Innovation Learning Event

Wednesday 5 July 2017

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Introduction

Paul Turner
Innovation Manager

Housekeeping

Mobile phones

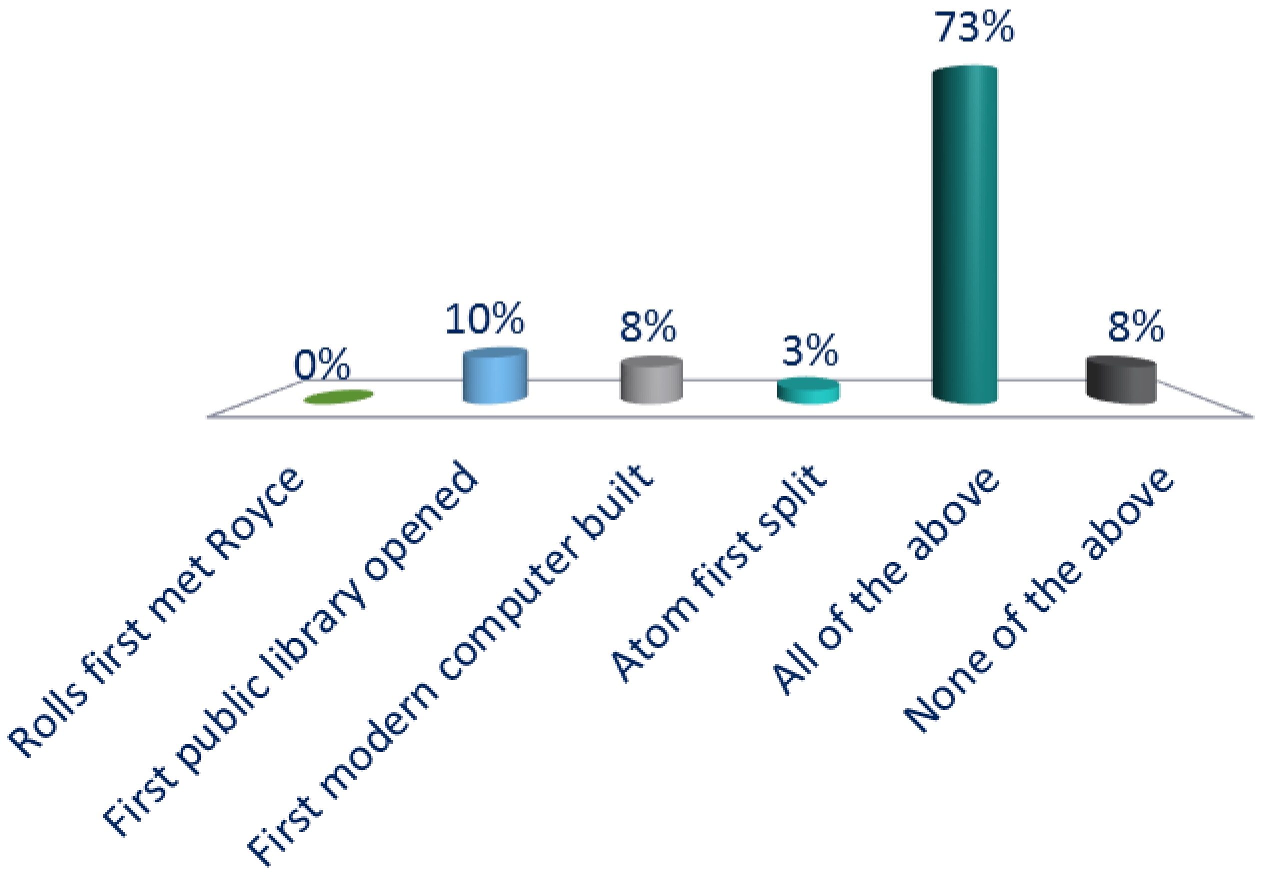
Breaks

Fire alarms

Main Q&A at end of day

Which of the following took place in Manchester?

A. Rolls first met Royce
B. First public library opened
C. First modern computer built
D. Atom first split
E. All of the above
F. None of the above



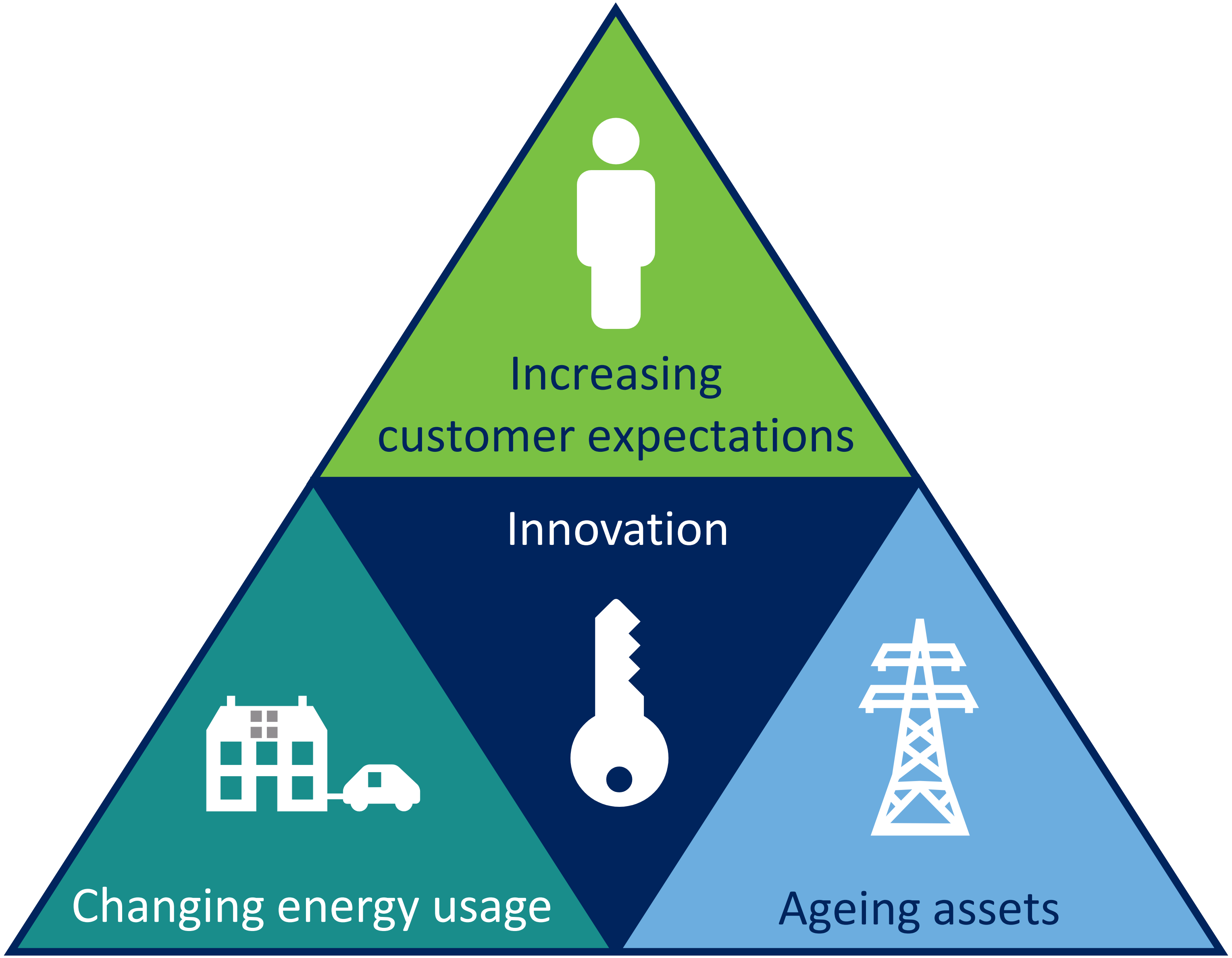
Agenda

Innovation strategy 10.00 – 10:15am	Respond 10.15 – 10.45am	Break 10.45 – 11.05am	Celsius 11.05 – 11.35am	DSO 11:35am – 12:05pm

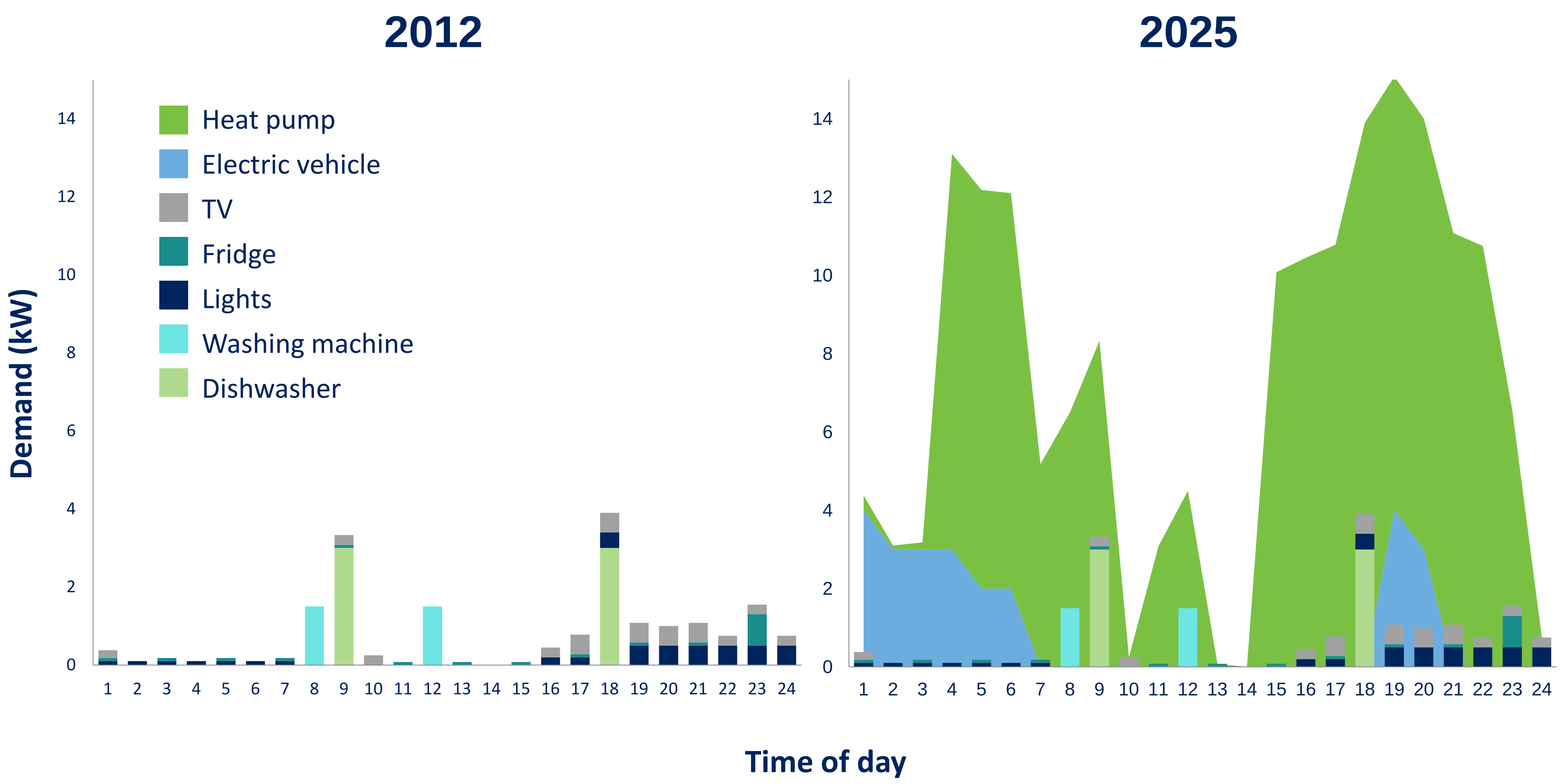
Introduction to our partners followed by lunch/networking 12.05 – 1.15pm

Breakout session 1 1.15 – 1.35pm	Breakout session 2 1.35 – 1.55pm	Break 1.55 – 2.25pm	Breakout session 3 2.25 – 2.45pm	Q&A & close 2.45 – 3.15pm

Our challenges

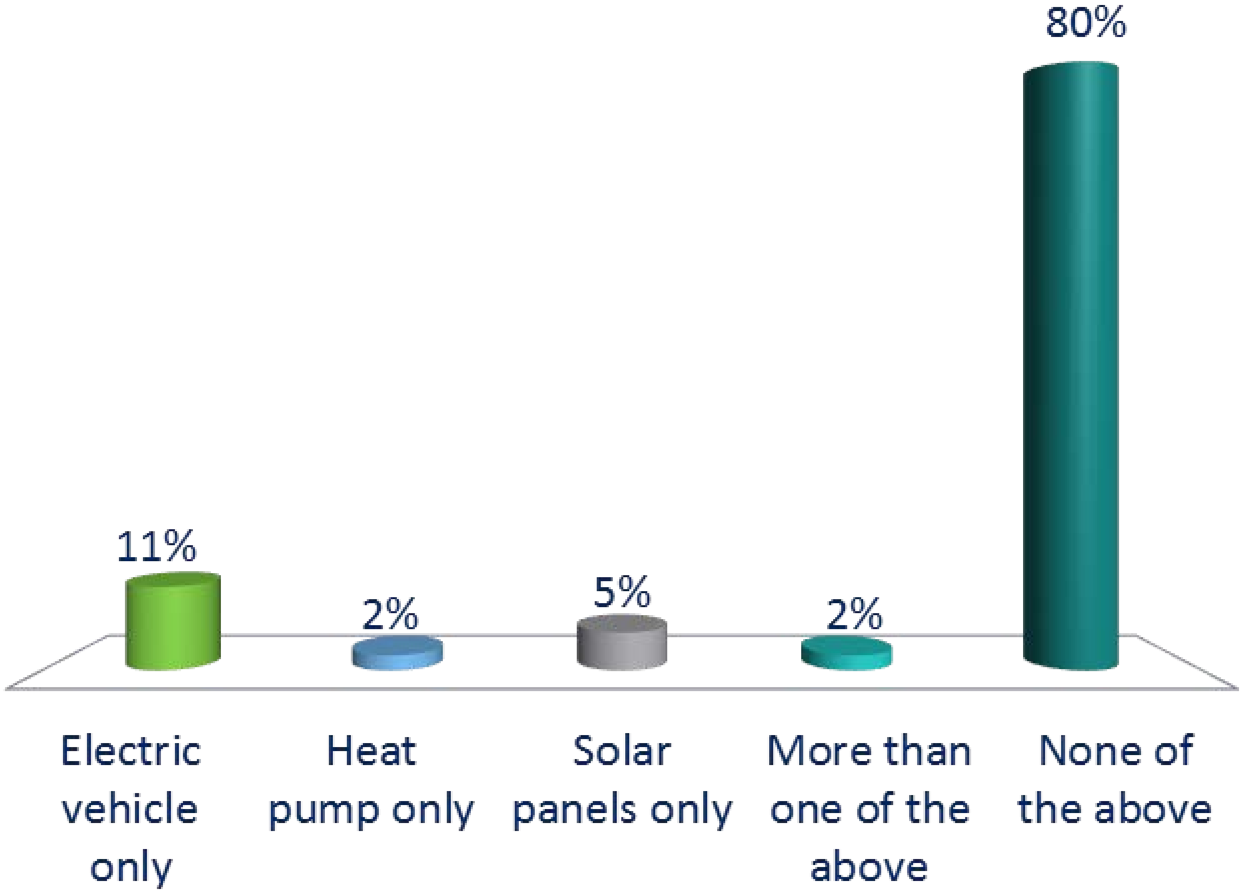


Demand changes



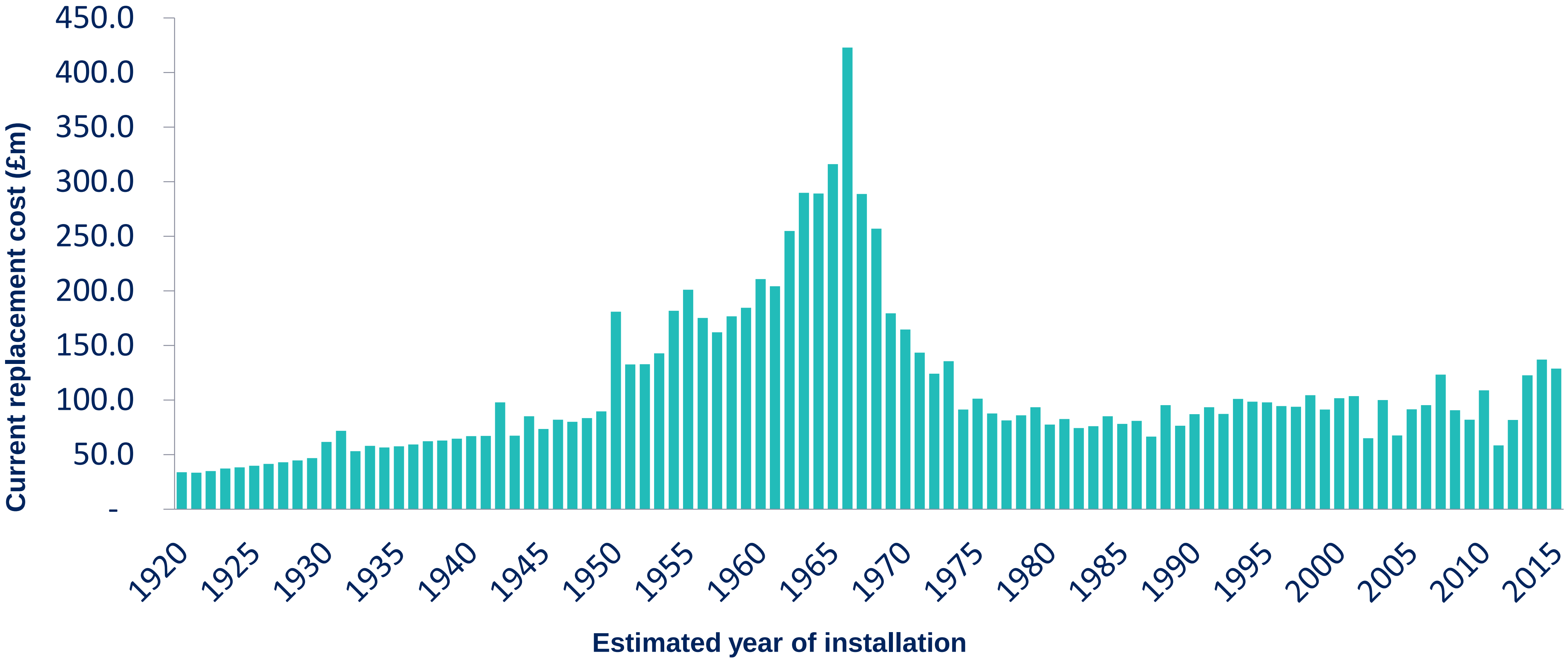
Do you use any of the follow low carbon technologies?

