Active fault level management

Introducing the Fault Current Limiting service

LCN Fund
Low Carbon Networks

electricity north west
Bringing energy to your door

Introduction

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RESPOND

Background	The Respond project	The Fault Current Limiting (FCL) service	Helping us to trial the FCL service

Introducing Electricity North West

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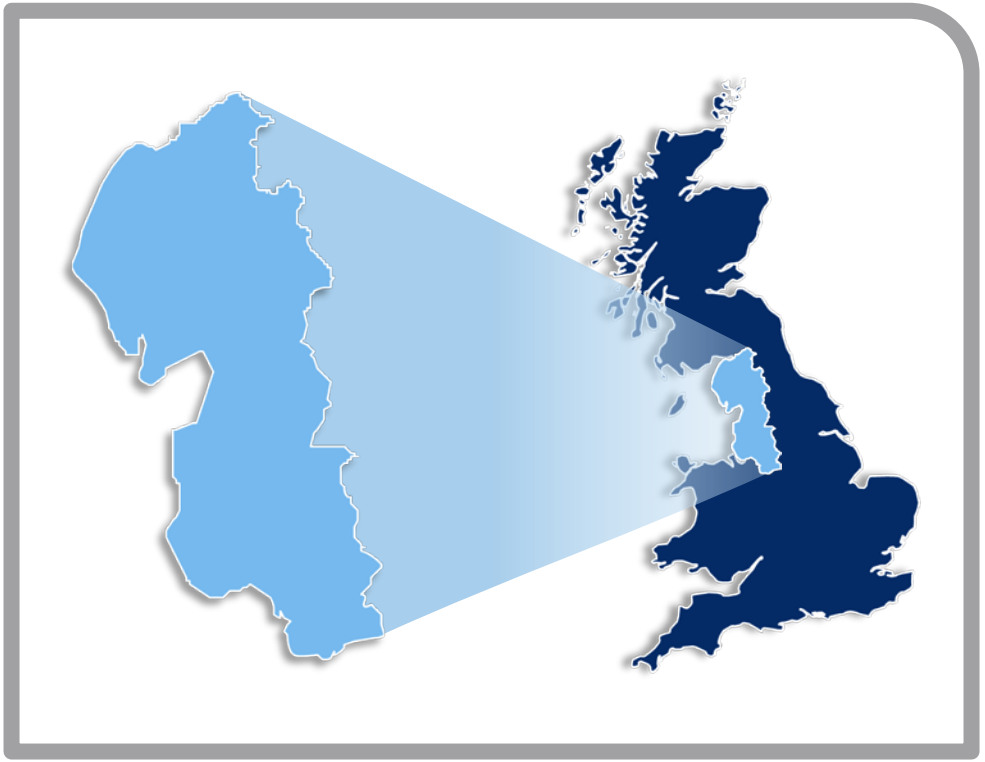
4.9 million

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

UK energy challenges

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2015

1/3 gas
1/3 electricity
1/3 oil

2020

15% of energy from renewables

34% reduction in CO_2

Generation mix is radically ‘overhauled

2030

60% reduction in CO_2

Electricity demand increases, driven by electric cars & heat pumps

Distribution network capacity significantly increases

2050

80% CO_2 reduction

Significant increase in electricity demand

Uncertainty in future demand and generation ● Difficult to predict demand ● More pressure to meet customers’ needs at minimum cost

Background

LCN Fund
Low Carbon Networks

Competitive competition

Funded by GB customers

Learning, dissemination & governance

4th of ENWL's 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
PB PARSONS BRINCKERHOFF
ENER-G
ABB
Impact Research
United Utilities
ade

