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# Electrical Network Improvements and System Operability

LCNI Conference Oct 2018

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# RESPOND

## Innovative Active Fault Management

**Ben Ingham**

*Innovation Project Manager*

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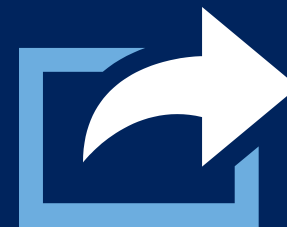
# RESPOND



Introduction

Project overview

Adaptive protection



Is-limiter

Fault current limiting service

Summary and next steps



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



Financial benefits

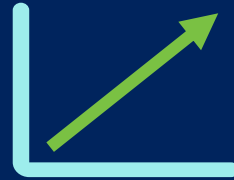
Up to £2.3bn  
to GB by  
2050

Project partners





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



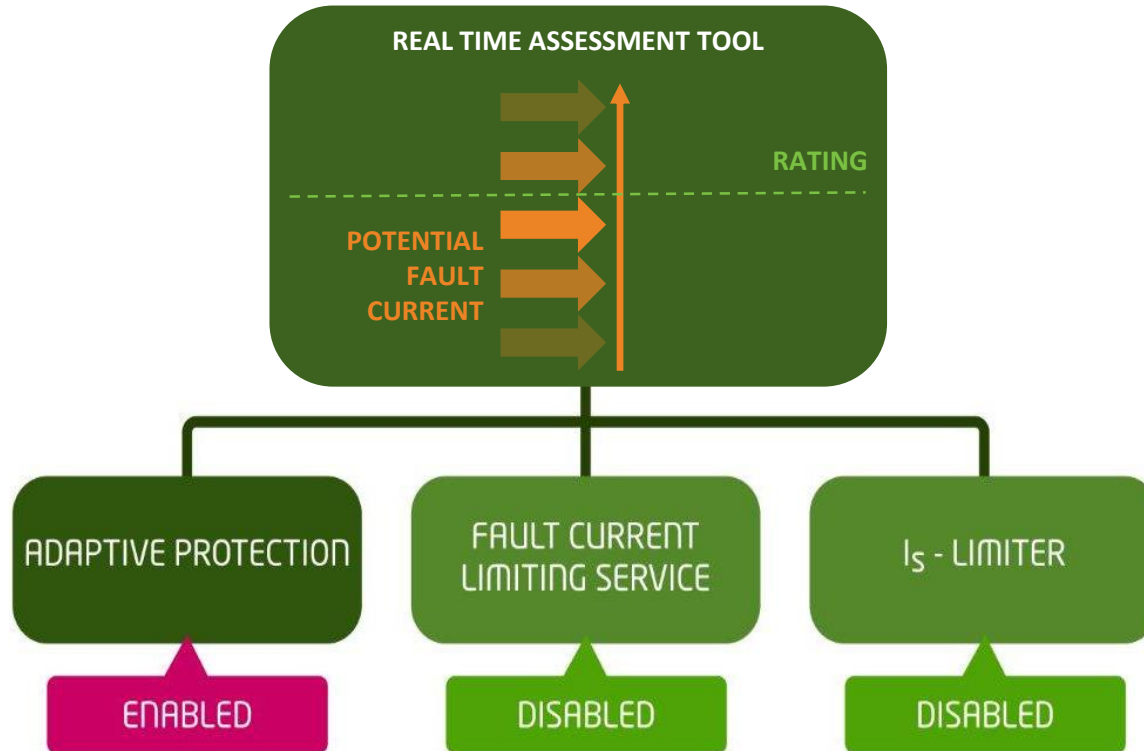
Enables a market for the provision of an FCL service