A. Electric vehicle only
B. Heat pump only
C. Solar panels only
D. More than one of the above
E. None of the above



Ageing assets

Age profile of assets



Opportunities

New technology

Automation

Weezap

Smart meters

Access to more data

New markets

DSR

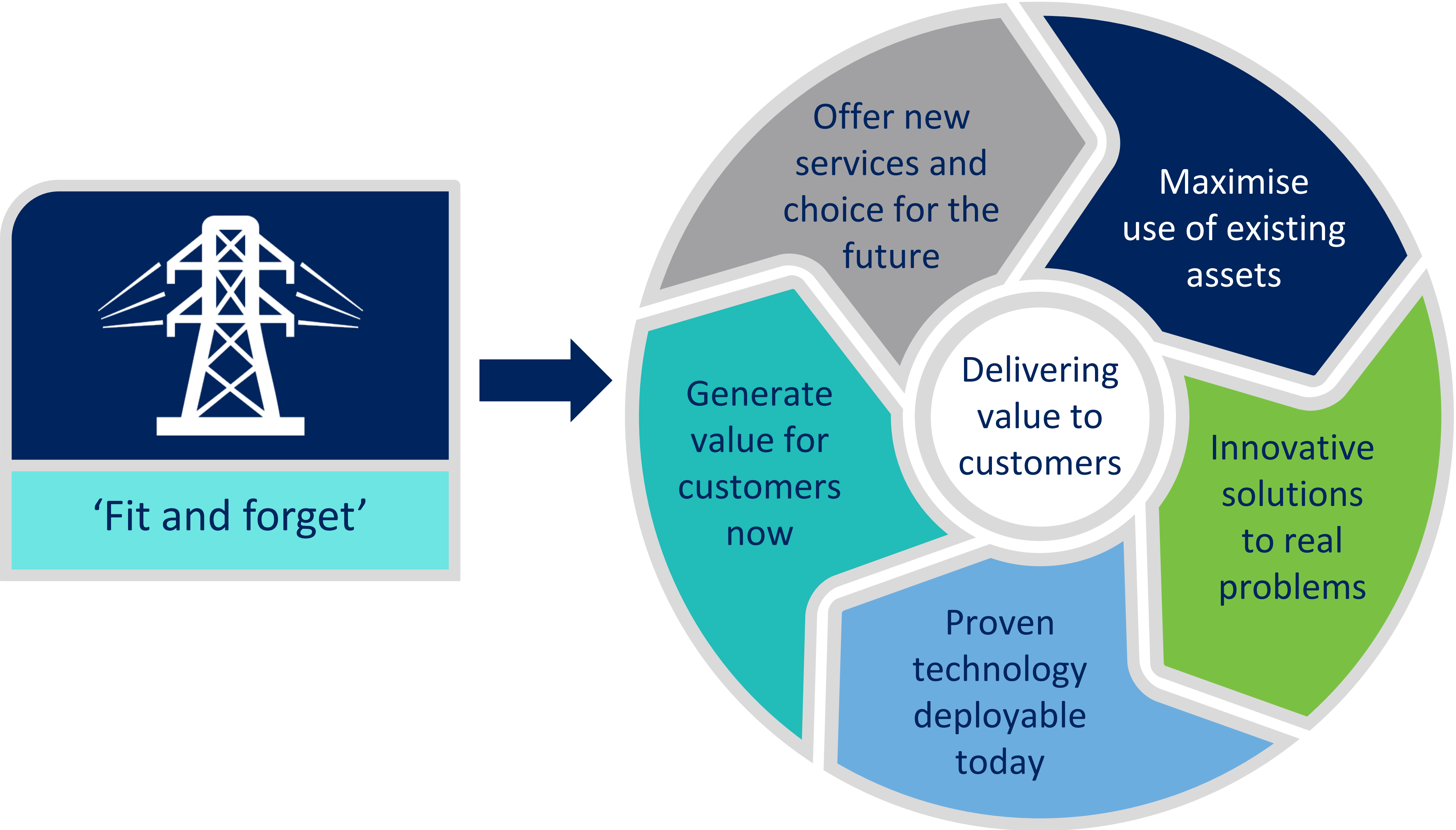
More open regulation

Incentives

Storage

Provision of response services

Our strategy



Transition to BaU

Assess

Assess learning to develop rollout plan

Allocate

Allocate to business owner

Policy

Update policies, processes and specifications

Impact

Review training and people impact

Brief

Conduct briefings and training

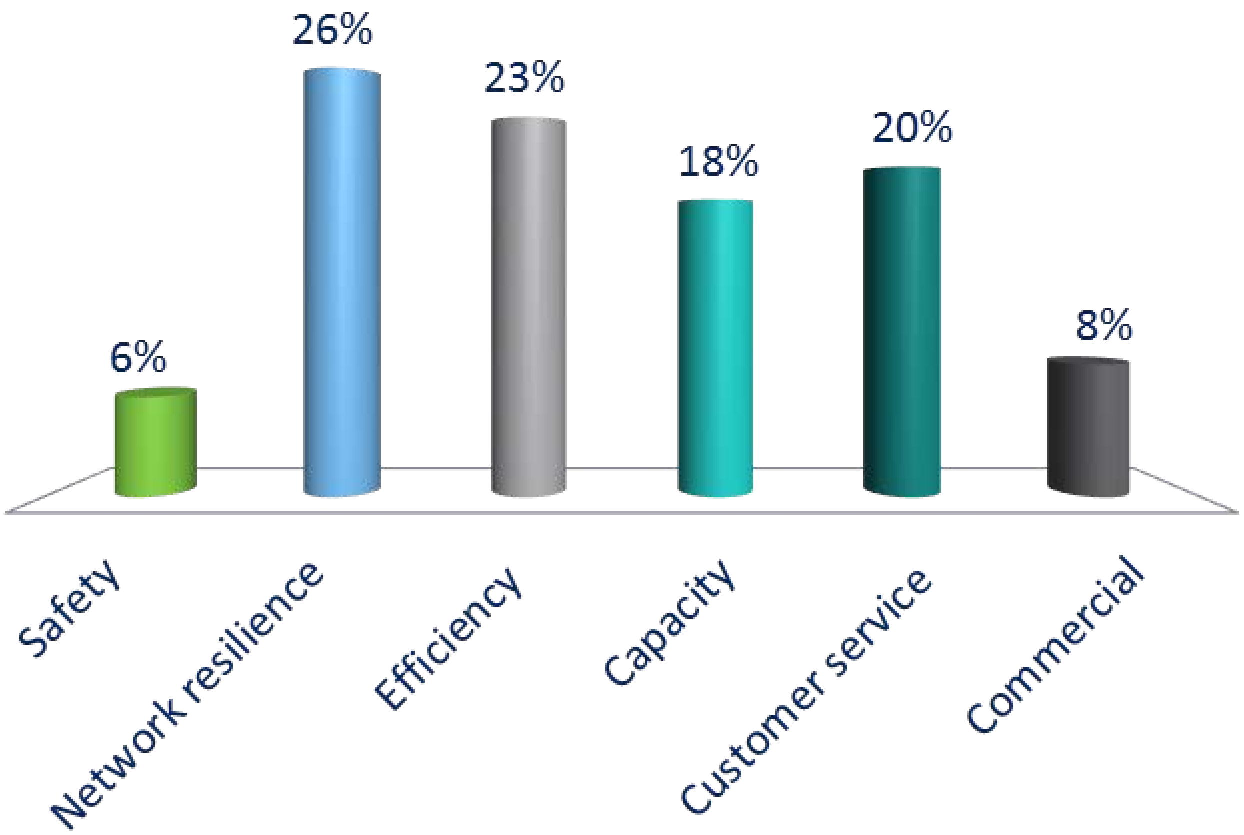
Business as usual

Innovation themes

Safety & environment	Network resilience	Capacity	Efficiency	Customer service	Commercial evolution
Strive to continuously improve safety and reduce impact on the environment	Improve network performance and reduce risk	Maximise the use of existing assets to increase demand and generation capacity	Provide our existing services at lower cost	Improve customer experience, offer new services and more choice	Change our role from network operator to system operator

On which strategy area would you like to see more focus

A. Safety
B. Network resilience
C. Efficiency
D. Capacity
E. Customer service
F. Commercial



Respond
Innovative Active Fault Management

Steve Stott
Innovation Engineer

Agenda

- Brief introduction to Respond
- Project aims
- Fault mitigation techniques
- Results so far
- Customer
- Safety case for techniques

Respond overview

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

Project partners

KELVATEK, Impact Research, WSP Parsons Brinckerhoff, ENER-G, ABB, Schneider Electric, United Utilities, ade

Financial benefits

Up to £2.3bn to GB by 2050

Respond project hypotheses

Faster and cheaper to apply than traditional reinforcement

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

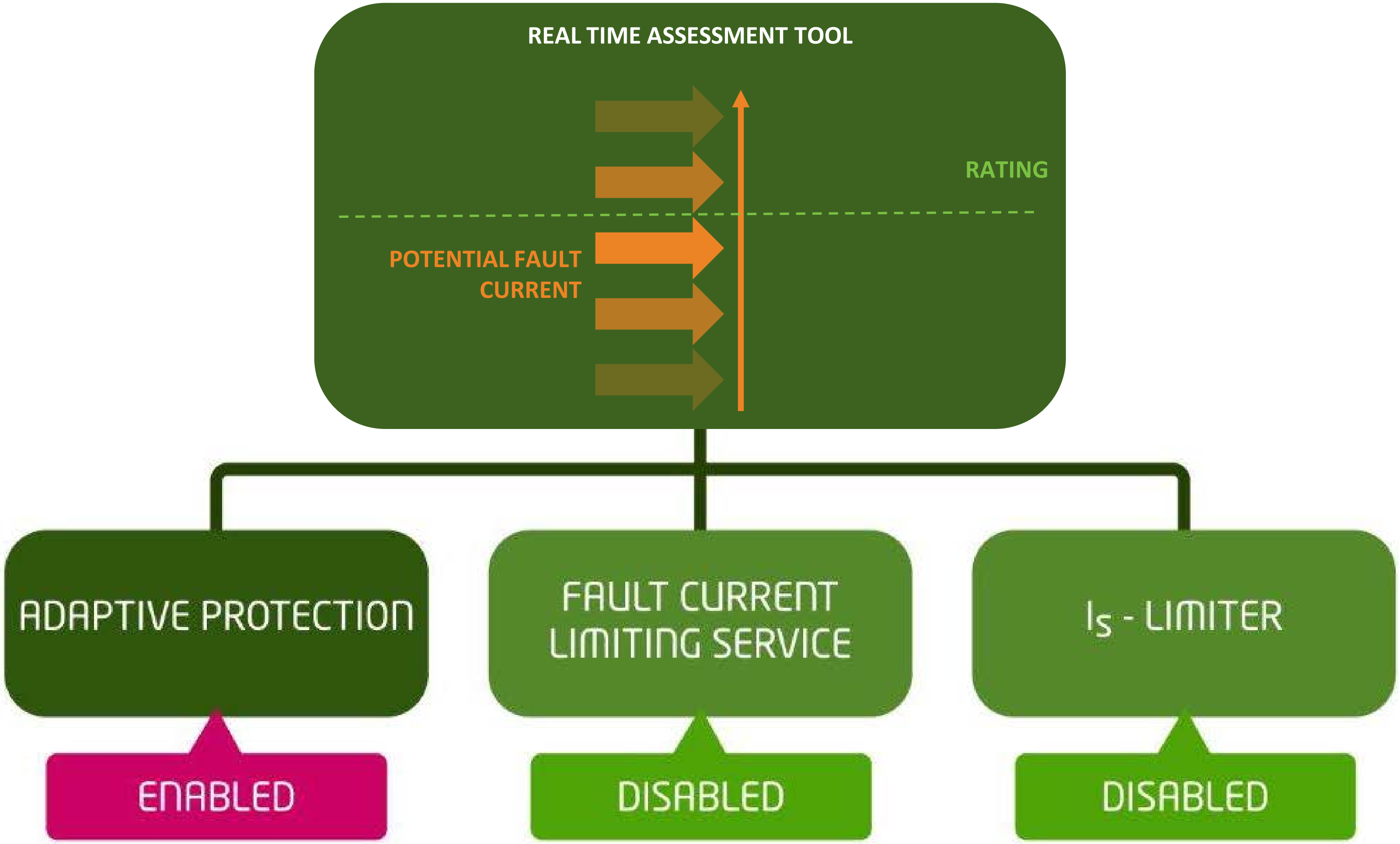
Facilitates active management of fault current, using retrofit technologies and commercial services

Enables a market for the provision of an FCL service

Uses existing assets with no detriment to asset health

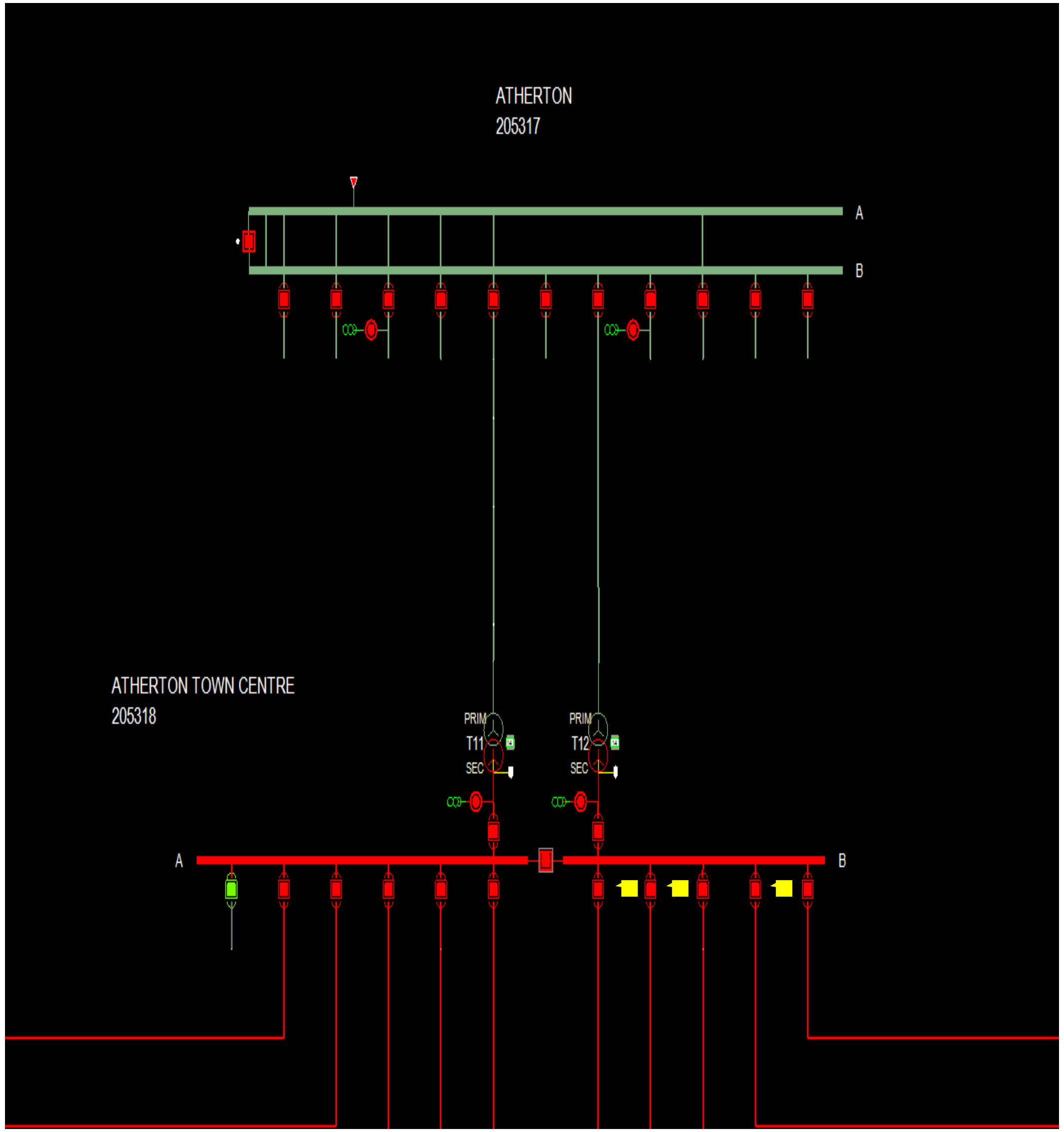
Reduces bills to customers through reduced network reinforcement costs