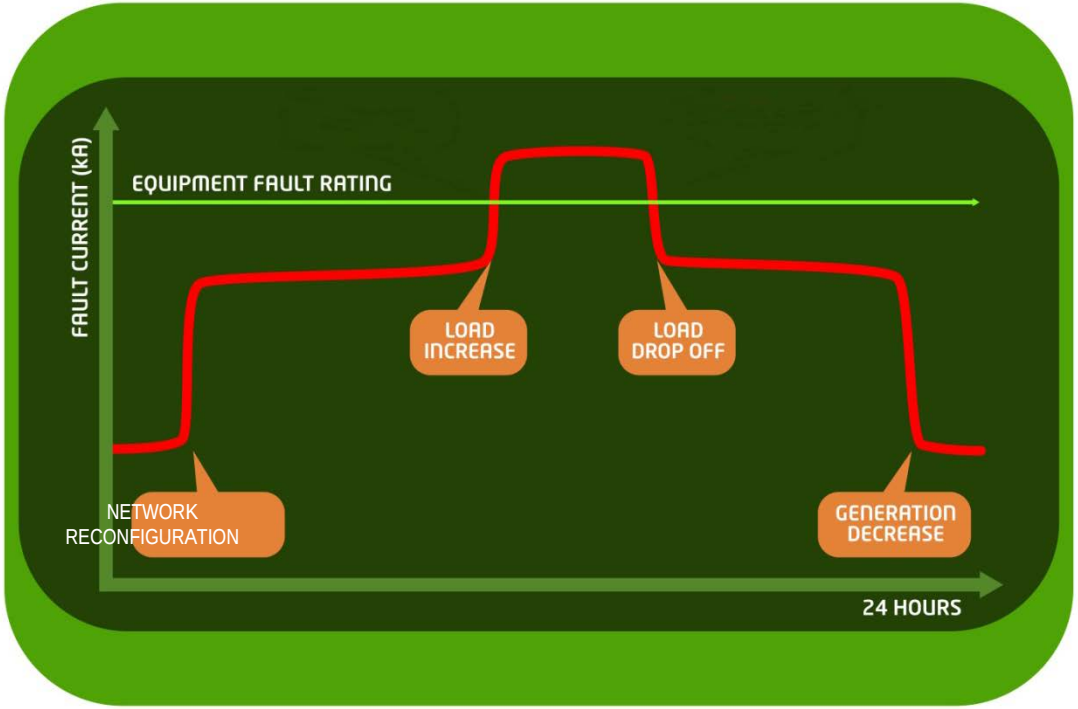
Financial benefits

Up to £4.9m at project scale

Respond video

Fluctuating fault level

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



Can we manage these issues without expensive reinforcement ?

What is fault current?

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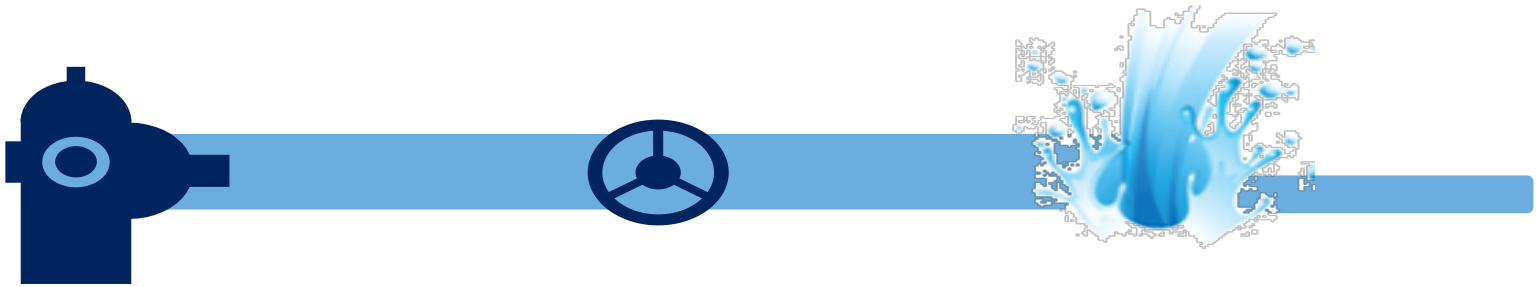

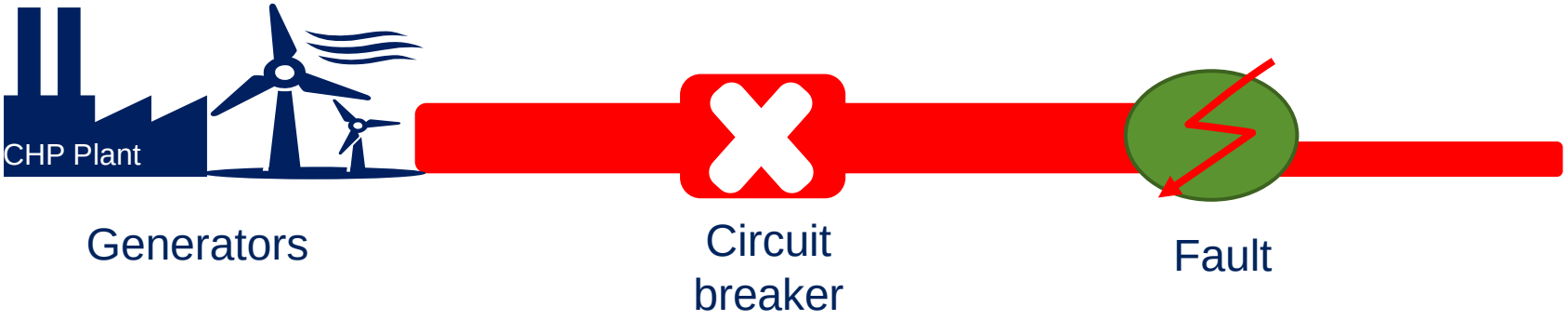

Turning off some of the flow of electricity from generation sources, for just a few minutes when a fault occurs will prevent damage to the electricity network.

1: Background (Fault current)

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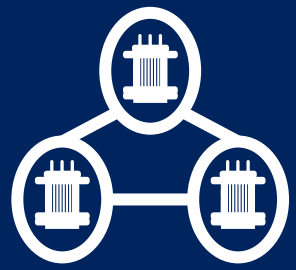
One connected network



All electrical plant, equipment, cables are connected together as one electrical system

Any change or fault has an impact on the whole system

It's just a matter of scale

Sources of electricity

Electricity can be generated in a number of ways:

Rotating machines

Solid state (PV panels)

Fault current

A rush of current from every source of generation to the point of the fault

This fault current depends on the type and size of generator and distance to the fault

Fault current is the total of all individual fault currents produced by every connected source of generation

1: Background (Protective devices)