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
-



Real time calculation  
successfully  
demonstrated



Control of on-site  
devices shown



Data issues led to  
inaccuracies in results



Network already designed to break fault current

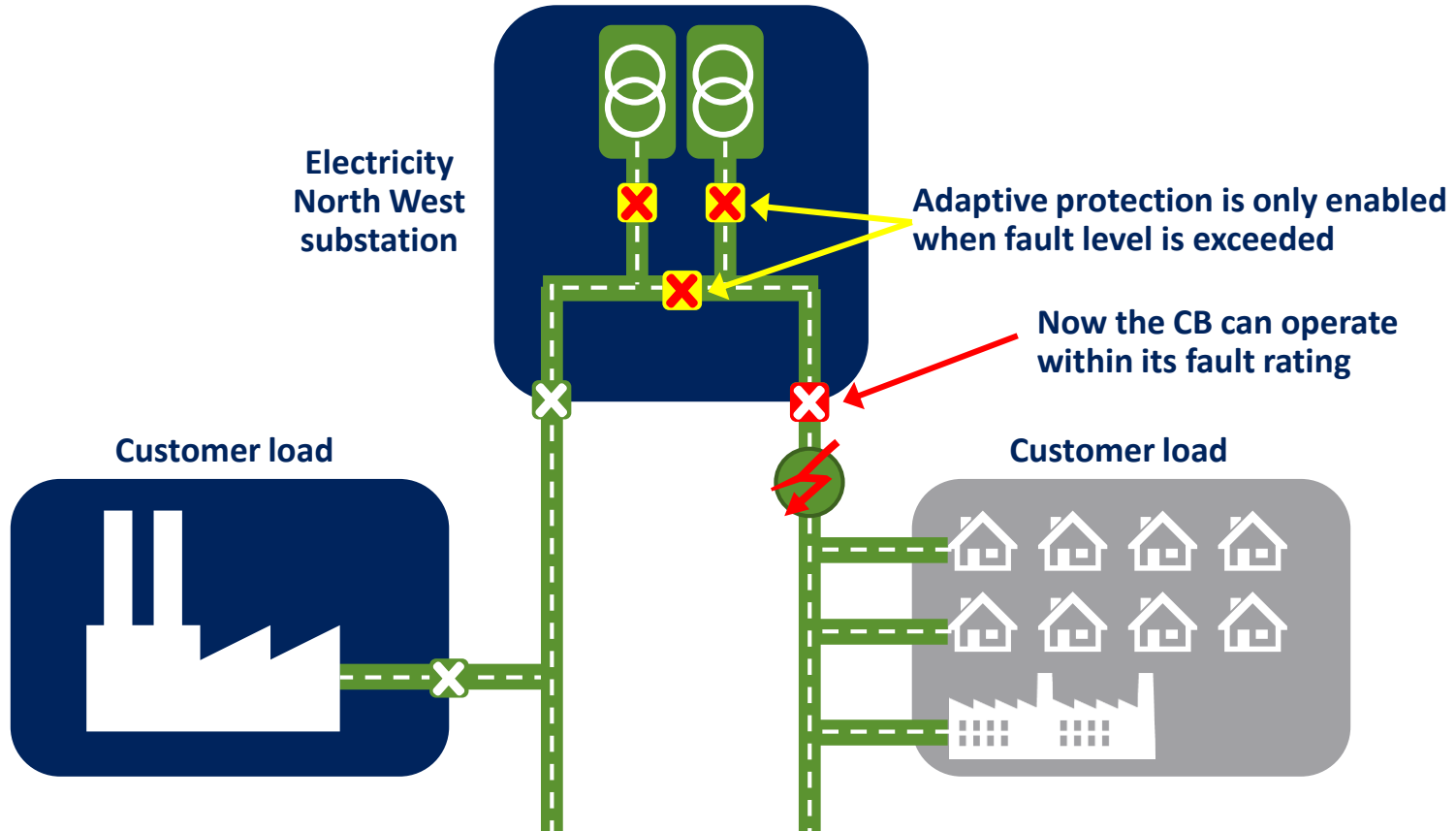


Adaptive protection changes the order in which circuit breakers operate to safely disconnect the fault