Real time mitigation techniques



● Real time fault current assessment ● Safe network operation ●

Fault Level Assessment Tool



Fault level calculation
Trigger topology
Change/time

Compares calculated FL with CB rating capacity

Symmetrical RMS break

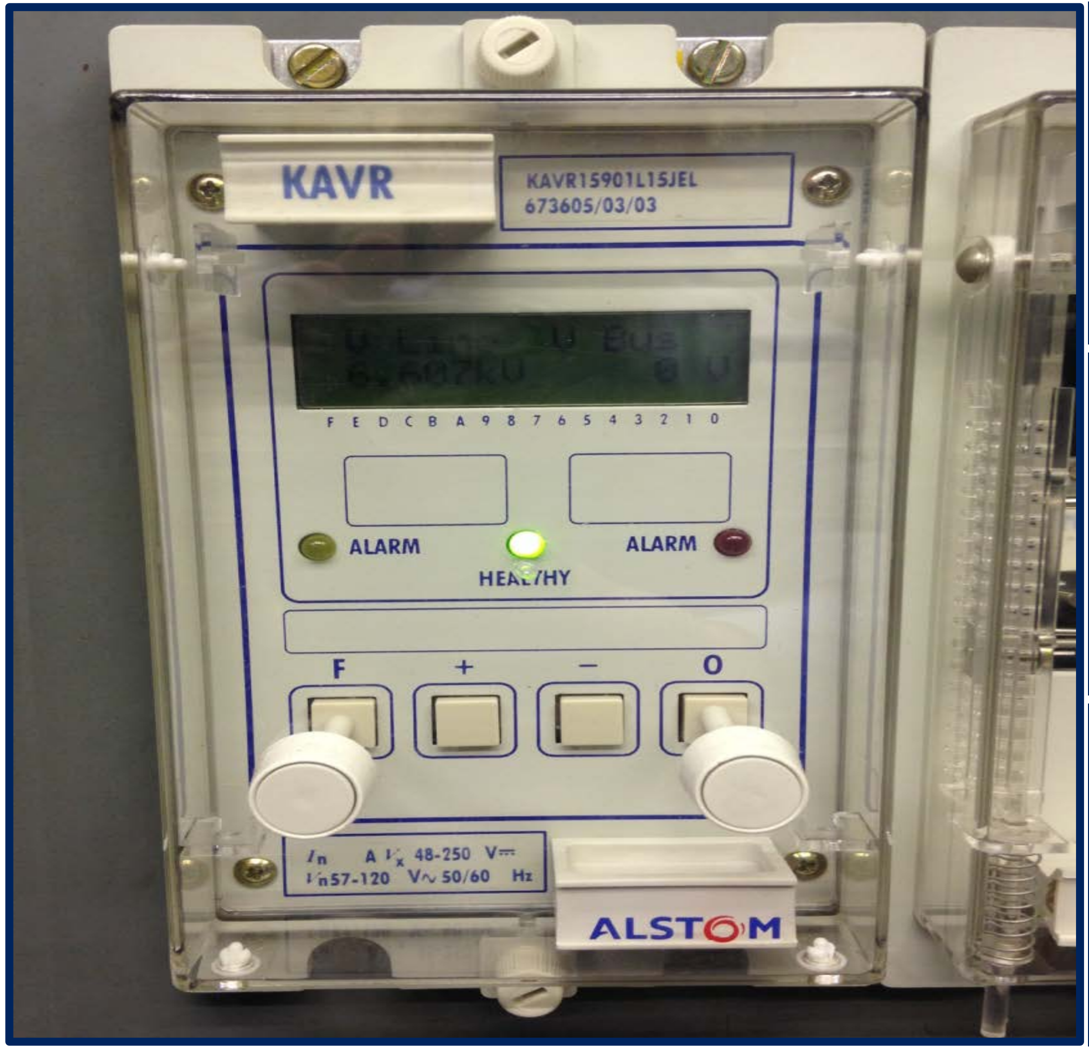
IEC606909

DISABLE

ENABLE

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

Adaptive protection at five sites

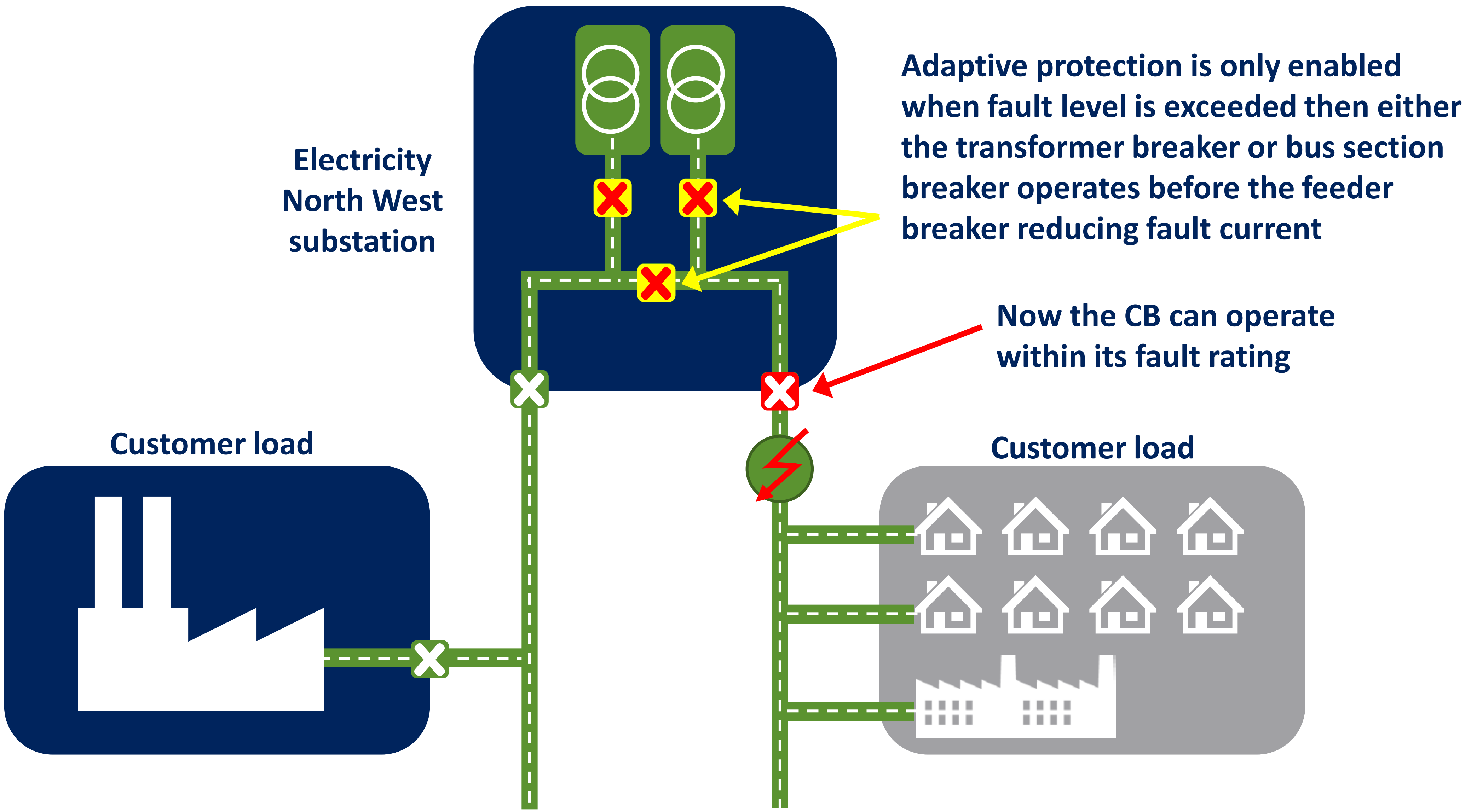


Network already designed to break fault current

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



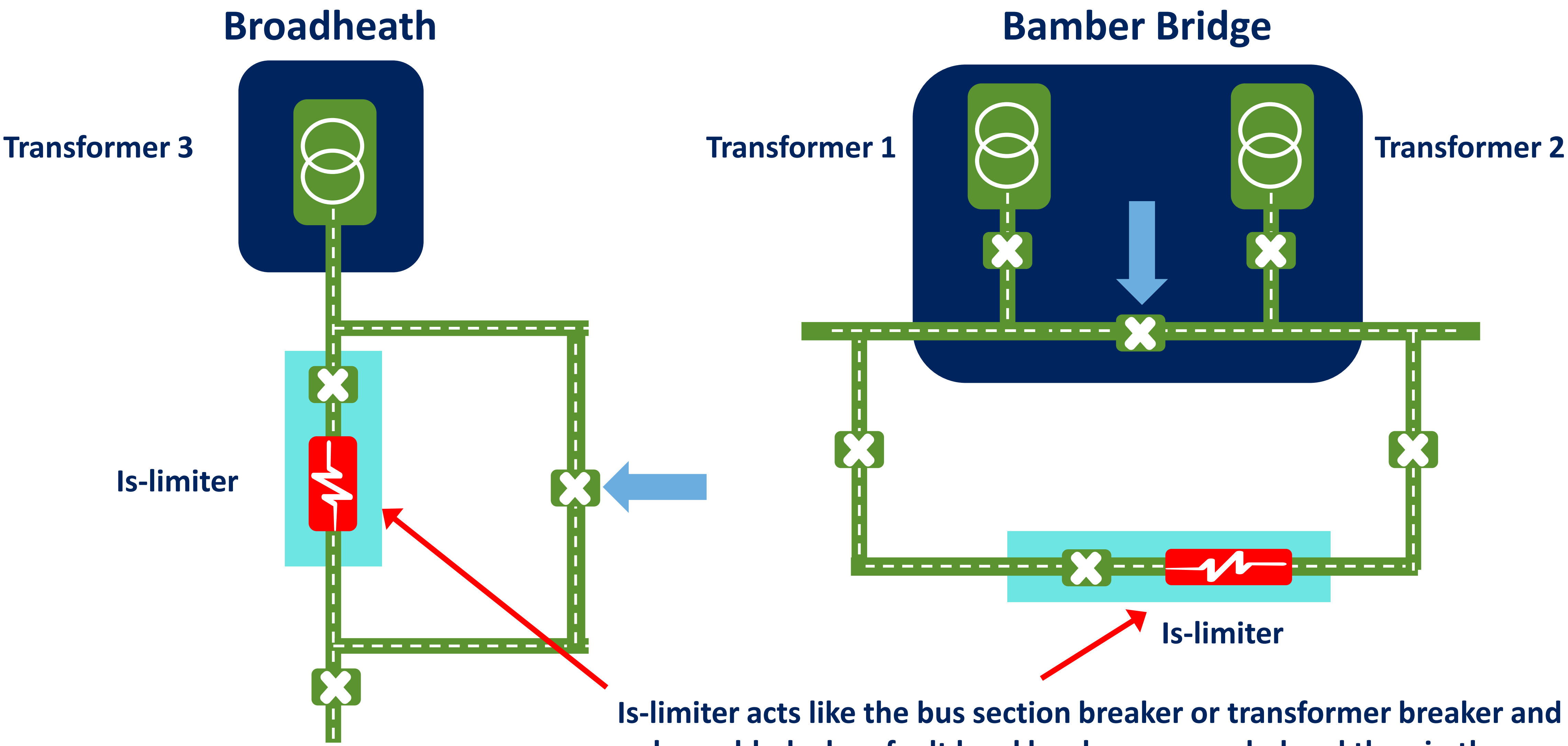
I_S limiters – Two sites and five sensing sites

Operates within 5 milliseconds or 1/200th 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



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
A01_1
INTERCONNECTOR
ABB


ABB
UniGear
ABB
UniGear
A01
INCOMING FEEDER
A02
OUTGOING FEEDER

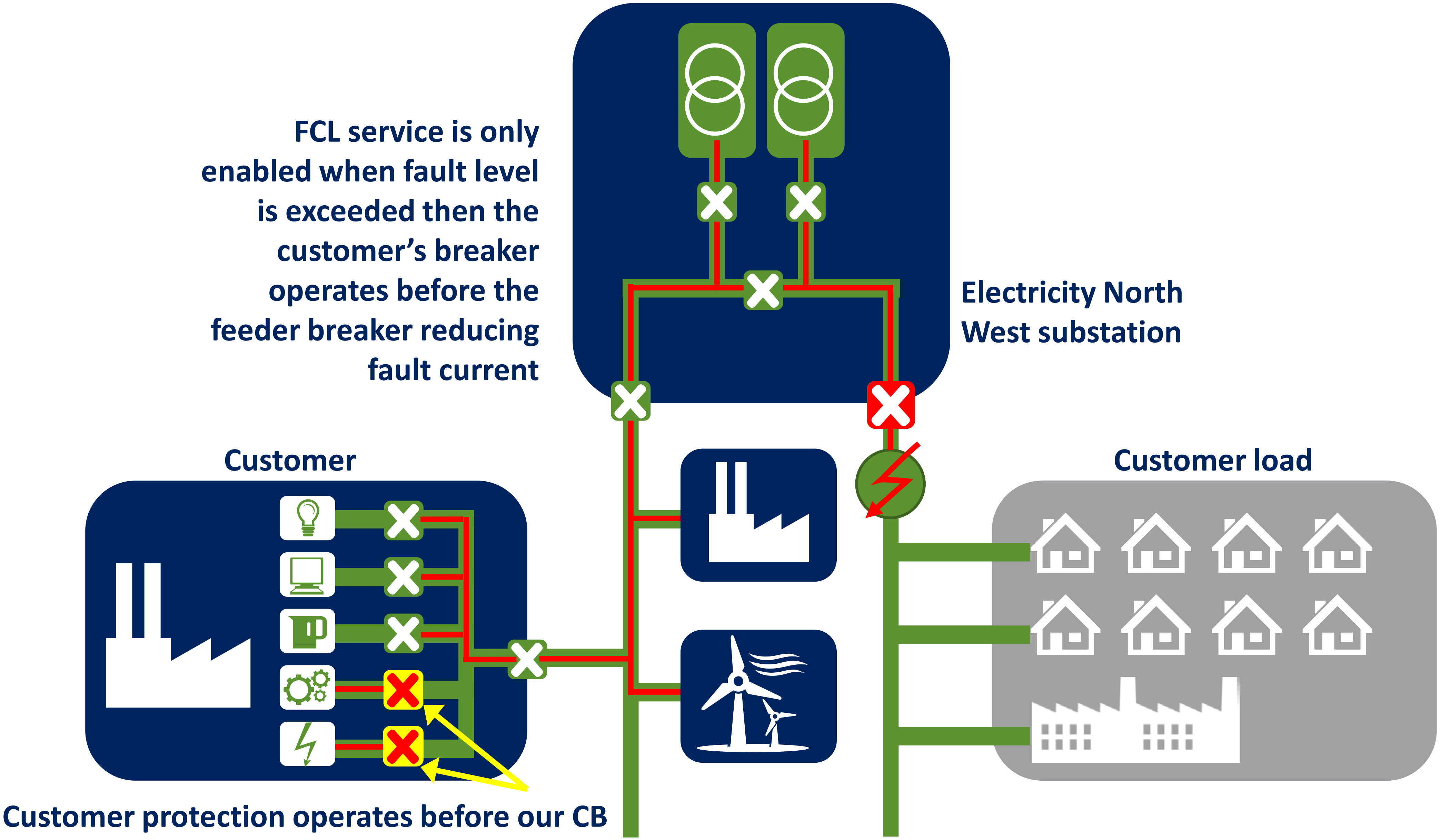
Fault Current Limiting (FCL) service

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

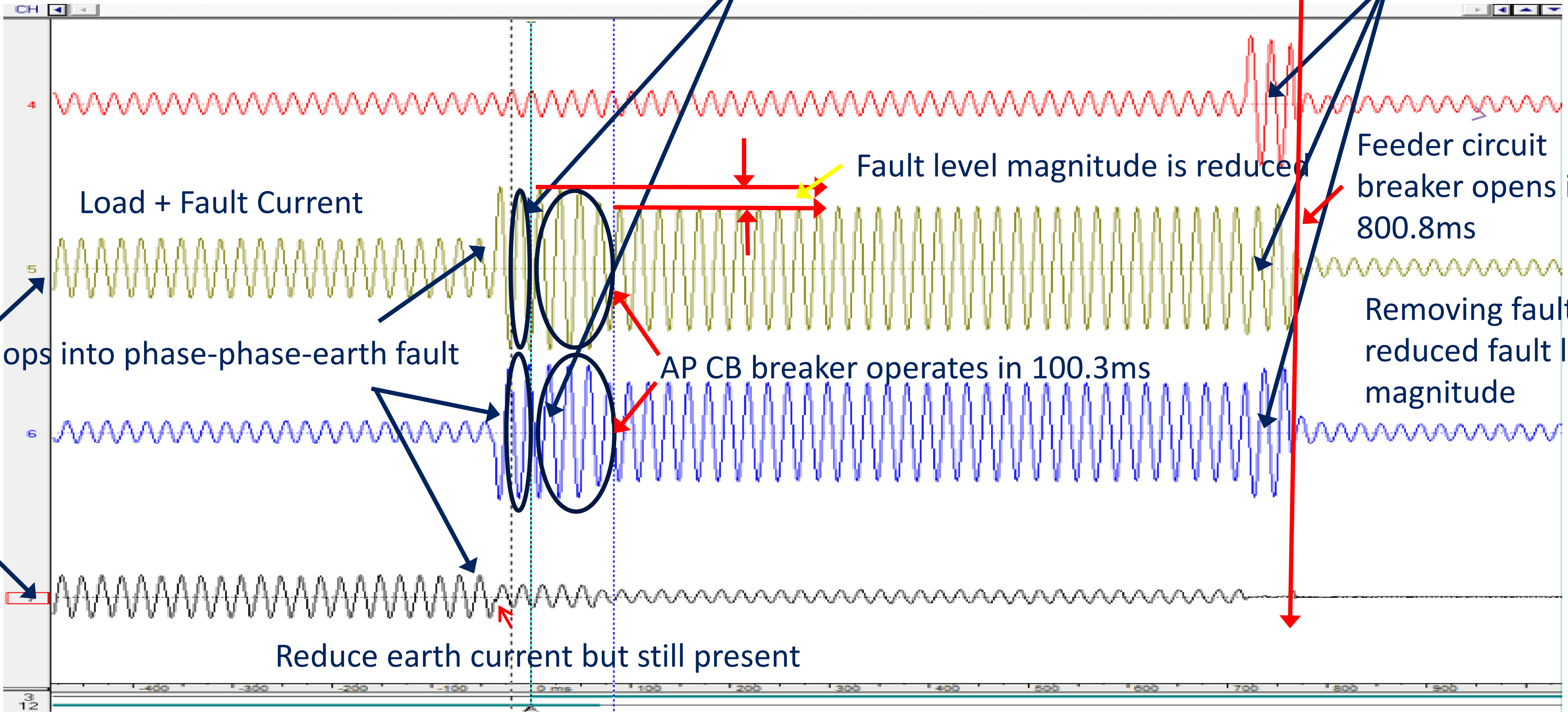


Trial for 12 months – what have we found out?