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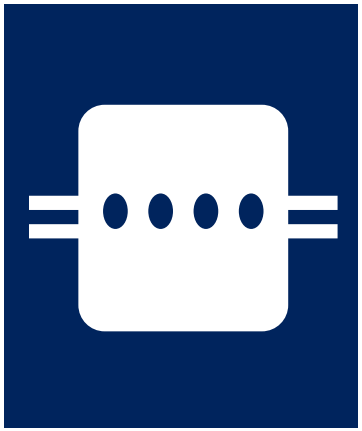
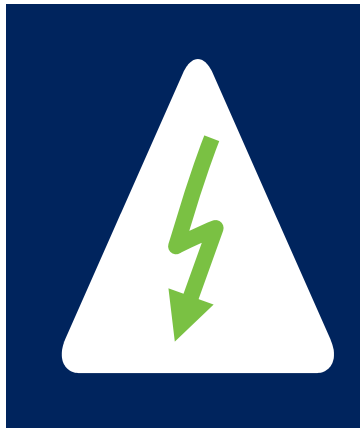
Public and private electrical networks are designed to fail safe by law



Electrical networks are designed to have protective devices such as fuses, switches and circuit breakers in key locations

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



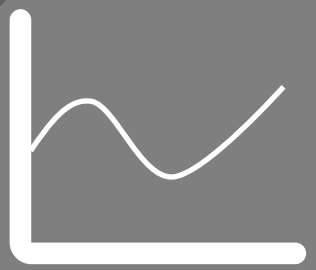
This prevents the uncontrolled release of energy at the fault location and removes the fault

Each protective device has its limits

Operation beyond those limits could cause it to fail and cause a second fault

Respond – the fault level challenge

Networks are designed to meet customers' load or demand



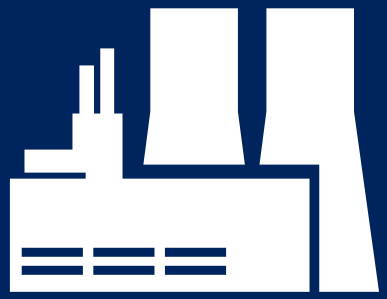
Design takes account of worst case scenario

Respond reduces fault level to within safety capacity, using one of three innovation solutions

If fault level is higher than safety level, traditional approach means asset replacement

Respond

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 at up to five 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

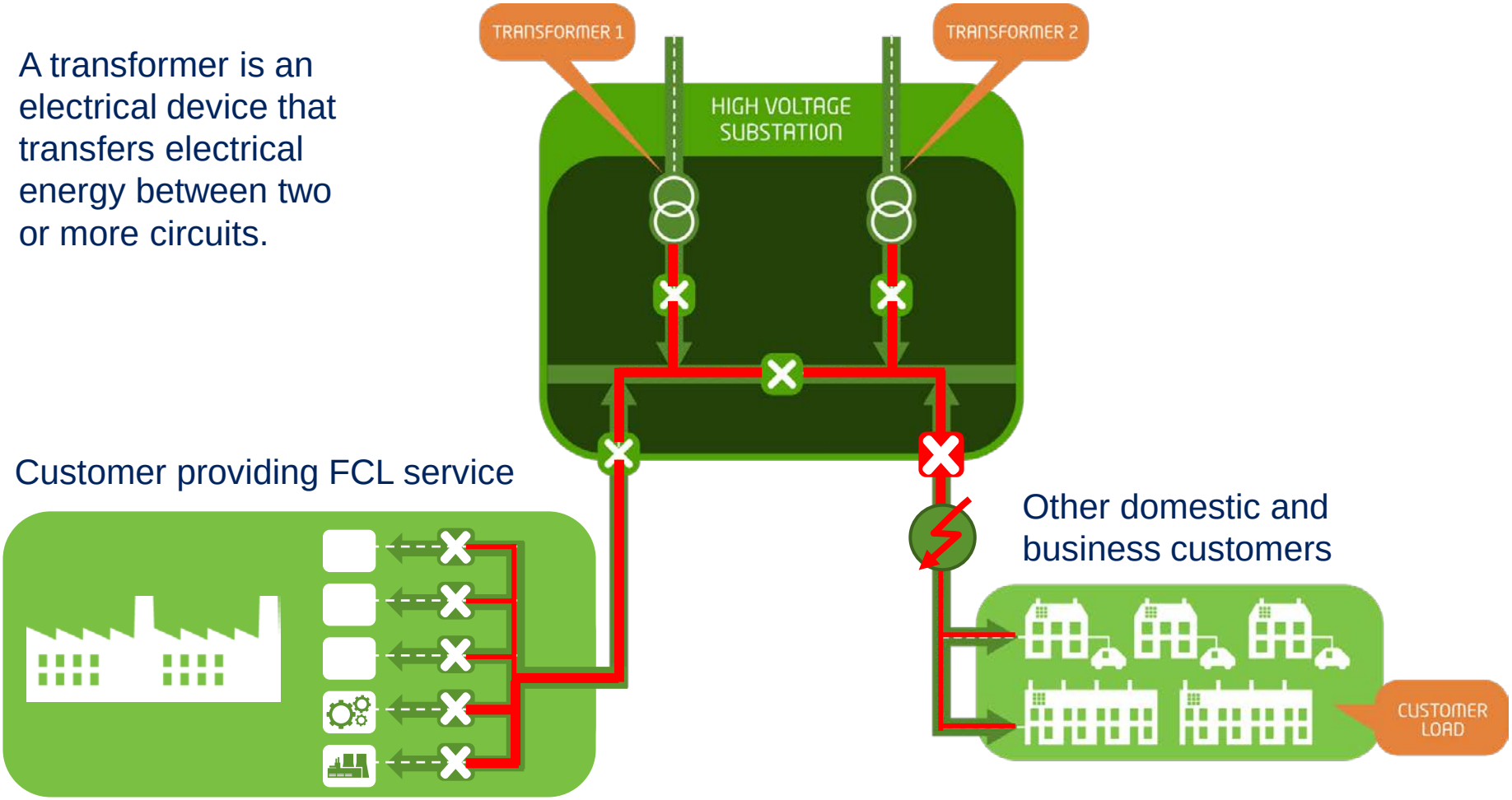
We are now engaging with customers, to take part in a trial of the FCL service

Suitability for the FCL service is dependent on:
The demand or generation capacity of your equipment / Your organisation's operating voltage / The Fault Level on the part of the network that supplies you.