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







Eight successful operations of adaptive protection

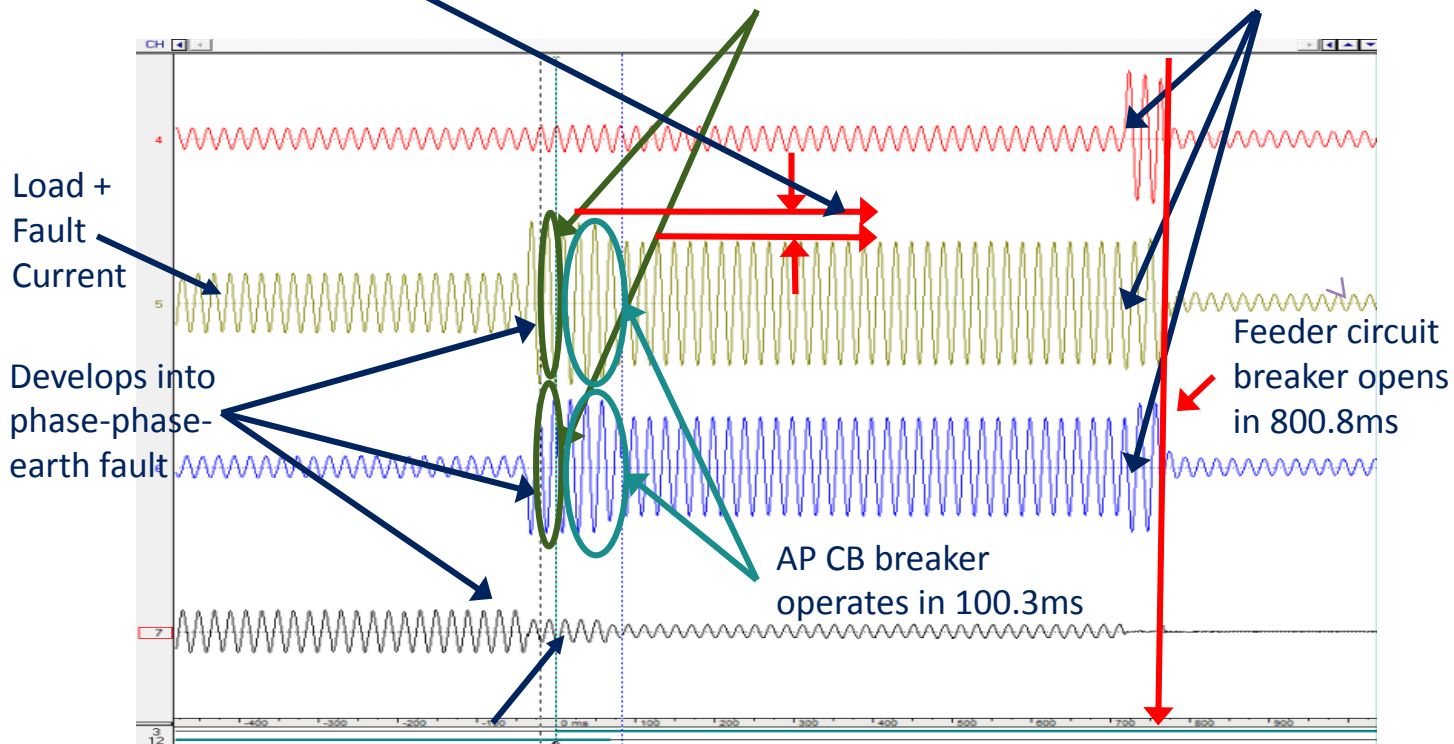
No mal-operations

Faults seen to develop

Fault level magnitude is reduced

Adaptive Protection sees the Fault and operates in 35.5ms

Develops into a 3 phase fault