Substation	FLM technique	No of Network faults out of Substation	No of primary substation trips	No of successful operations of FLMT	No of failures of FLMT
Bamber Bridge	HV Is Limiter bus section	6	3	1	0
Broadheath	HV Is Limiter Incomer	8	2	0	0
Atherton Town Centre	HV Adaptive Protection	13	5	3	0
Denton West	HV Adaptive Protection	0	0	0	0
Blackbull	HV Adaptive Protection	8	1	1	0
Irlam	HV Adaptive Protection	0	0	0	0
Littleborough	HV Adaptive Protection	3	1	1	0
Monton	EHV 33kV AP	0	0	0	0
Offerton	EHV 33kV AP	0	0	0	0
Athletic St	EHV Is sensing	0	0	0	0
Wigan	EHV Is sensing	0	0	0	0
Longridge	HV Is sensing	22	2	0	0
Nelson	HV Is sensing	8	3	0	0
Hareholme	HV Is sensing	11	2	0	0
	Totals	79	19	6	0

Atherton Town Centre – Collier brook 11kV cct
29 July 2016 @ 22:39

Disturbance Record (T11 and T12 currents)

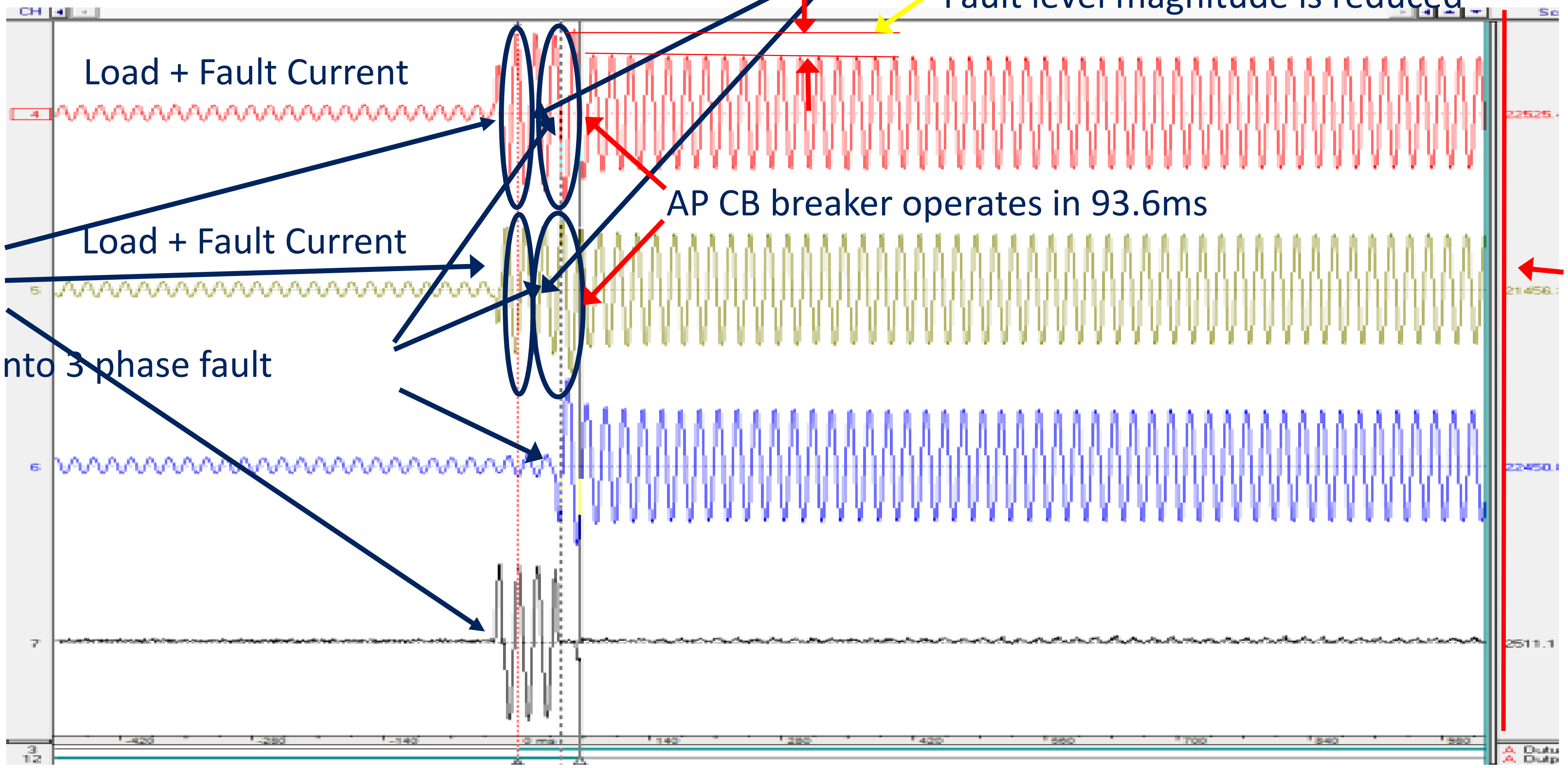


Atherton Town Centre – Thomas St/Holland St 11kV cct.
28 August 2016 @ 19:35

Disturbance Record (T11 and T12 currents)

Adaptive Protection sees the Fault and operates in 23.7ms

Fault level magnitude is reduced



Fault Current

Phase to Phase to Earth Fault

Fault Current

Develops into 3 phase fault

Normal Current

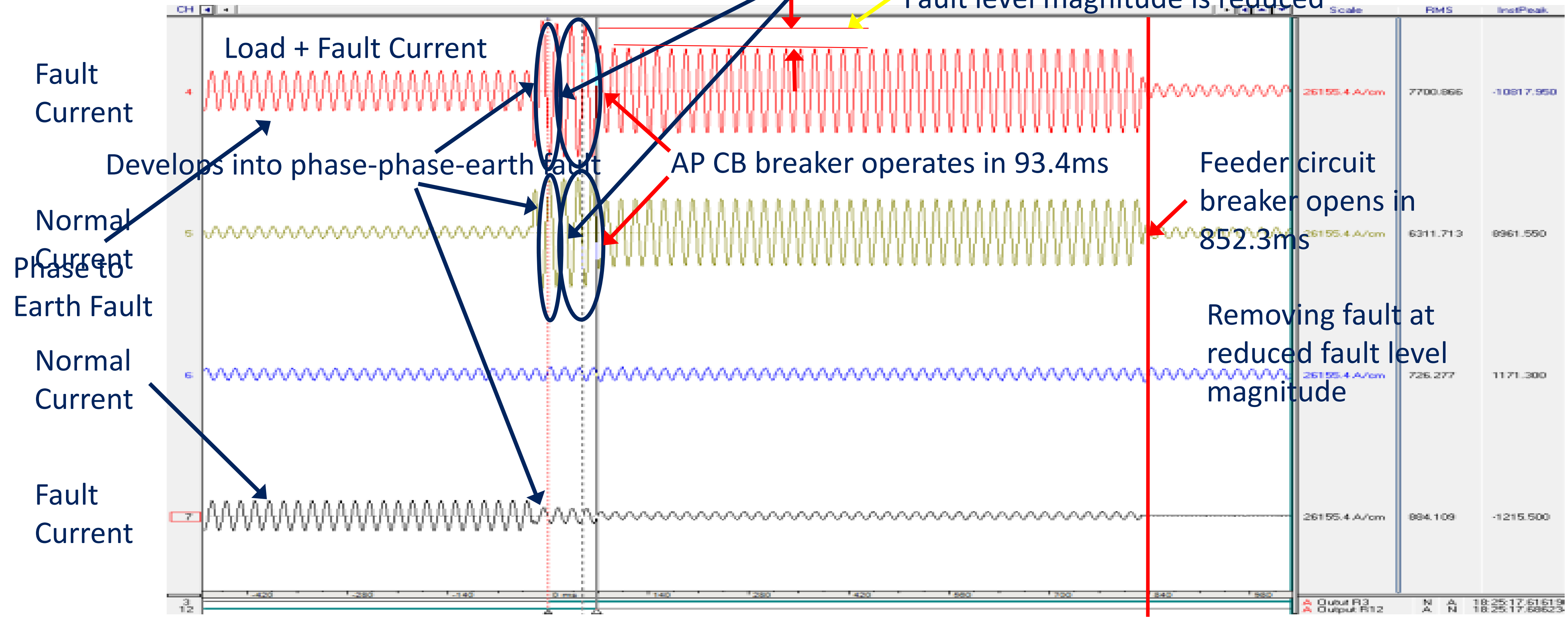
Fault Current

Feeder circuit breaker opens in >1000ms, outside of recoding window.

Removing fault at reduced fault level magnitude

Atherton Town Centre – York St 11kV cct
29 September 2016 @ 18:25

Disturbance Record (T11 and T12 currents)



Customer and commercial strategy in Respond FCL service

ECP	UK-wide Customer survey	Dialogue & terms	Trial phase	Consultation
Formulate engagement materials	Test appetite Establish price point Commercial arrangements that need to be in place (Oct 15 – Feb 16)	FCL service agreements with at least 1 demand & 1 generation customer May 16 – Apr 18	What technical arrangements need to be in place?	Qualify customer experience Assess long term & scale of benefit to GB customers

September 15 ***"The method enables a market for the provision of an FCL service"*** **May 18 2018**

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 & capacity market) & 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

Current position and delivery risks

Agreeing sites to be trialled with United Utilities

Ongoing customer consultation

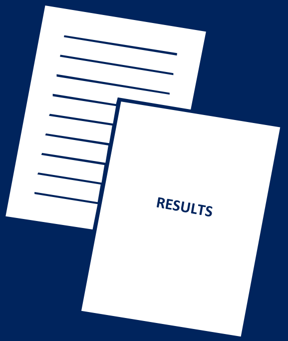
Trial technology outside 'triad period'

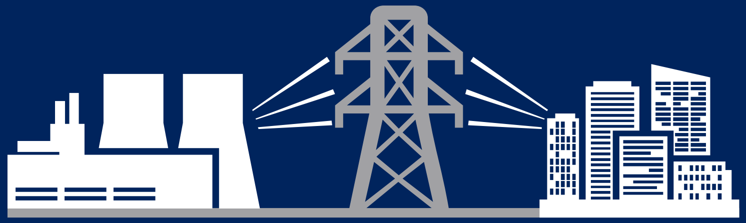
CBA of traditional connection vs new constrained connection agreement

Customer survey report published May 2017

Contract templates & commercial arrangements developed, published May 2018

Lessons learned to date





Survey analysis
'appeared to prove'
the hypothesis that the

There is a market for an FCL service, where a constraint will have little or no impact

Future potential to provide alternative ' constrained' connection offers

(lower cost and quicker connection on fault level constrained networks)

Objective

Produce a written safety case for each fault level mitigation technique:

Adaptive Protection

Is Limiter

Fault Current Limiting service

Publish the peer reviewed safety case by September 2018

The UK HSE regards ***a safety case as***

“*a document that gives confidence to operators, owners, workers and the competent authority that the duty holder has the ability and means to manage and control major accident hazards effectively”.*

Safety case process

ALARP = As Low As Reasonably Possible

- Identify hazards and quantify their potential impact
- Show how mitigated risk can be managed to ALARP
- Identify remaining high risk hazards and redesign to ALARP
- Challenge and make clear the assumptions and judgements used
- Provide supporting evidence
- Justify the mitigations for the worst credible scenarios
- Provide documentation to record and support the safety case

Respond safety case approach

It is essential that the safety case demonstrates

- All the risks and hazards have been assessed in all techniques installation scenarios
- Any appropriate limits and conditions for their use have been defined
- Identify failures modes of the techniques by a thorough and systematic fault sequence process
- Demonstrate the techniques/installations follow established good practice
- Follows the risk management standards
- Complies with appropriate legislation
- Independent assessment of safety cases

The safety case will be a clear and logical document so that the three techniques can be operated safely and reliably

Next steps for Respond

Complete the FCLS installations and learning

Complete and peer review the safety cases

Monitor the trial and analysis of the techniques for another 12 months

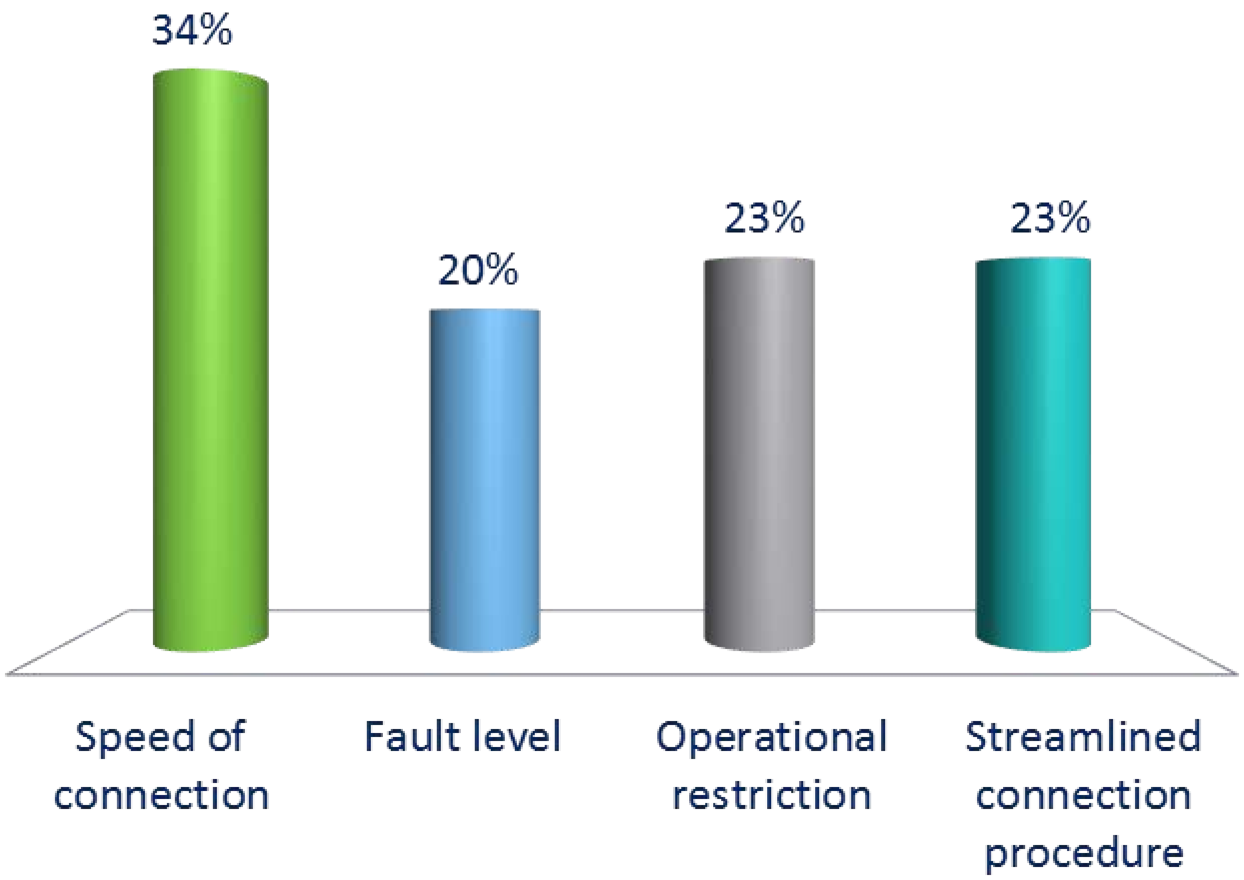
Produce a buy order of the fault level mitigation techniques

Assess the health impact of the trial on our assets

Carbon footprint study of the techniques

Which challenge do you feel is the most important for a new connection?