- FCL service video

Current situation: Total fault current could overload a circuit breaker

A transformer is an electrical device that transfers electrical energy between two or more circuits.



Respond Scenario: Fault current reduced by customer providing FCL service

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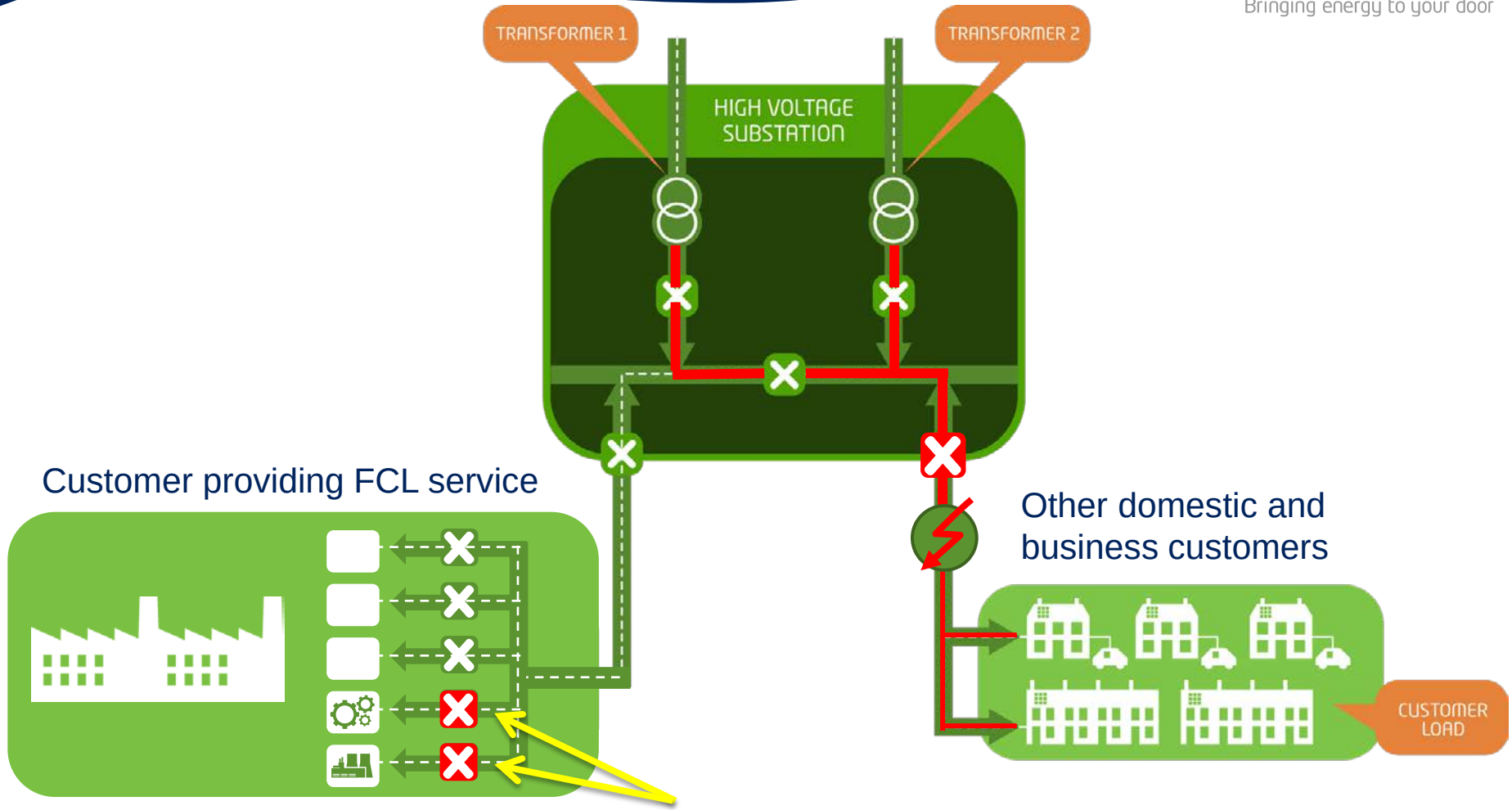
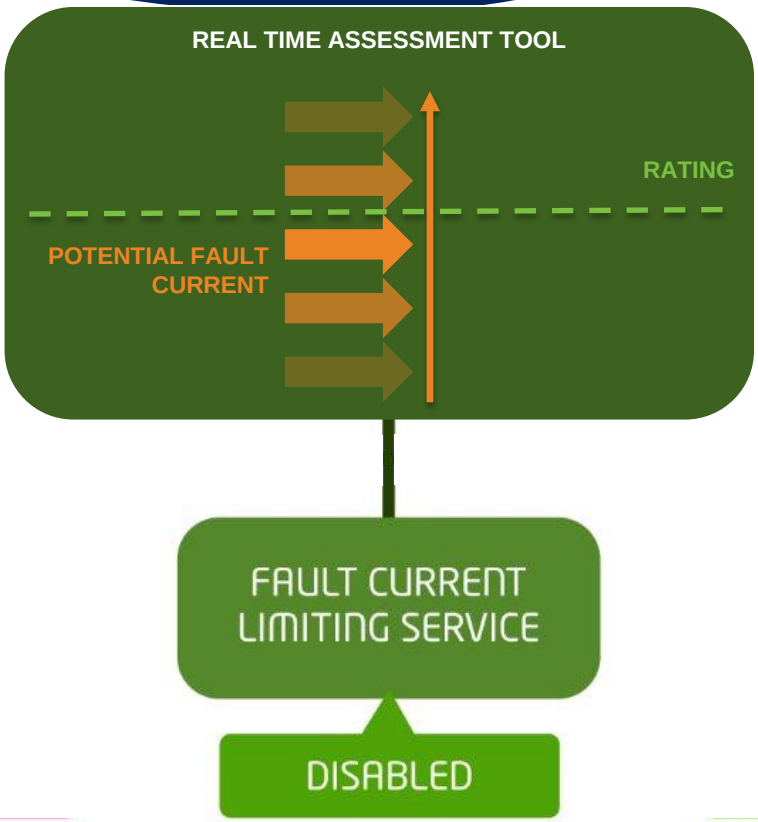