Reduced earth current but still present



Two additional  
designs  
completed

Single digital  
Tx relay variant

Single relay  
integrated  
with existing  
analogue  
protection

# I<sub>s</sub>-limiters – two sites and five sensing sites



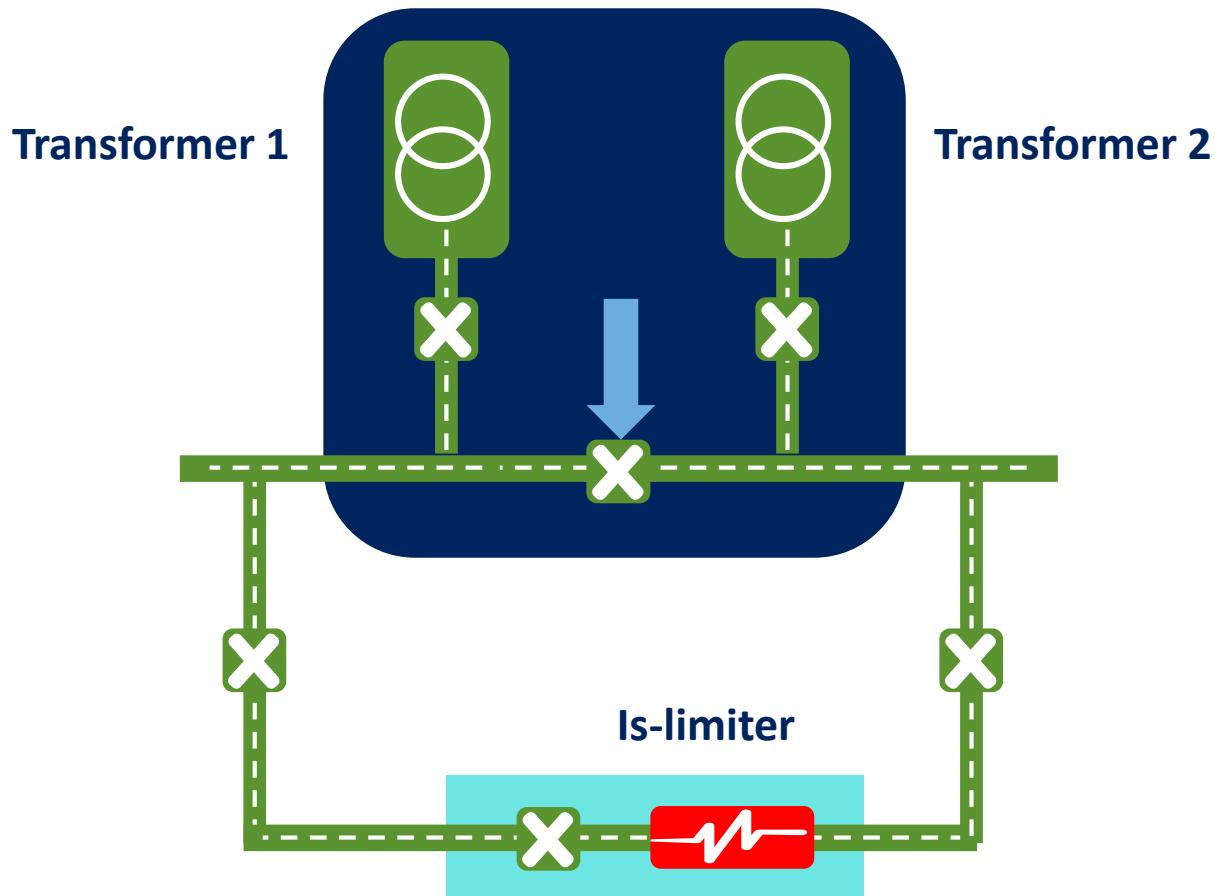
Operates within  
5 milliseconds or  
1/200<sup>th</sup> of a second