A. Speed of connection
B. Fault level
C. Operational restriction
D. Streamlined connection procedure



Celsius

Damien Coyle

electricity north west

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Agenda

Celsius

Brief introduction to Celsius	Project aims	Thermal monitoring
Data monitoring	Customer	Next steps

Celsius

Awarded: 9th December 2015

Go live

Monitoring installation Mar 2017

Monitoring trial Mar 2018

Thermal ratings tool stage 1 Oct 2018

Retrofit cooling installation Jun 2018

Cooling trial Jun 2019

Thermal ratings tool stage 2 Jan 2020

Closedown Mar 2020

Investment	£5.5 million	Up to £583m across GB by 2050	Financial benefits

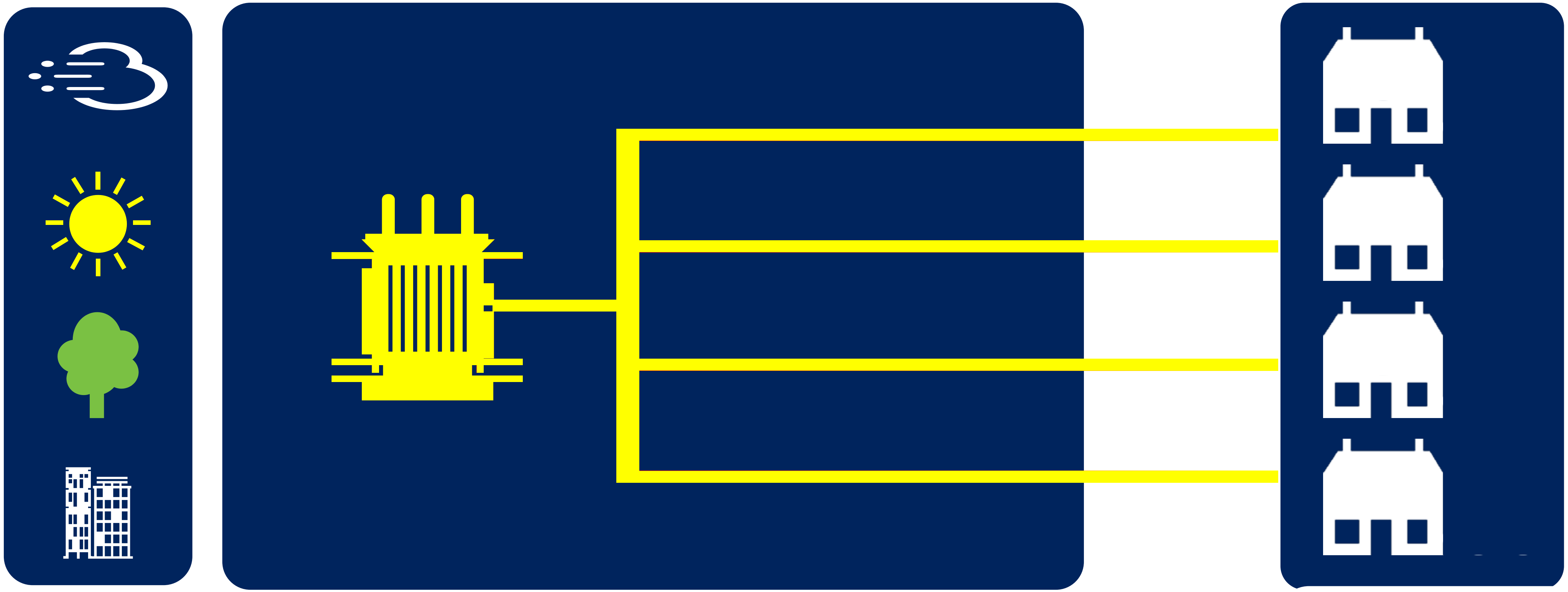
RICARDO-AEA

ASH ■ CREATIVE WIRELESS ELECTRONICS ■

Impact Research

UK Power Networks Delivering your electricity

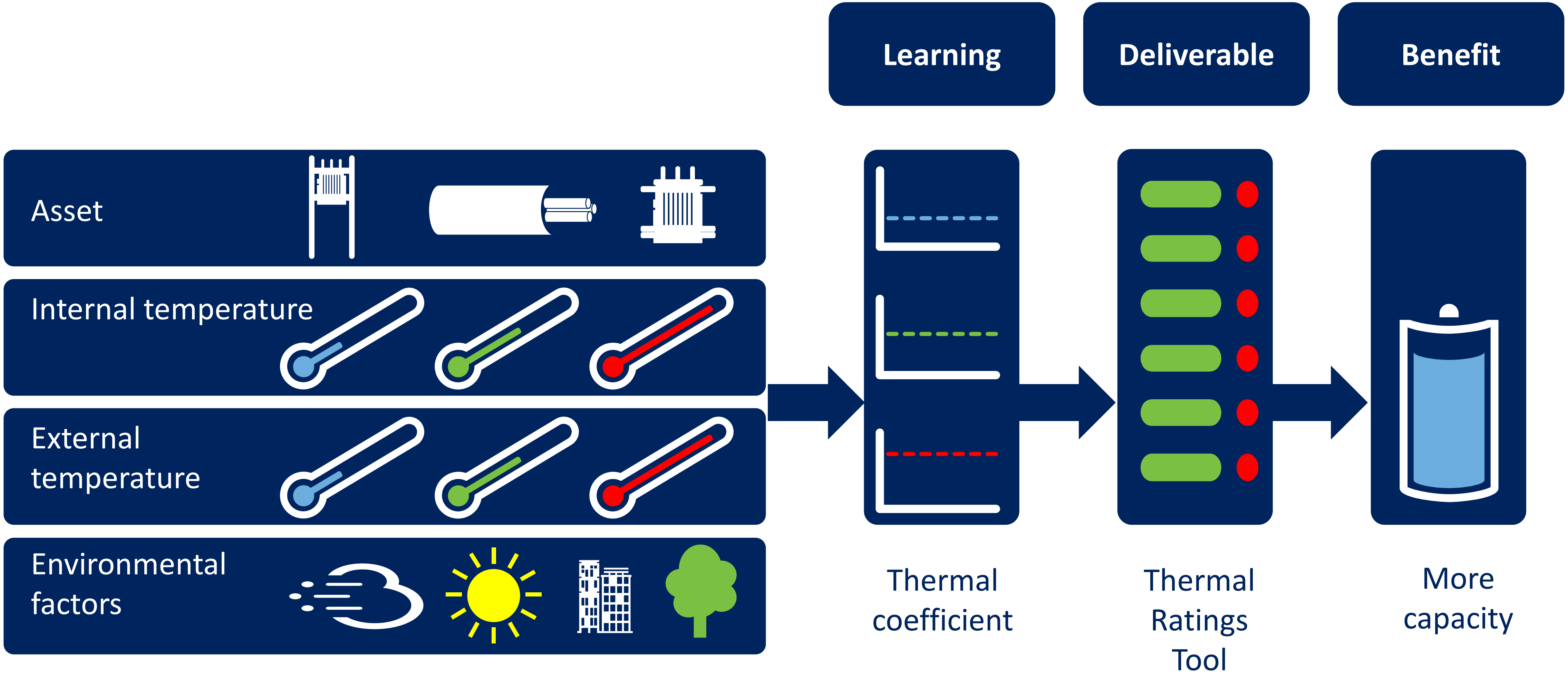
The problem



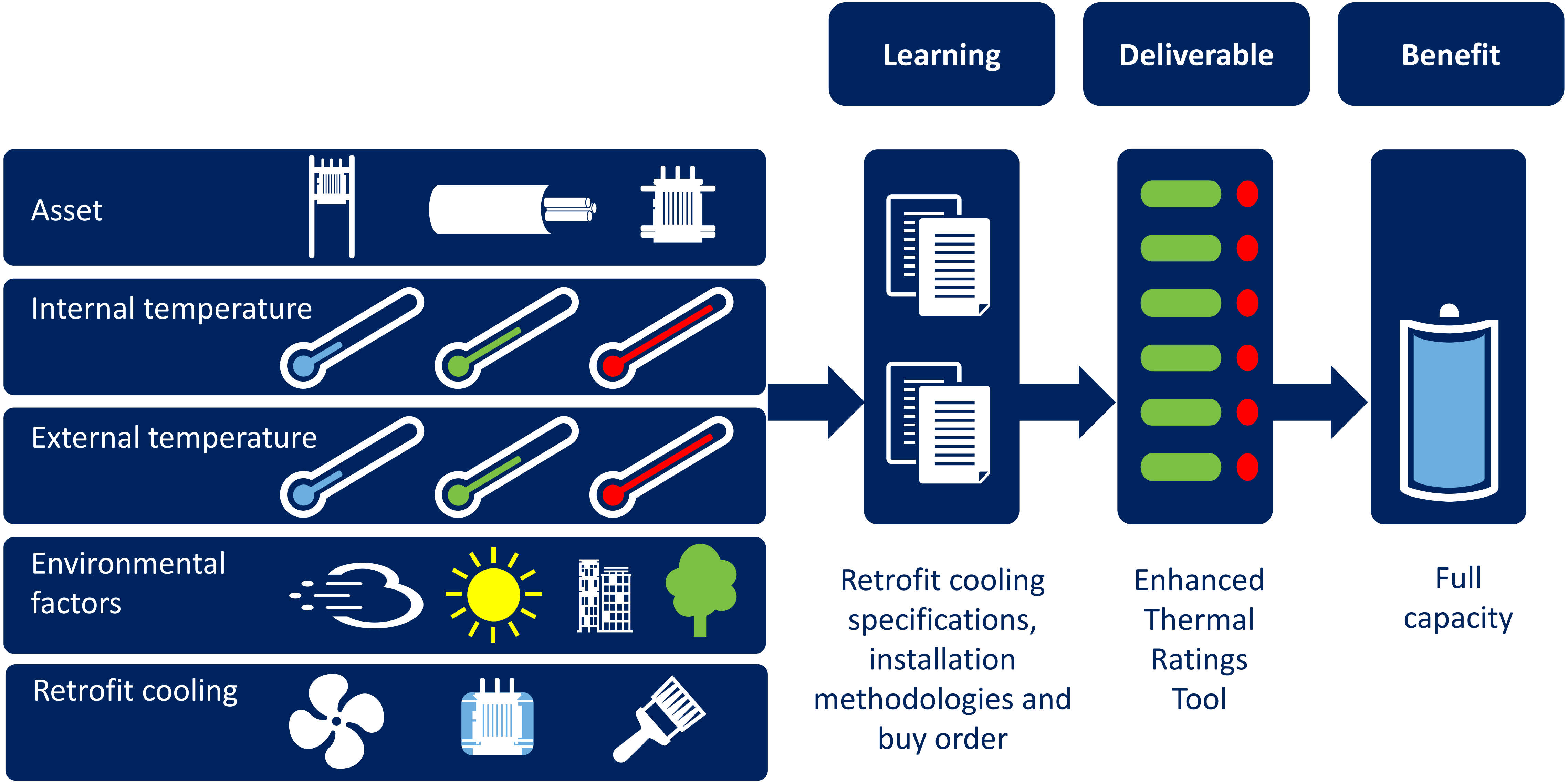
Distribution substation

Customers' LCTs

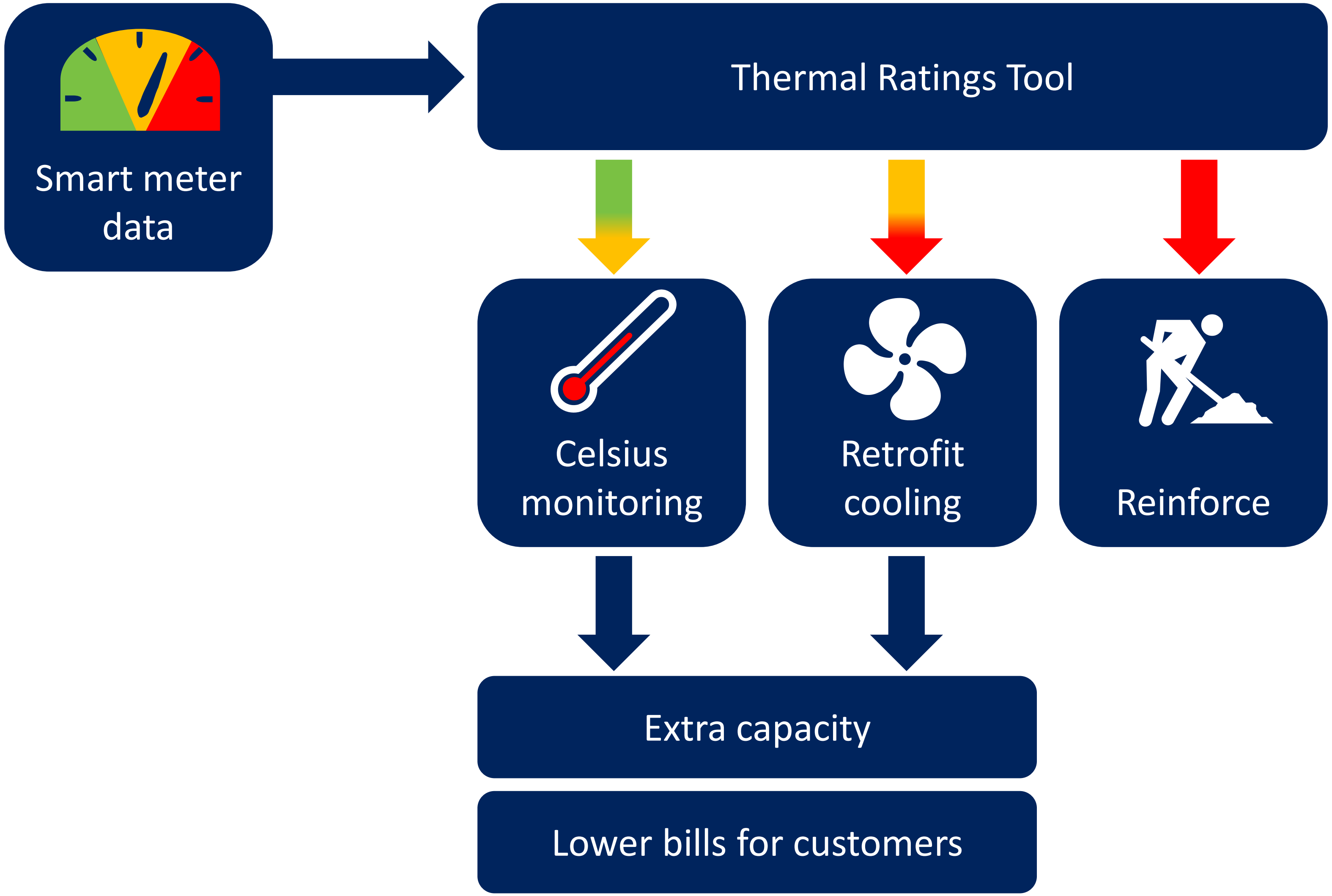
Step 1: Fit thermal monitoring



Step 2: Retrofit cooling



Celsius as part of the smart future

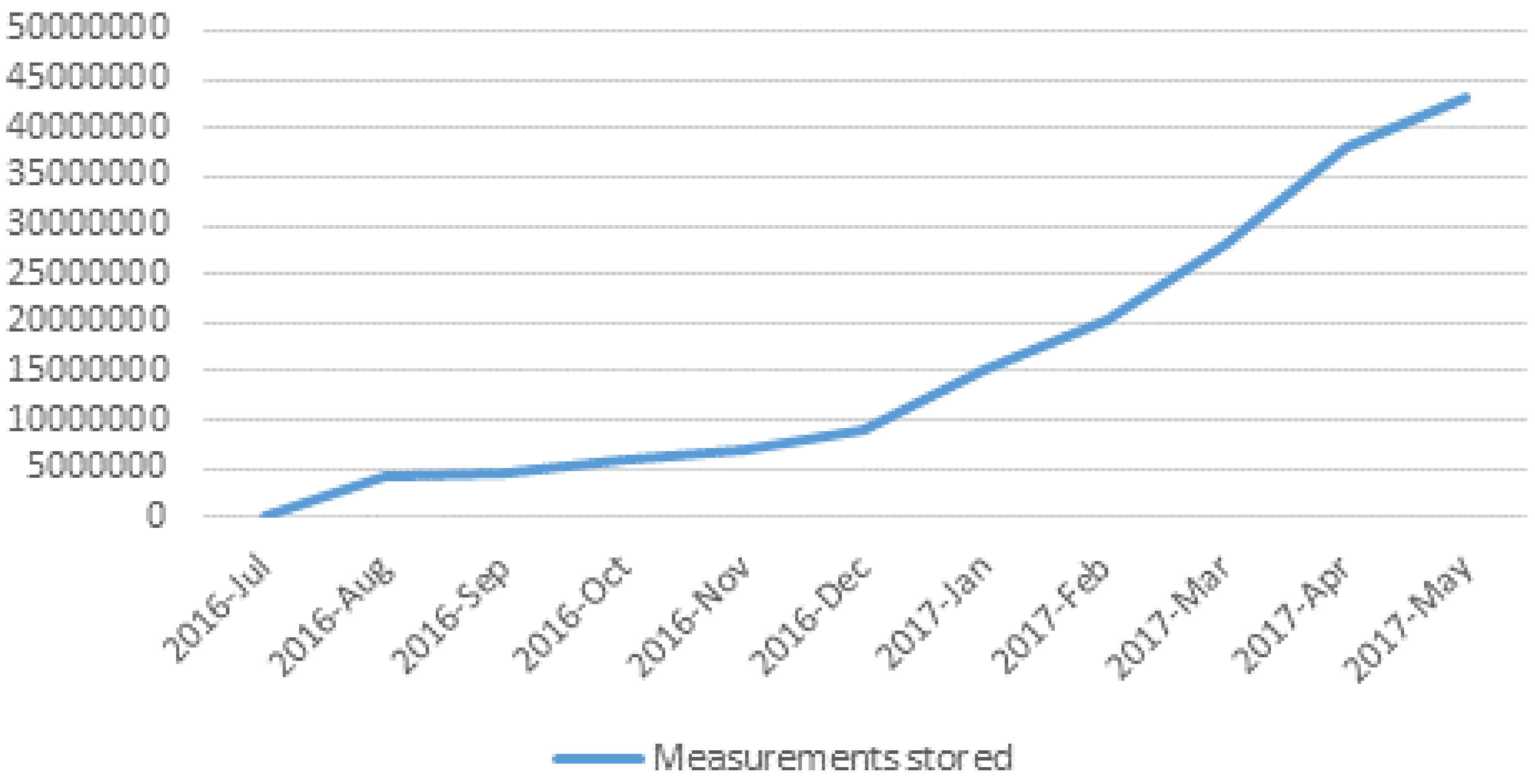


Case studies

Thermal analysis (step 1)	q_{core} Internal asset temperature = Thermal coefficient × $q_{external}$ External asset temperature
Thermal flow study (steps 1 & 2)	Research into heat and air flows for optimal substation design
Asset health study (steps 1 & 2)	Examines effects of increased load and cooling techniques on assets