Customer protection operates before our CB

Motor or generation source remotely turned off by Electricity North West for just a few minutes, so that it no longer contributes to the fault current.

Real time mitigation techniques



The technique will only operate when the fault level is exceeded and FLAT enables the technique, then we need to have a network fault.

Therefore the probability of triggering is low, so we have the ability in the FLAT tool to reduce fault triggering level to test the techniques

Customer A : 5MW generator near to the primary substation

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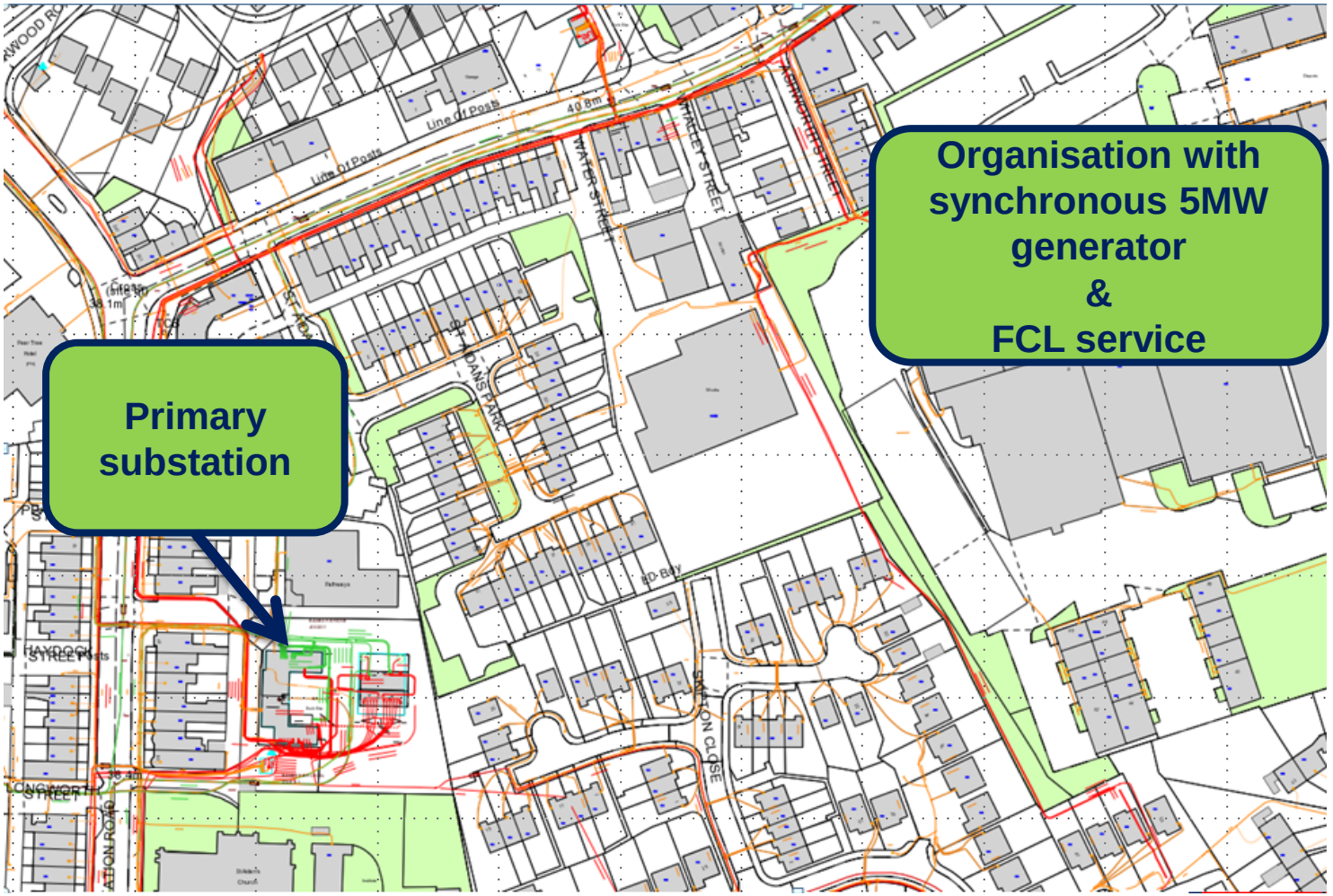