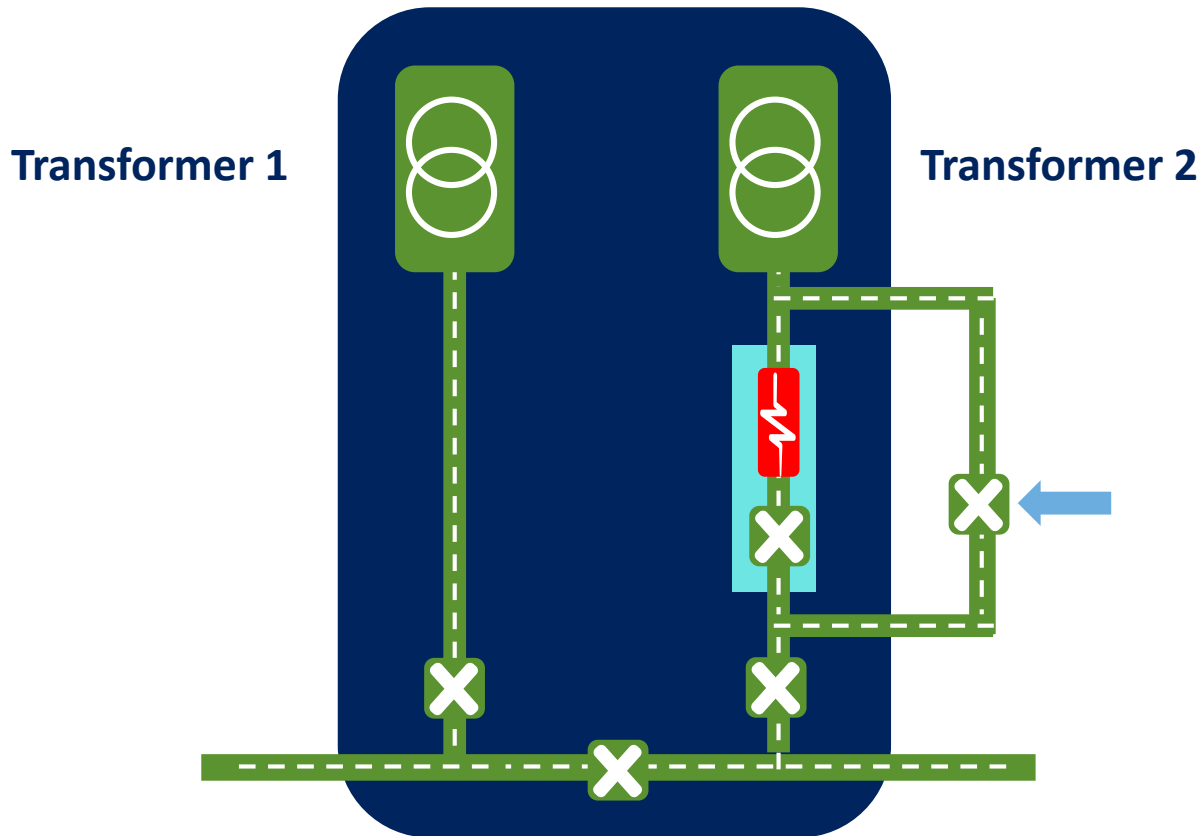


Detects rapid rise in current  
when a fault occurs and  
responds to break the  
current



Respond has proven the  
technology, reviewed the  
safety case and deployed at  
two sites







1

The red phase  $I_S$ -limiter responded to a fault and operated to interrupt the fault

2

The time interval between the Bamber Bridge local feeder earth fault alarm and the tripping of the  $I_S$ -limiter was 10 ms

3

The series circuit breaker opened 51 ms after the tripping of the  $I_S$ -limiter

4

The event log indicates that the Bamber Bridge local 11kV protection relay operated 1.371 seconds after the  $I_S$ -limiter series CB opened