Data to date

Measurements stored



Latest metrics

289,477 inbound requests handled

43,292,611 measurements stored

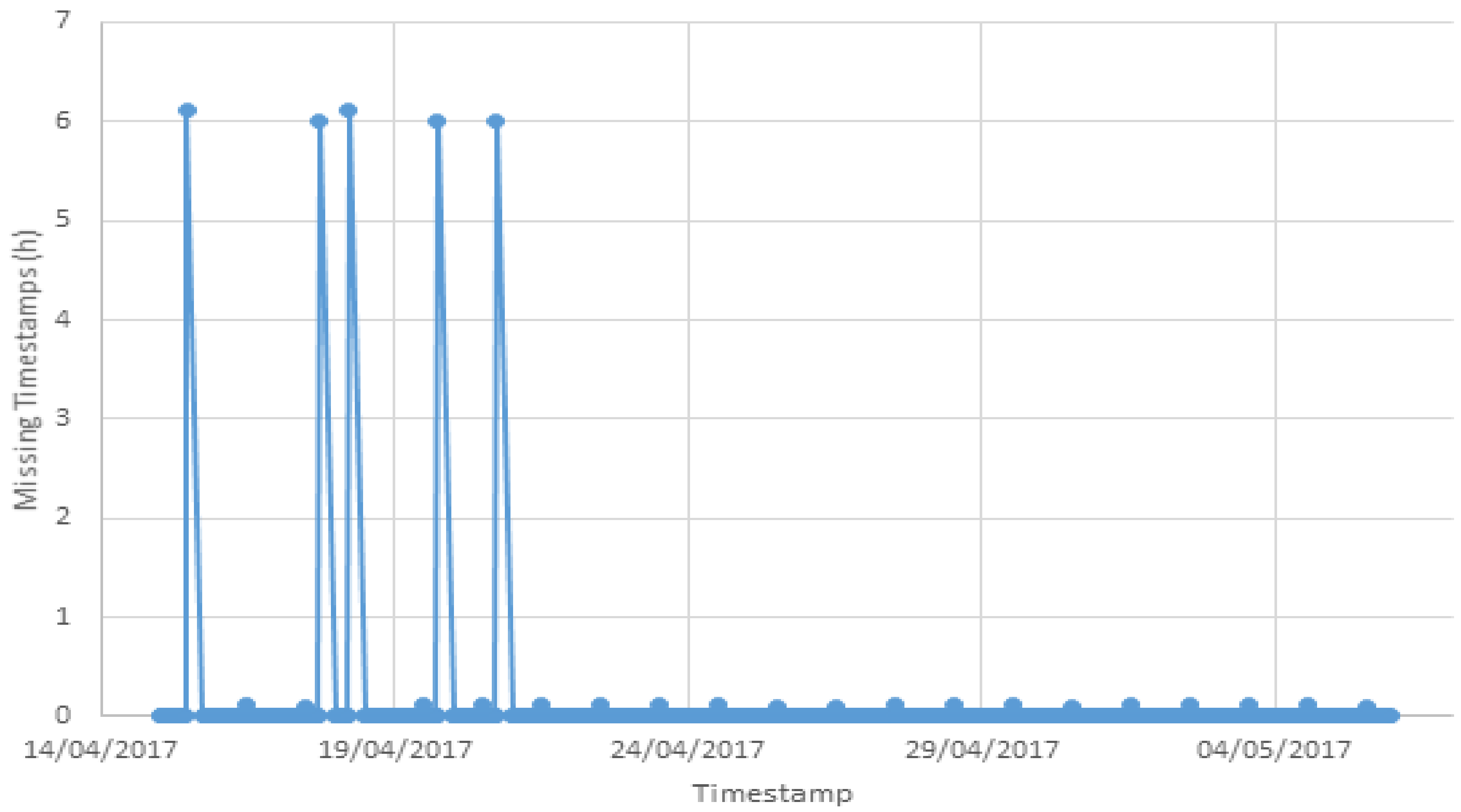
72,081 lines of code

Installation issues

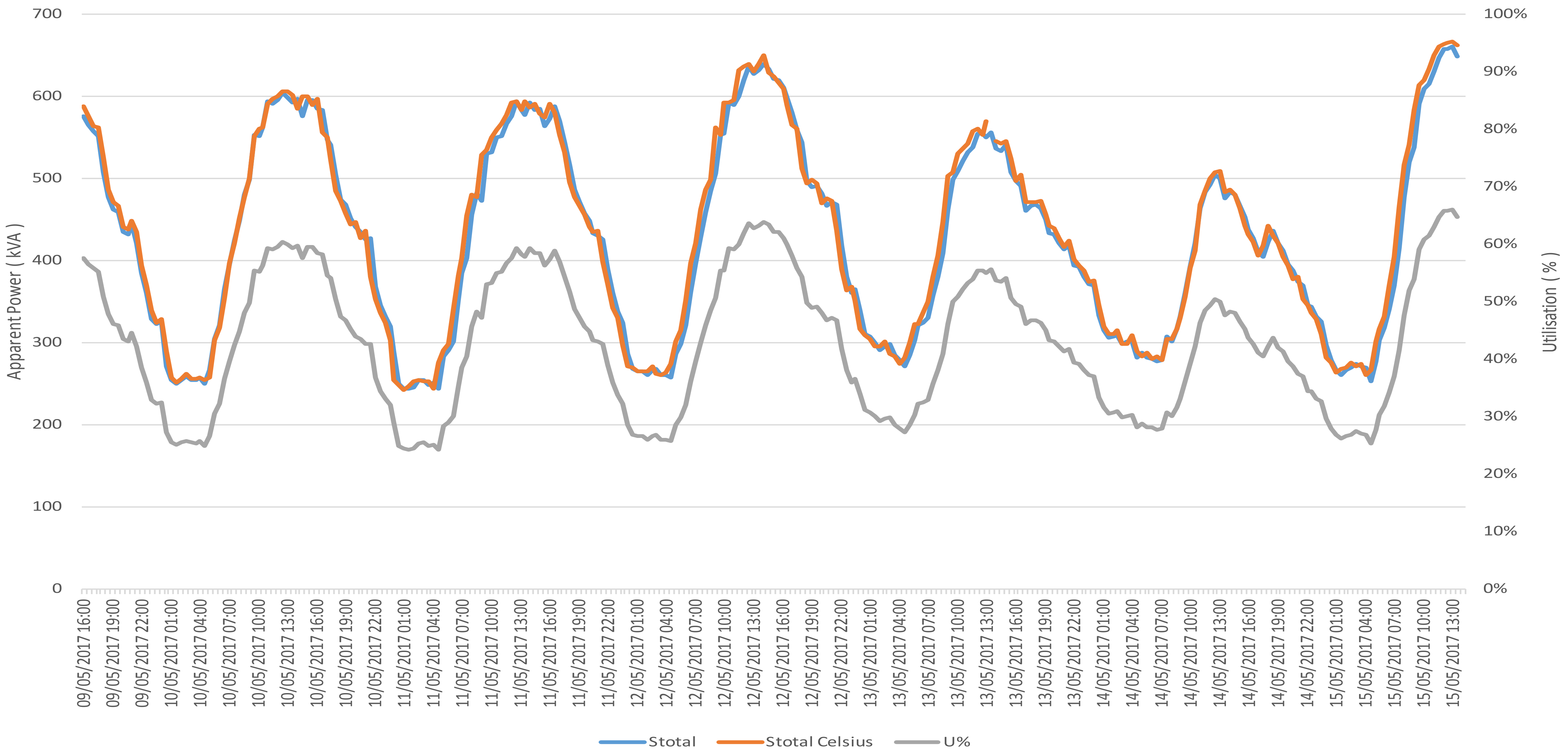
- Data gaps through GPRS connection
- Data gaps caused by backend algorithm and timestamp handling
- Firmware upgrade to the KTSO1 wireless temperature sensor
- Firmware upgrade to HEX
- Firmware upgrade to HUB (OTA)

HUB OTA update

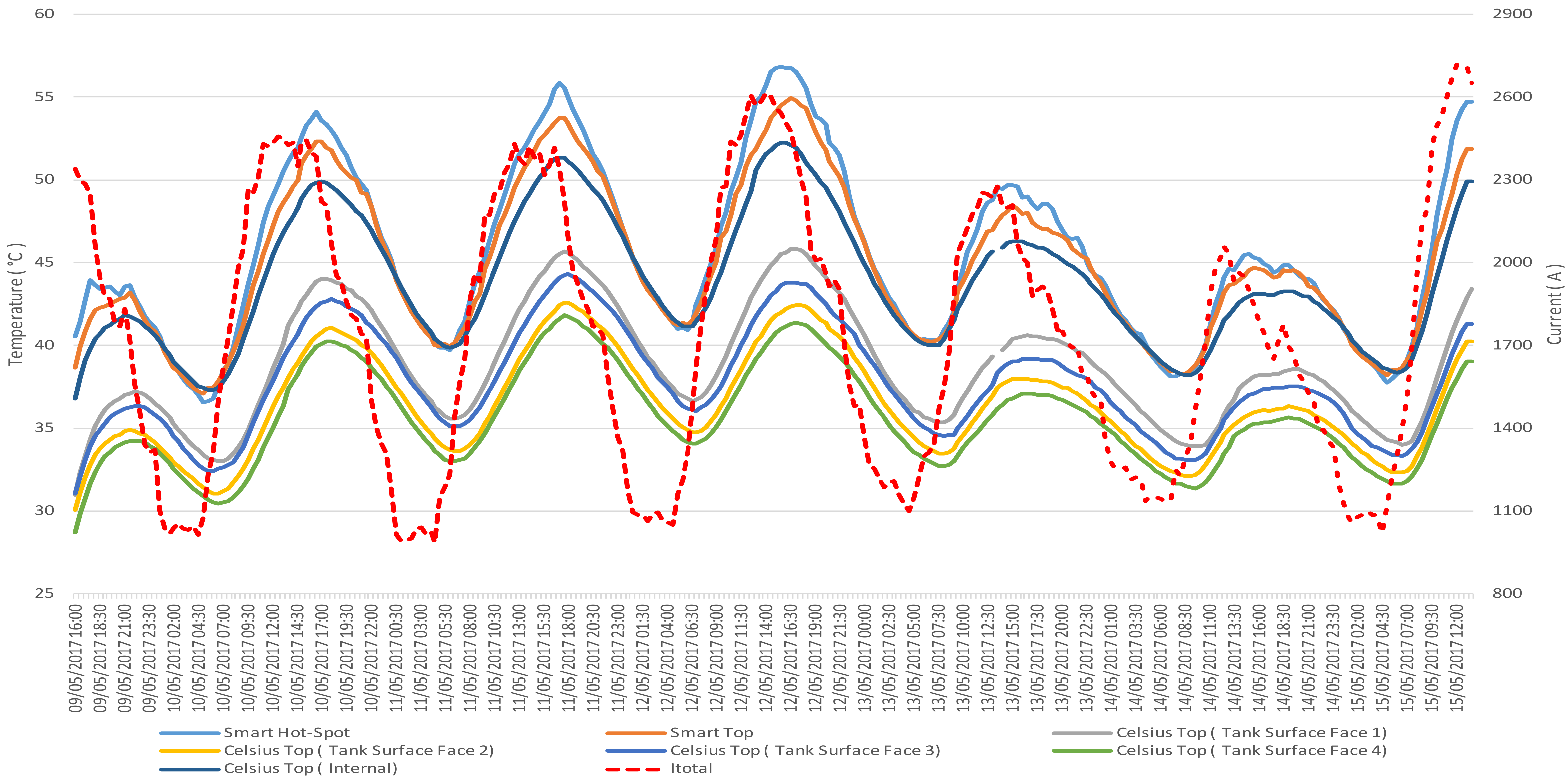
Ramillies Avenue



Smart Tx vs Celsius: power



Smart Tx vs Celsius: temperature



Customer engagement

Customers in the Celsius trial areas will find the implementation of innovative retrofit cooling techniques as acceptable as traditional reinforcement

Customers who are educated as to the need for and benefits of Celsius are significantly more likely to find it acceptable

Customer engagement plan	Baseline survey	Test survey	Focus groups
Website	Video/ podcasts	Customer mailing	Social media

Progress and next steps

January – June 2017	July - December 2017	January – June 2018	July – December 2018
Data capture Thermal flow study DNO cooling workshop Customer focus groups	Monitoring installation report Cooling Technologies selection Cooling installation plan Thermal flow study report	Installation of Retrofit cooling technologies Customer surveys	Asset health study Carbon Impact assessment Asset temperature behaviour report Thermal ratings tool (Step 1)

Knowledge sharing and dissemination

Distribution System Operator (DSO) Vision

Steve Cox

electricity north west

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DSO: definition and exclusions

"A DSO balances capacity on the distribution network to enable new connections and meet the requirements of existing customers through the use of flexible distributed energy resources, network investment and commercial services ensuring security and quality of supply standards are delivered"

The DSO is not the owner of the network(s) that it operates, for example independent DNOs or private networks connected to the licensed DNO's network or indeed multiple licence areas

The DSO is not limited to one licence area or indeed one group boundary. It is conversely likely that within a given network area the DSO will encompass all emerged networks eg IDNO

The DSO should not normally own permanent generation, storage or other DERs unless it does so as the owner of last resort (and in such circumstances subject to the guidance in the EU package)

DSO: essential components

- Network capacity provision
- Network capacity market management
- Network access management and forecasting
- Service definition and charging
- Wider market engagement

Network capacity provision

Our responsibility:

To enable customers connected to our networks the freedom to buy and sell their energy safely, securely and at lowest cost

Requires new service model for network management and design

Provision of flexible network capacity through local and regional balancing

DSO will need to determine:

- Point of Connection and operating terms
- Any new capacity required
- Quality of supply
- Security and Resilience standards
- Electrical losses optimisation

Internal capability	Organisational structure	Licence/ regulation

Internal capability	Subject matter experts/resource levels/ skills
Org structure	Existing/ change required/ new function
Licence/reg	Current licence and regulatory environment situation

Network capacity market management

Maximising utilisation of all existing network capacity ensures efficiency

Provision of capacity **for** customers **from** other customers is often lowest cost, first option

DSOs must facilitate local markets for flexible capacity

Direct customer access ● Access through aggregators

Exchange of information and enhanced transparency necessary to avoid inefficient network over-stress and maintain security of supply

Internal capability	Organisational structure	Licence/ regulation

Network access management

Dynamic network management becomes a 24/7 function to balance security, cost and access

- Commercial solutions
- Managing essential outage plans
- Engineering solutions

New service metrics and mechanisms required

- Generation Indices
- Constraint Indices

Internal capability	Organisational structure	Licence/ regulation

Forecasting capacity

Enhanced forecasting abilities required

Day ahead	Year ahead	Long-term forecasting
...24	**...365**	**--2030--**

Internal capability	Organisational structure	Licence/ regulation

Service definition and charging

Structure of network charging will require fundamental review

Charging arrangements must reflect service customers require

Capacity based charging structure

Potentially enhanced by recognition of requirements for services such as:

- Security of connection
- Power quality
- Voltage stability
- Fault Level
- Reactive power and inertia

Internal capability	Organisational structure	Licence/ regulation

Wider market engagement

DSOs well placed to provide additional, value-adding but non-essential, services to network users, such as

Generation output optimisation

RESPOND

Power factor correction

DSOs can support the Transmission System Operator in whole system balancing through commercial provision of services

ENWL commercial roll-out of CLASS technology this year is first example of this

CLASS
Customer Load Active System Services

Internal capability	Organisational structure	Licence/ regulation

Capability matrix

DSO Functions	Current										
Network capacity provision											
Network capacity market management											
Network access management and forecasting											
Service definition and charging											
Wider market engagement											
Capabilities	Forecasting	Regulation Codes/Frameworks	Commercial. Frameworks	Power System Analysis	Contractual Arrangements	Dispatch	Pricing	Outage Planning	Data	Settlement	Contract/Service Compliance

ENA TSO-DSO project

TSO-DSO Project

1. T-D Process: Whole system investment and operational planning processes

2. Customer Experience: Customer journey maps for connections and updated connections agreements

3. DNO to DSO transition: DSO transition roadmap, functional requirements and model for DSO, market model options

4. Charging:
Short: Identify problems of current charging arrangements
Medium: recommend smart tariff, flexible connection and ancillary services pricing
Long: Strategic review/ whole system pricing

Phase 1 – Definition of T-D processes, customer experience, DNO to DSO transition and charging