FAULT LEVEL ASSESSMENT TOOL

NETWORK MANAGEMENT SYSTEM

FAULT LEVEL HIGH
ENABLE THE FCL SERVICE

NETWORK FAULT OCCURS

RESPONSE ACTIVATED - CIRCUIT BREAKER TRIPS

Your fault history (last 5 years)

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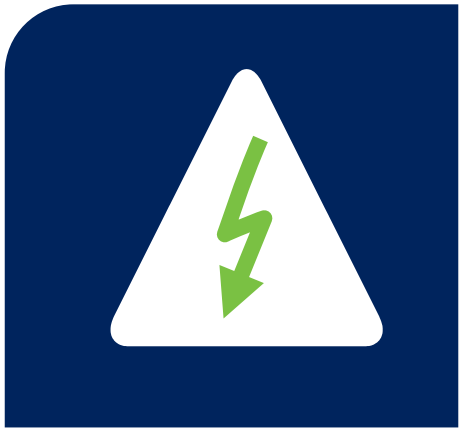


Fault History

40 faults

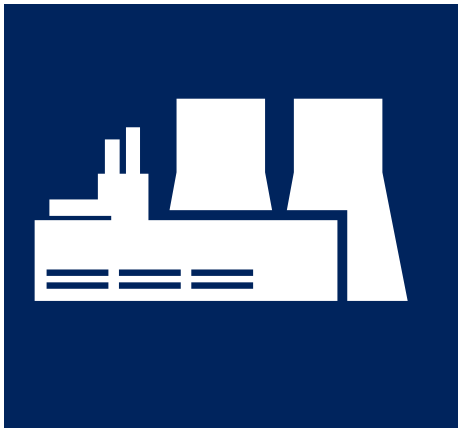
in **5** years

on circuits out of the primary substation

supplying your site

8 each year

on average

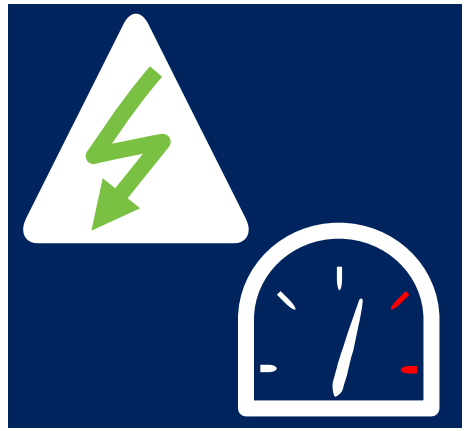


Loss of supply

In 5 years your factory has experienced

1

fault that interrupted your electricity supply



Enabling the FCL service

Of these 40 faults

8

where the type that could have activated the FCL service

But **Only IF** Fault Level was high at the time

Activating the FCL service