5

No waveforms are available

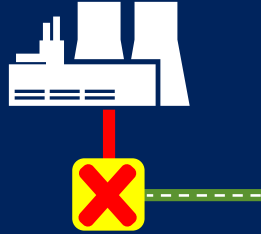
# Bamber Bridge red phase fuse





# 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



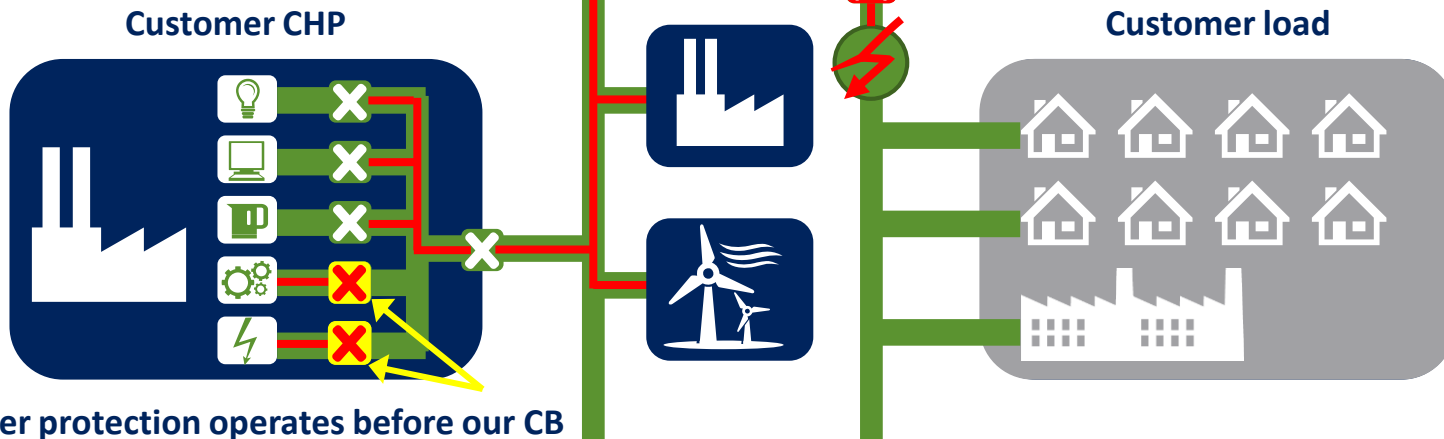
Challenge was to identify customers to take part in a trial of the FCL service