End 2017

Phase 2 – Impact assessment of options and preferred design

Phase 3 – Regulatory enactment

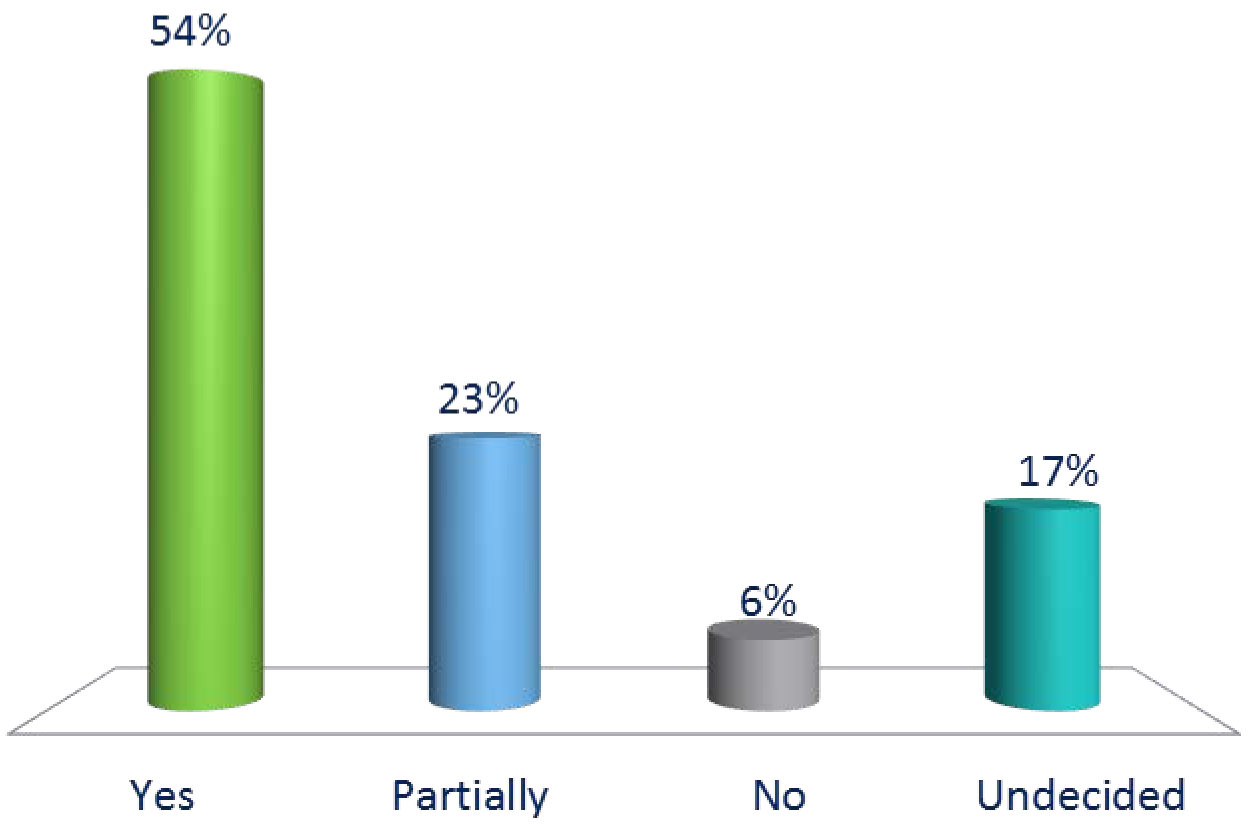
Phase 4 – Design, build and test

Our high level roadmap

	Technical activities	Commercial activities	Customer based activities	Regulation
ED1 year 3	• Forecasting/modelling • Capacity Planning (need identification) • Strategic Investment • ANM Specification of requirements	• CBA to inform decisions for selected solutions (traditional vs smart) • Flexible Connections Contract Management • Purchase of flexibility services (DSR) • Curtailment Factor management	Constraint Management • Curtailment Factor • Generation Index	• Review of licence and codes to identify impacts and raise change if required • Review of EU codes and identify DSO accountabilities • Develop Capacity Incentive • Investment ahead of need
ED1 Year 4	• Point of Connection - prototype • CLASS functionality – Live • CLASS 2 - trial • Active Network Management implementation • Data visibility (SO)	• Sell flexibility services (CLASS) • Active Network management offering	• Active Network Management Launch • Trial energy efficiency	• Review of licence and codes to identify impacts and raise change if required
ED1 Year 5	• Balancing of network capacity (load group) • Data visibility (Aggregators/suppliers)	• Market operation service auctions	• Develop energy efficiency incentive	• Review of licence and codes to identify impacts and raise change if required
ED1 Year 6, 7 & 8	• Fault prioritisation based on curtailment and DSR impact.	•	• Trial energy efficiency incentive • Implement energy efficiency incentive	• Review of licence and codes to identify impacts and raise change if required
ED2	• Active System Management • Provision of flexible services to TSO • Extensive use of data analytics	• Commercial operations become core business capability • Non regulated commercial opportunities		• Operating as a Regional DSO • Regulated commercial opportunities

Do you think that DSO will support flexibility and innovation?

A. Yes
B. Partially
C. No
D. Undecided

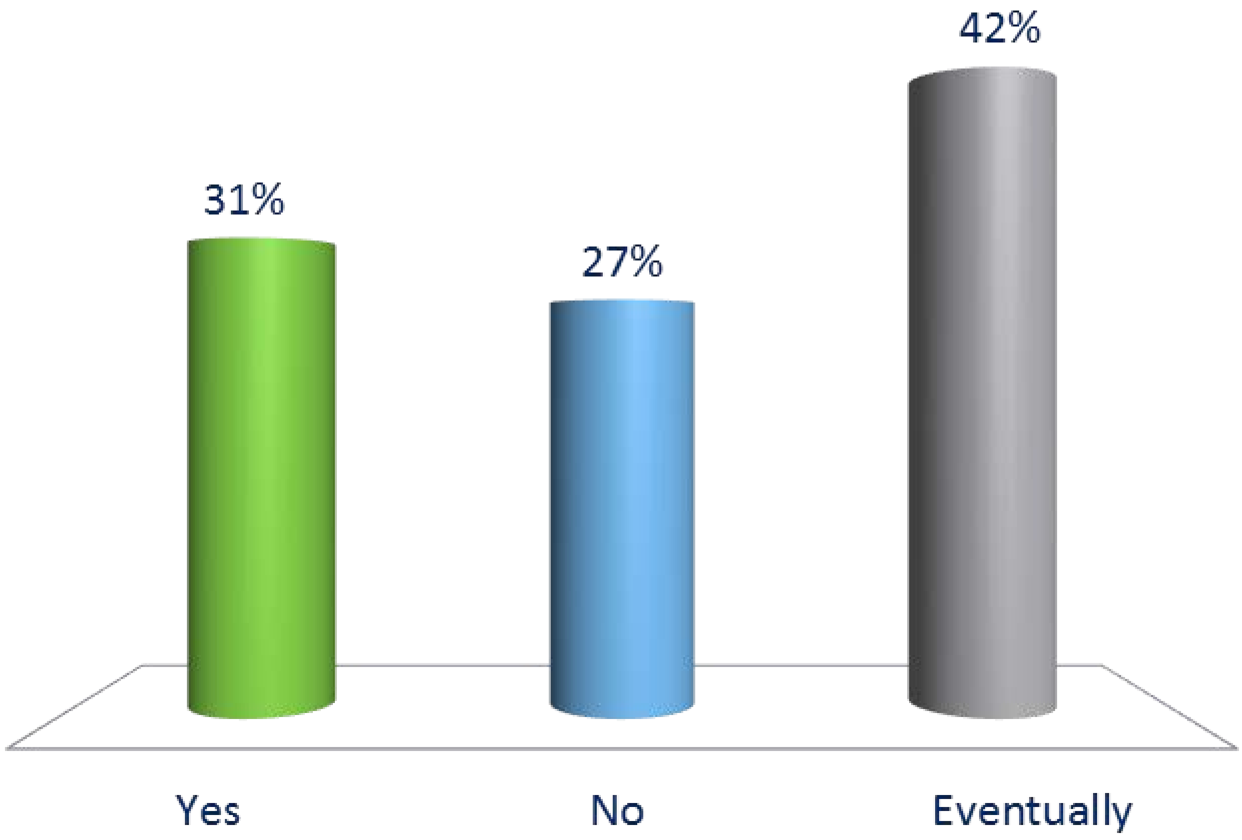


Should the DSO encompass all energy options eg gas, heat

A. Yes

B. No

C. Eventually



DSO transformation programme

Microsoft Project - DSO readiness and resource outline.mpp

	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1	**DSO programme scoping**	**450 days?**	**Mon 03/04/17**	**Fri 21/12/18**		
2	Develop DSO Definition for ENWL	60 days?	Mon 03/04/17	Fri 23/06/17		DSO steering group
3	Consider implications for ENWL business ir	450 days?	Mon 03/04/17	Fri 21/12/18		DSO steering group
4	Consider implications for regulatory framev	100 days?	Thu 06/04/17	Wed 23/08/17		Regulation/ steering
5	Develop a plan for sharing and getting supp	60 days	Mon 08/05/17	Fri 28/07/17		Central Services Mai
6	Keep watching brief on other development	100 days?	Thu 06/04/17	Wed 23/08/17		Capacity Strategy
7	Output from phase 1 of ENA DSO:TSO proj	1 day?	Wed 01/11/17	Wed 01/11/17		
8	Quantify potential costs and benefits asso	100 days?	Mon 14/08/17	Fri 29/12/17		Consultant?
9	**Network Management**	**563 days?**	**Thu 06/04/17**	**Mon 03/04/23**		
10	**Losses optimisation**	**563 days?**	**Thu 06/04/17**	**Mon 03/04/23**		
27	**Constraint Management**	**588 days**	**Wed 01/03/17**	**Fri 31/03/23**		
28	**Curtailment Factor**	**24 days?**	**Thu 30/11/17**	**Tue 02/01/18**		
29	Agree mechanism with Ofgem	1 day?	Thu 30/11/17	Thu 30/11/17		Regulation
30	Implement CF process with customers	1 day?	Tue 02/01/18	Tue 02/01/18	29	Capacity Strategy
31	Generation Index	1 day?	Mon 02/10/17	Mon 02/10/17		Capacity Strategy
32	**Active Network Management**	**423 days?**	**Wed 01/03/17**	**Fri 12/10/18**		
33	**Implement C2C into Business as U**	**366 days**	**Wed 01/03/17**	**Wed 25/07/18**		**Innovation Engine**
34	LV Technology/service termination	21 days	Mon 02/04/18	Mon 30/04/18		
35	Policies - Demand to be	21 days	Thu 01/06/17	Thu 29/06/17		
36	Policies for DG done to be embedde	5 days	Tue 01/08/17	Mon 07/08/17		
37	DG Processes	5 days	Tue 01/08/17	Mon 07/08/17		
38	Demand Processes	10 days	Thu 01/06/17	Wed 14/06/17		
39	DG Technical procedures for Contr	21 days	Mon 02/10/17	Mon 30/10/17		
40	Demand Technical procedures for C	21 days	Mon 02/10/17	Mon 30/10/17		
41	RTU Design – using VTs to power it	21 days	Mon 01/05/17	Mon 29/05/17		
42	Costs to be carried out for both N-0	21 days	Mon 01/05/17	Mon 29/05/17		
43	System Data requirements: GIS / NM	60 days	Wed 01/03/17	Tue 23/05/17		
44	Identification of backlog of managed	300 days	Thu 01/06/17	Wed 25/07/18		
45	Process audit	21 days	Mon 02/04/18	Mon 30/04/18		
46	Document all Active Managed Connecti	60 days?	Mon 08/05/17	Fri 28/07/17		Capacity Strategy
47	NMS Go Live	1 day?	Fri 31/08/18	Fri 31/08/18		IT&T
48	Integrate Active Managed Connections	30 days?	Mon 03/09/18	Fri 12/10/18	47	Capacity Strategy
49	**Export Risk Based Services & Export I**	**410 days?**	**Mon 06/11/17**	**Fri 31/03/23**		
50	Customer Stimulation	1 day?	Wed 28/02/18	Wed 28/02/18		Capacity Strategy
51	Market Analysis	90 days?	Mon 06/11/17	Fri 09/03/18		Consultant
52	NMS Go Live	1 day?	Fri 31/08/18	Fri 31/08/18		IT&T

Ready

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Introducing our partners

Paul Turner

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Meet our partners

Schneider Electric	Impact Research	Ricardo	WSP/Parsons Brinckerhoff	Kelvatek	Ash Wireless	TNEI
European multinational corporation specialising in electricity distribution and automation management Suppliers of Electricity North West's network management system	Leading marketing and research organisation with extensive experience in customer engagement activities in the UK utilities industry Successfully delivered research for a number of innovation projects	Technical consultancy with experience in all aspects of power generation, transmission and distribution Experience in collecting, analysing and interpreting network data such as substation load and temperature	Technical consultancy organisation with experience in all aspects of power generation, transmission and distribution	UK leader in low voltage (LV) switching, automation and fault management technology Brought a number of innovative product solutions to the power industry through robust research and development	Creative electronics design consultancy Specialists in sensing technologies and have a track record in providing bespoke monitoring solutions to the utility industry	Experienced in all aspects of power generation, transmission and distribution Particular expertise in network modelling

Breakout sessions

	Smart Street	Oil regeneration	Load forecasting	Customer engagement
Session 1 **1.15 – 1.35pm**	Room 1	Room 2	na	Boardroom
Session 2 **1.35 – 1.55pm**	Room 1	na	Room 2	Boardroom
Break **1.55 – 2.25pm**				
Session 3 **2.25 – 2.45pm**	Room 2	na	Room 1	Boardroom

Smart Street Technology

Ben Ingham

electricity north west
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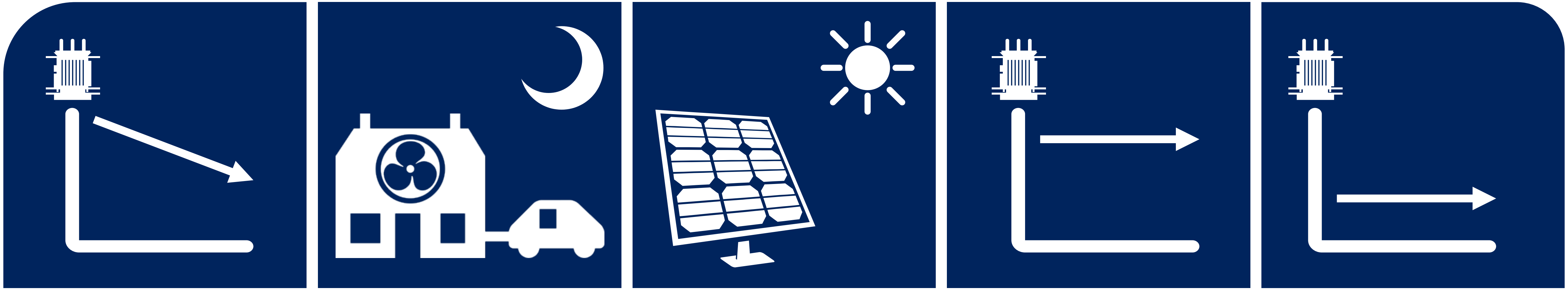
Background



Historic networks have no active voltage regulation

LCTs create network issues

Customer demand could cause voltage to dip below statutory limits

Customer generation could cause voltage to exceed statutory voltage limits

Smart Street stabilises voltage across the load range and optimises power flows

Conservation voltage reduction

Stabilised voltage can be lowered making our network and customers' appliances more efficient

Project overview

£11.5m, four-year innovation project	Started in Jan 2014 and finishes in Apr 2018	Quicker connection of LCTs Lower energy bills Improved supply reliability	Trials period Jan 2016 – Dec 2017	Extensive customer engagement programme throughout project