On average

twice

per annum

Customer A - contribution to Fault Level and indicative payments available

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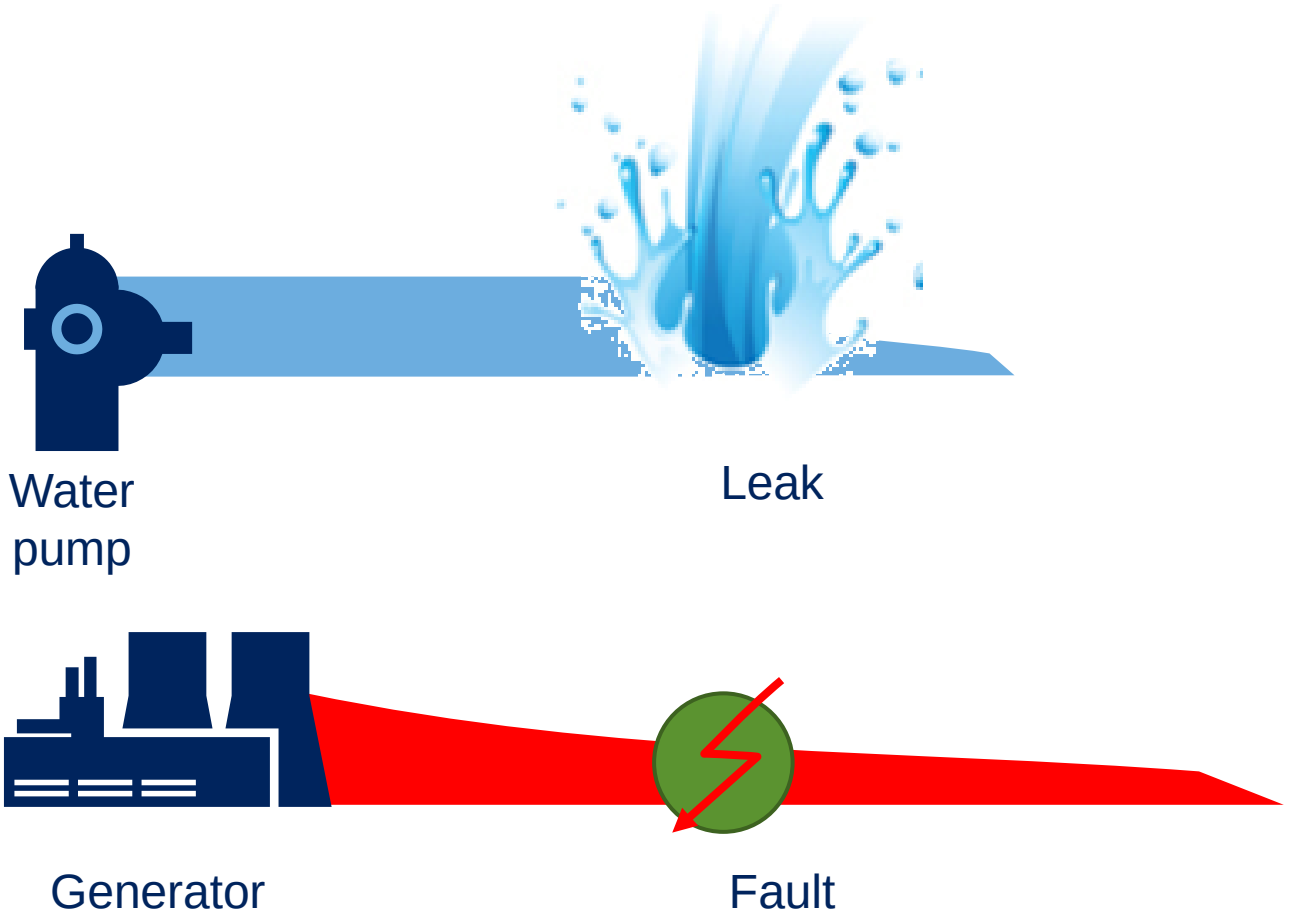
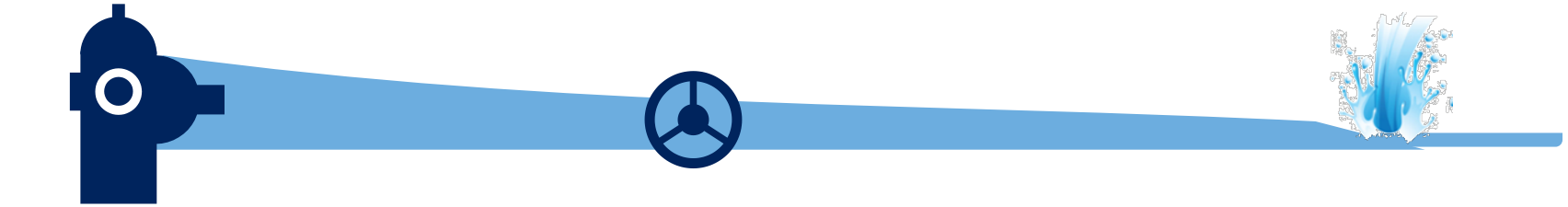
Generator type	Synchronous	
Capacity of generator (MW)	5 MW	
Operating Capacity	Full	
Operating Frequency	Constant	
Fault level contribution (multiplier of MVA nameplate rating)	6 X	
Maximum Fault Level contribution (MVA)	30 MVA	
Distance to primary substation	0	
Actual Fault Level contribution at the primary substation	30 MVA	
Historical fault events per year	2	
Annual availability payment	£53,065	1
	£63,678	2
	£76,291	3
	£84,904	4
	£95,517	5

Term of contract (years)

FCL service
Contribution to fault current (water analogy)