# 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

Electricity North West substation



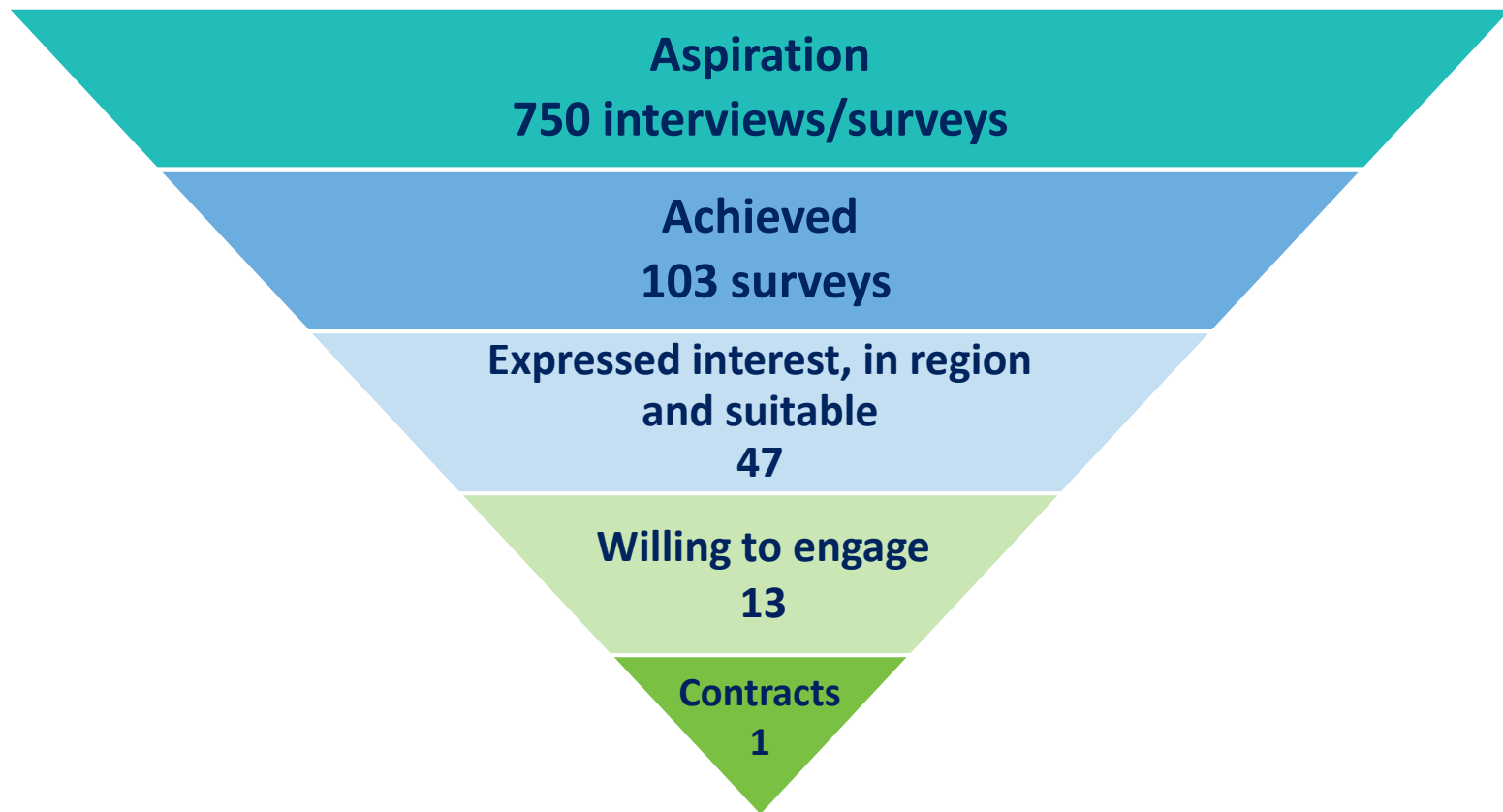


Survey analysis  
*'appeared to prove'*  
the hypothesis that the

**Respond method enables a  
market for an FCL service**



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



# Risks - barriers to transitioning from interest to agreeing terms



Essential to have electricity available 24/7 or a 10 minute constraint would have significant impact  
Connection not within project timescale or not connected in parallel



Nervousness about the number of constraints  
Long- and short-term impact on equipment/increased maintenance



Impact on operation of their business & loss of export ability  
Breach of service level agreements (Triad and capacity market) and reputation



Unease at relinquishing control of equipment  
Arrangements for re-closure/having staff on standby



Financial incentive = key driver for target market  
**But only if sufficient to offset all risks AND the revenue from other commercial arrangements**



## DNO community must develop greater commercial understanding of its target market



Transition from expression of interest to active participation in FCL service identifies need for greater awareness



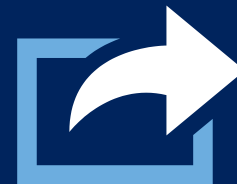
Loss of critical plant, even for a short duration, can have a significant impact



Assessment of risk verses the incentives and saving available is fundamental in an organisation's decision-making process



Conflicts with other services are a significant barrier  
DNOs need to better understand services already available in expanding and competitive marketplace



While there are potential conflicts, equally there could be possible synergies which warrant further investigation



~ 10% of primary  
switchboard  
replacement costs  
for adaptive  
protection



$I_s$ -limiters more  
cost effective  
when deferring  
cable overlays



Up to  
502,594kgCO<sub>2e</sub>  
for adaptive  
protection



Up to  
40,331kgCO<sub>2e</sub>  
for I<sub>s</sub>-limiters



Extrapolates to  
~7,432,431kgCO<sub>2e</sub>  
for a GB-wide  
rollout





Demonstrated FLAT can be used to calculate near real-time fault levels and enable techniques



AP and Is-limiter were successfully implemented and can reduce fault level



FCL service is technically proven but there is currently no commercial appetite



Safety cases produced and peer reviewed for each technique



Closedown report – end October 2018



Update our policy and procedures to use the Respond techniques

# QUESTIONS & ANSWERS

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