion.
Financial rewards	How are they calculated? Do they depend on frequency and length of faults?
Benefits of proposition	Questioning the risk and whether the benefits outweigh the risk to the company and the equipment. What does Respond do for the company?
Constraint of equipment	Will there be notice of the supply being cut off and going back on? How long would this be? What times of day/ year would this occur if needs be?
Installation, maintenance and equipment	Who would look after the equipment installed to make Respond possible? What costs could this have?
Damage to equipment	Some equipment needs turning on steadily or with engineers present, rather than via a ‘on/off’ method which may cause damage. What would be the process for switching back on?

RESPOND

So who represents the target market for Respond?

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Target market

24%

10 minute constraint
no significant impact

This equates to 25 companies

Target market – industry type

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5 manufacturing

20 other industries

7	3	3	2
Mining, Utilities, Waste Management	Human health	Education	Agriculture, forestry & fishing
2	1	1	1
Real estate	Transport	Professional	Construction

Includes 8 aggregators

Target market – location

	Single site	2 – 9 sites	10 + sites	Total
 ENW region	1	8	7	16
 Outside ENW region	4	4	0	8
Total	5	13	7	

Target market – equipment

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9 in special industry relationship/contracts

13 no existing contracts

Largest single equipment/customer ranges from 0.5 Kw – 6 MW

6 motor

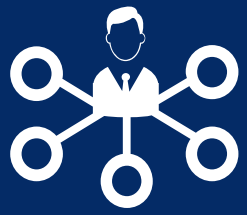
8 generator

11 generator and motor

Customer engagement hypothesis

"The Method enables a market for the provision of a FLC service"

Engaged customer panel



Formulate engagement materials

Customer survey (Pre-trial)

Establish appeal of the commercial proposition

Customer survey (monitoring)

Qualify customer experience

Completed

Completed

2016

Purpose of engaged customer panel 2

Test customer engagement and contractual materials for purchasing FCL service

Three key objectives

1. To test a customer presentation which would be given to potential FCL trial participants
2. To test a comprehensive Q&A document about the FCL trial
3. To review existing engagement materials tested previously by the ECP

Information shared with customers

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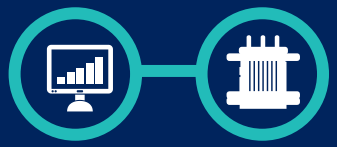
Fault history	Max fault level contribution (MVA)	Distance to primary substation	Annual availability payment
			
A site-specific five-year history of faults that could have activated the FCL service	Details of the maximum fault level contribution at their primary substation	Proximity of site to the primary substation to calculate impedance	Indicative payment based on hypothetical figures

Final ECP lessons learned

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- Customer presentation and leaflet worked well together
- Materials were suitable to meet the diverse requirements of different customers
- Customer presentation will work well in an F2F environment which allowed interaction
- Site specific fault history info useful
- Concept still unappealing based on illustrative reward figures
- Customers wanted more information about risk

Going forward ...

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Refine communication materials based on feedback from reconvened ECP

FCL service agreement developed and trialed with up to five participants

Publish final contract templates & commercial arrangements May 2018

Comprehensive customer survey report published May 2017

RESPOND

Paul Turner

Delivery Manager

Next Steps

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Respond project summary

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£ 5.5 million

Build
Sep 2015 to April 2016

Trial
May 2016 to April 2018

Decommission & closedown
October 2018

Fault Level Assessment Tool

- Adaptive protection (5 HV, 2 EHV sites)
- Fault Current Limiting (FCL) service
- I_S limiters (2 HV full install, 3 HV and 2 EHV sensing equipment)

Delivers same capacity but up to 18 x faster

Up to 80% cheaper

Could save GB £2.3 billion by 2050

Progress to date

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Customer engagement plan and data privacy statement submitted to Ofgem and approved

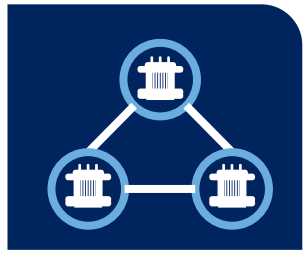
Go live of the Respond website and social media forums

Project publicised through partner organisations and in the media

Customers registered for engaged customer panel and survey

Survey completed

Orders placed for major items



Installation sites confirmed, trial equipment installed and activated

Next steps

May 2016

Trial period May 2016 through to May 2018

Start of trials	Post fault analysis	Health monitoring	Purchase FCL service
Publicise trial through media & dissemination events	Standard monitoring and analysis procedures for every fault	Assess the health impact on our assets of the trials	Operate up to five FCL services for customers' motors and generators

Knowledge sharing and dissemination

Post event feedback

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1) How would you rate the event for each of the following?

	Poor	Needs improvement	Satisfactory	Good	Excellent
Intellectual content		1	1	10	3
Industry insight			2	10	3
Innovative ideas			3	8	5
Networking			5	8	3
Overall experience			3	11	2

2) How would you rate the delivery and content of the event for each of the following?

	Poor	Needs improvement	Satisfactory	Good	Excellent
Presentation delivery		1	2	9	3
Clarity of the messages		1	2	8	5
Opportunity for questions		1	.3	6	6
Relevant responses to questions		1	3	8	4
Length of the sessions		1	3	9	3

Post event feedback

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3) Were all the topics you were interested in covered during the event? If not, please state which topics you would have liked to hear about?

Yes	**7**	**No**	**1 – Asset Impact**

4) How would you rate the following aspects of the event?

	Poor	Needs Improvement	Satisfactory	Good	Excellent
Administration			1	10	5
Venue facilities			1	10	5
Refreshments			2	9	5

Post event feedback

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5) Please provide any further comments you have about today's event.

A practical workshop would be very useful.
Provide a summary of project in pack.
Would really enjoy the opportunity to view operational system at site.
Interesting, very good networking opportunity, very friendly & approachable for suppliers. Opportunity for questions excellent although at start after 1 session due to overrun opportunity was later
Overall this is a nice event and very informative. Customer engagement part could be shorter. Any practical demonstration of technology would be excellent.
I felt event was pitched about right for the stage of the project. I would welcome more information (workshop) on safety case for I_S-limiter as this is developed.
Enjoyed it!
Will the three methods ever be used together? How do you compare methods? How do we progress to being able to increase fault levels? The adaptive protection and I_S-limiter will have some impact on customers due to some changes to network topology – how will you engage with them on this? Customer engagement was too long.