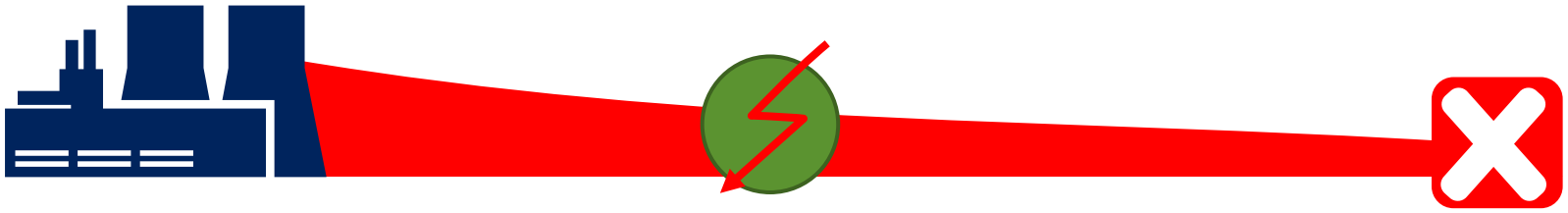
FCL service – effect of impedance



Water pump

Valve

Leak



Generator

Fault

Network Circuit Breaker at primary substation

Customer B: 5MW generator a distance from the primary substation

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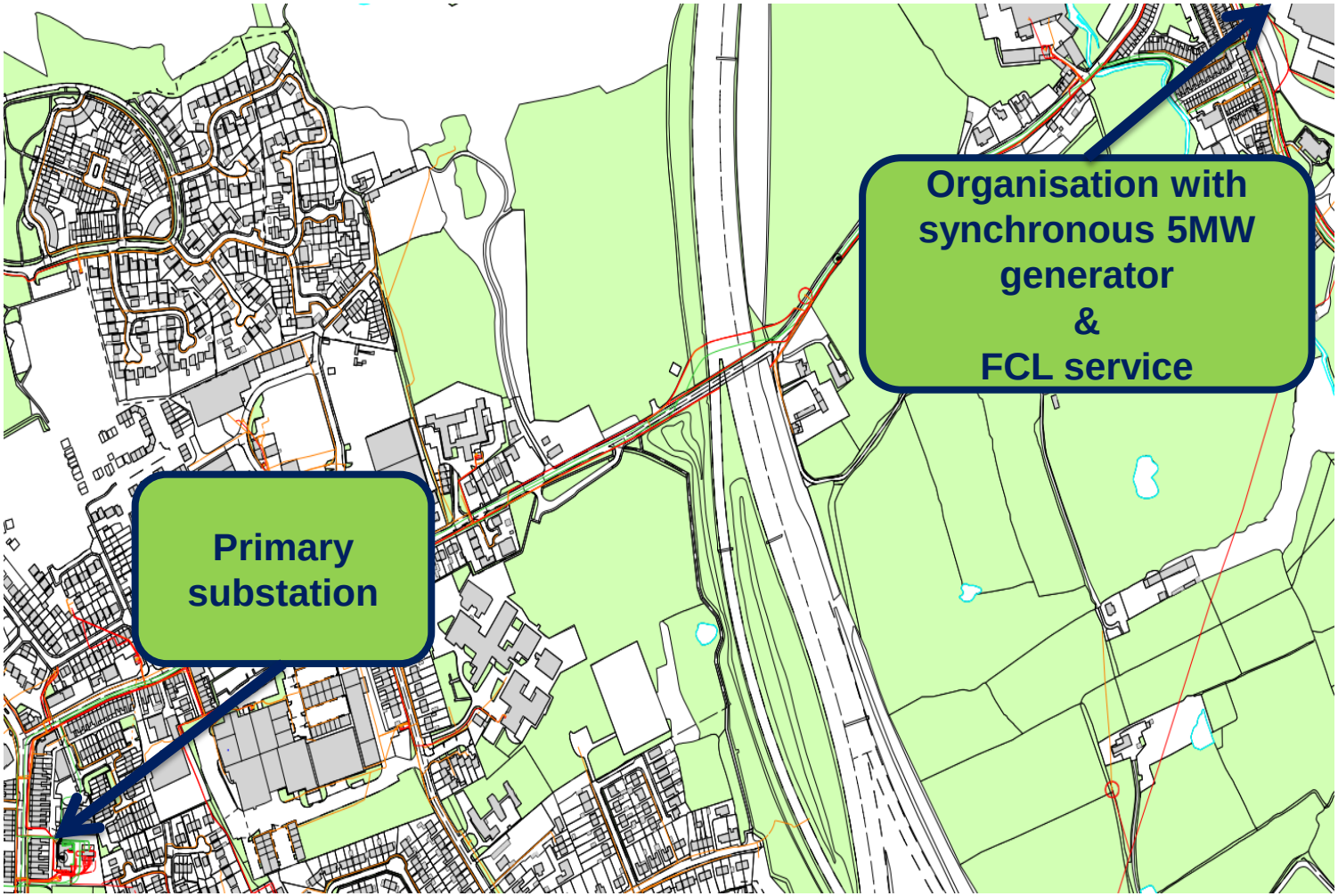

FAULT LEVEL ASSESSMENT TOOL

NETWORK MANAGEMENT SYSTEM

FAULT LEVEL HIGH
ENABLE THE FCL SERVICE

NETWORK FAULT OCCURS

RESPONSE ACTIVATED - CIRCUIT BREAKER TRIPS

Customer B - contribution to Fault Level and indicative payments available

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Generator type	Synchronous
Capacity of generator (MW)	5 MW
Operating Capacity	Full
Operating Frequency	Constant
Fault level contribution (multiplier of MVA nameplate rating)	6 X
Maximum Fault Level contribution (MVA)	30 MVA
Distance to primary substation Impedance calculation (length, size & type of cable)	Site embedded further out in the network
Actual Fault Level contribution at the primary substation	6 MVA
Historical fault events per year	2

Annual availability payment	Term of contract (years)
£10,613	1
£12,736	2
£14,858	3
£16,980	4
£21,226	5

Fault Current Limiting service
Getting involved in the trial

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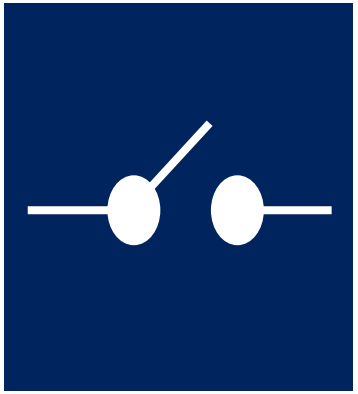
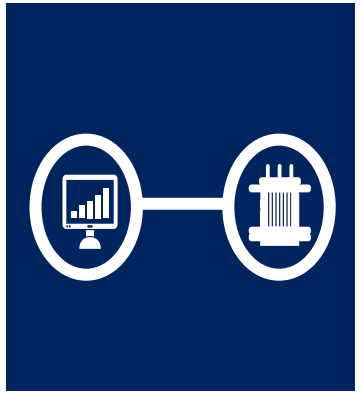
You have equipment that can contribute to fault current



Are you 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?

Next steps

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Feb 2016	Apr 2016	May 2016	Jun 2018	Oct 2018
Customer engagement Survey and results	Customer Consultation Contract and technical negotiations	Agree contract Install and test technologies	Trial Customer survey and post event analysis	Closedown Report findings

Knowledge sharing and dissemination

For more information on Respond

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	**www.enwl.co.uk/respond**
	**www.enwl.co.uk/respond-survey**
	**www.enwl.co.uk/respond-videos**
	**futurenetworks@enwl.co.uk**
	**0800 195 4141**

Thank you for your time and attention

QUESTIONS & ANSWERS

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