Lynx and Weezap

LV vacuum devices

Retrofits onto standard equipment

Replicates standard fuse curves up to 400A

Telemetered back to central monitoring point

Capacitors

LV units are multi-stage

HV units are single stage

Used for voltage control only

OLTCs

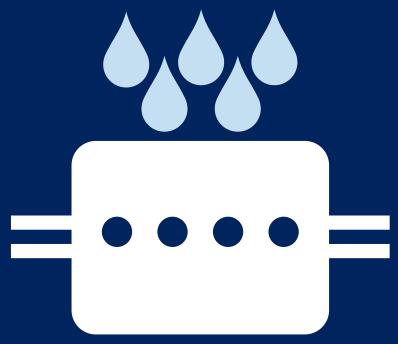
9 tap positions with 2% per step

Nominal tap

Self regulating on loss of comms

Learning points – site installations

Communications

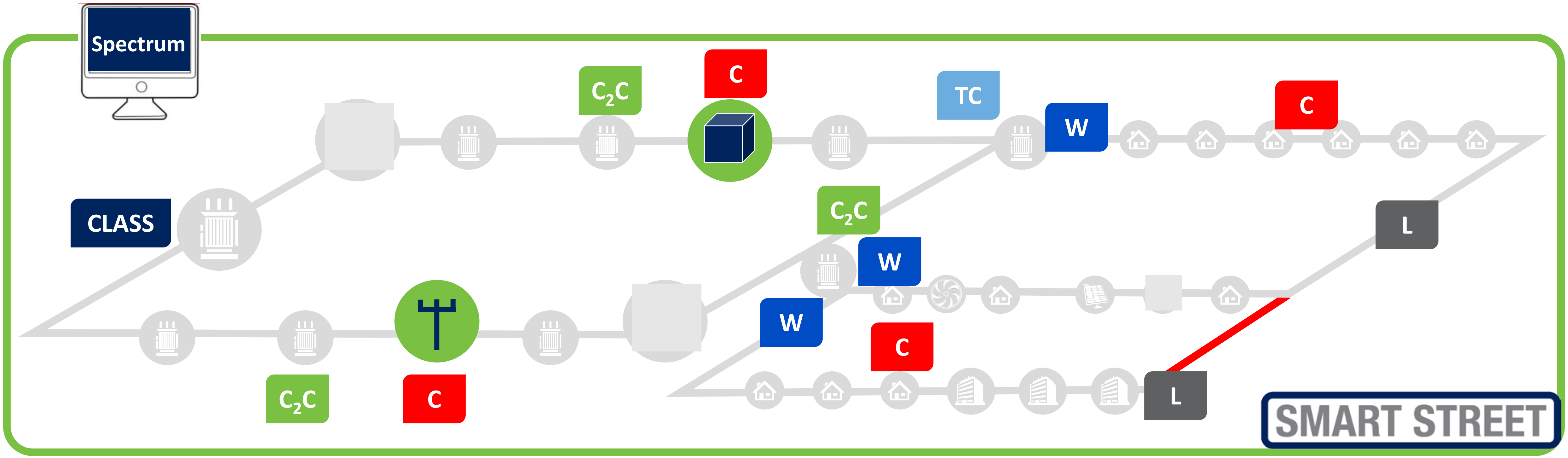


Water ingress

Cabinet design and location

Enclosure size

Network overview



C_2C Capacity to Customers

C Capacitor

W WEEZAP

L LYNX

TC On-load tap changer

Builds on C_2C and CLASS ● Storage compatible ● Transferable solutions

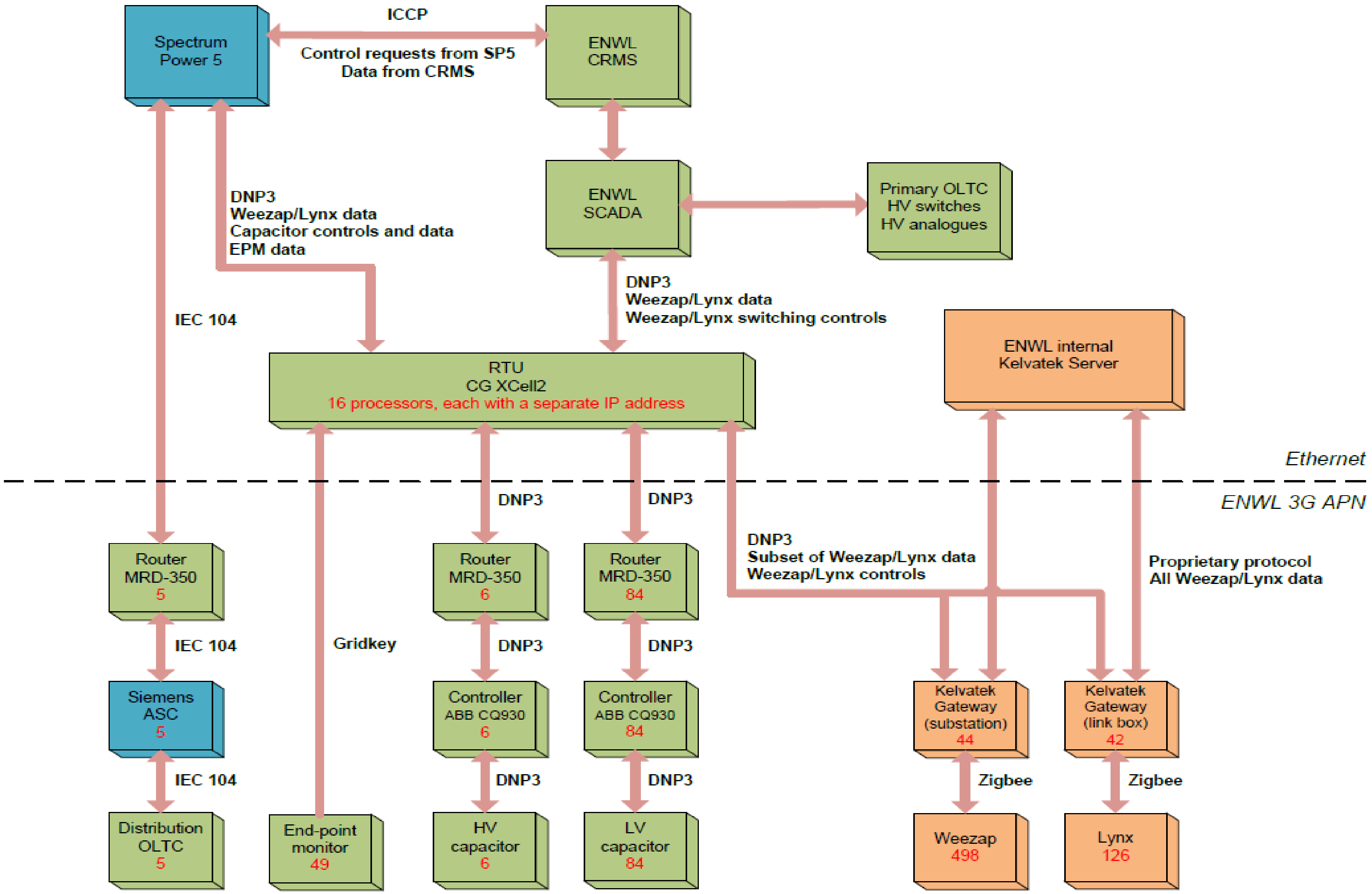
Spectrum Power 5

Siemens network management system

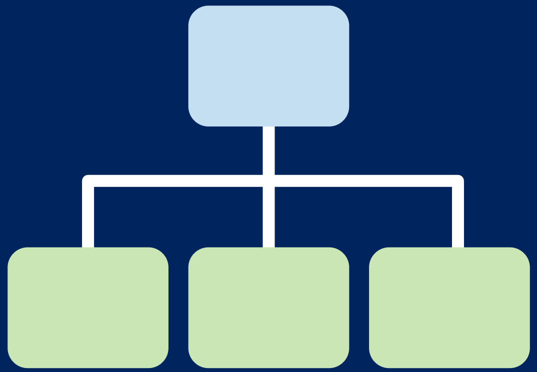
Optimisation module – DSSE/ VVC

Linked to CRMS via ICCP link

System architecture



Learning points – system



System architecture

Integration with existing SCADA system

Load Forecasting and ATLAS

Dr Rita Shaw

electricity north west

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Outline of presentation

Forecasts or scenarios for strategic planning?

Our two NIA projects

ATLAS for grid and primary

Identifying half-hourly true demand

Weather correction

P forecast approach

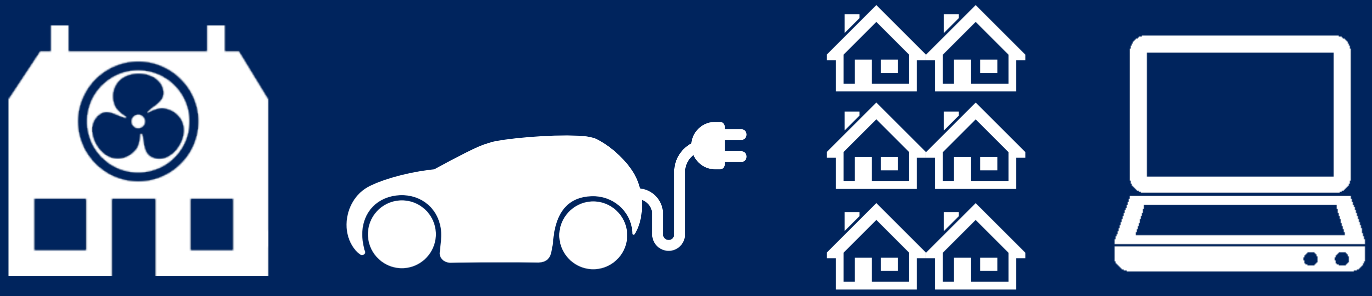
Q forecast approach

ATLAS for the secondary networks

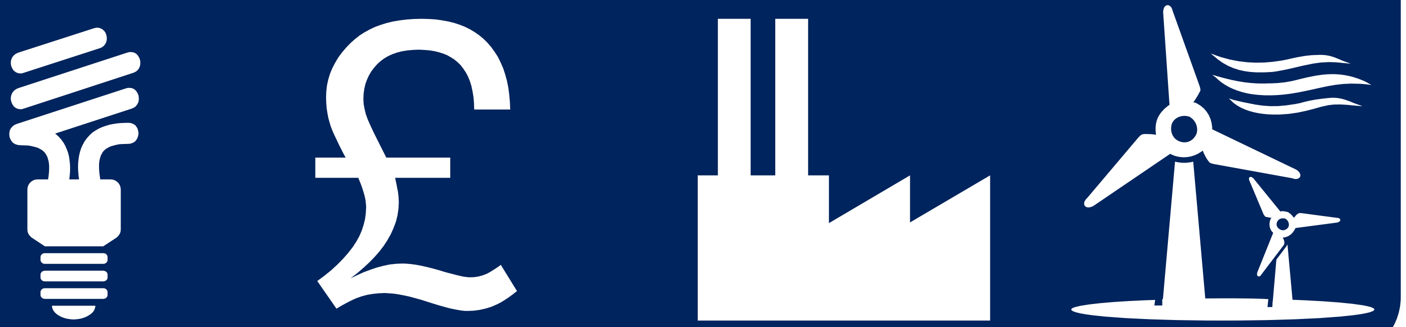
Final thoughts

Outlook for future demand

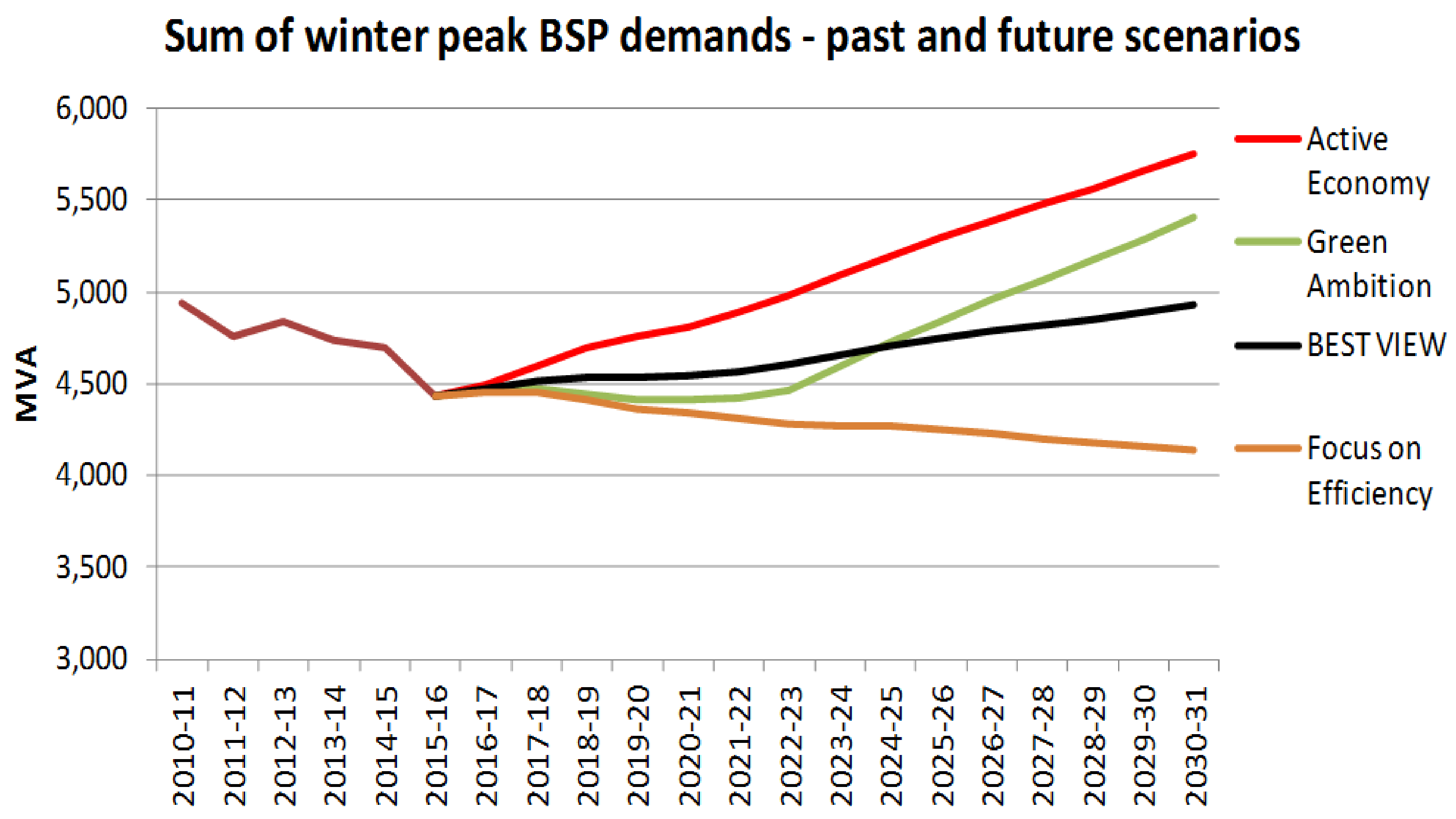
Why could demand go up?



Why could demand fall?



Forecasts or scenarios?



Objectives of our work

Credible demand and generation scenarios, reflecting uncertainty

Tailored to our region, assets and data

Support well-justified strategic planning of network capacity

Enabling good decisions about solutions to capacity problems, and informed dialogue with National Grid and other stakeholders

Two related NIA projects

Demand Scenarios with Electric Heat and Commercial Capacity Options

Winter / summer peak load

April 2015 - October 2016

ATLAS (Architecture of Tools for Load Scenarios)

Expanded scope

November 2015 – December 2017

Two related NIA projects

Demand Scenarios	ATLAS
Based on domestic v. non-domestic and differences by local authority	Half-hourly through year
Heat pumps and air conditioning – affecting winter and summer peaks	Monthly peak, average, minimum
Efficient investment in peak capacity – the Real Options CBA model	True demand and generation
	More detailed load model
	P **and Q**, then S and load factor

Expanding scope for ATLAS

P scenarios - learning from Demand Scenarios NIA, *but with more customer detail*

Q scenarios – learning from REACT NIA, *but for whole DNO network*

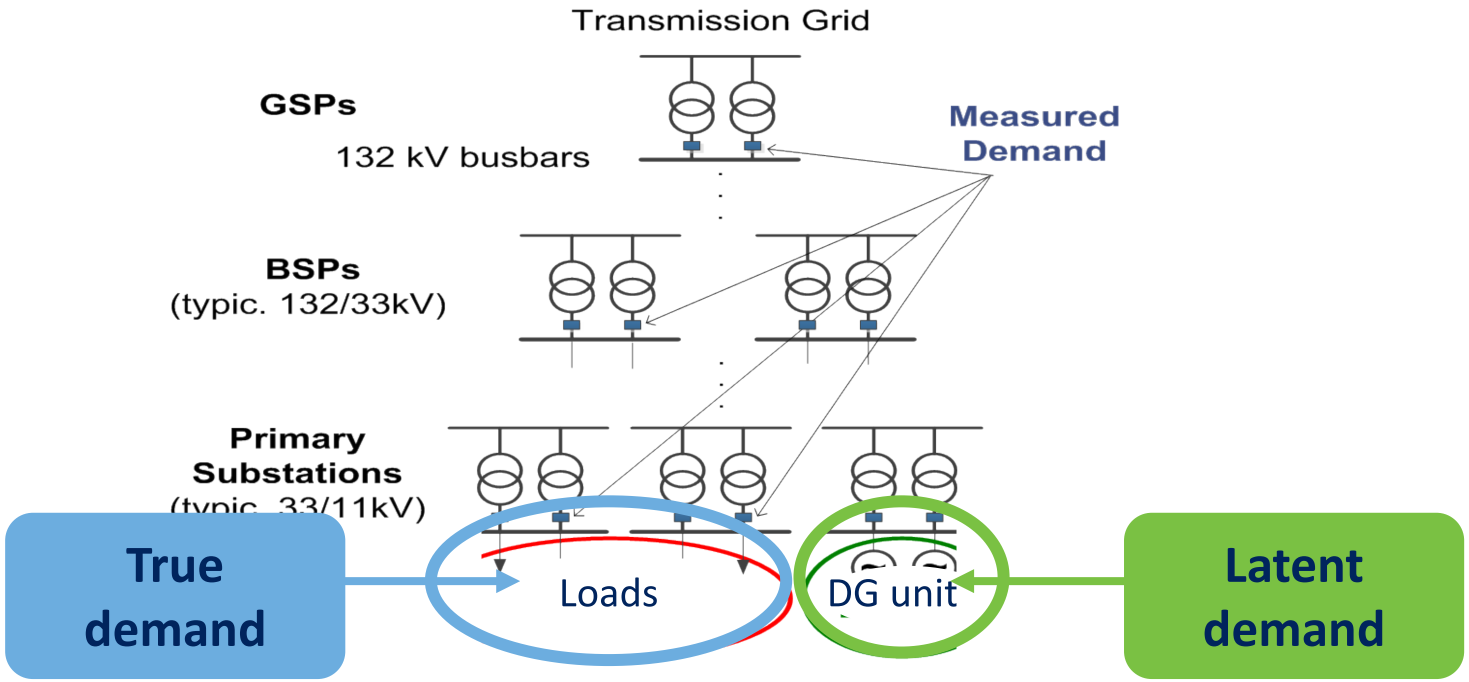
Prototype tools for grid and primary

Indicative comparisons to capacity

Specification for secondary networks

ATLAS – demand definitions

Measured Demand + **Latent Demand** (Generation) → **Demand** (or *True Demand* or *Group Demand*)



Measured demand + **Latent demand (generation)** → **True demand**

ATLAS – demand definitions

True demand = Measured demand + Monitored DG exports + Effects of DG on reducing customer demand + Non-monitored DG

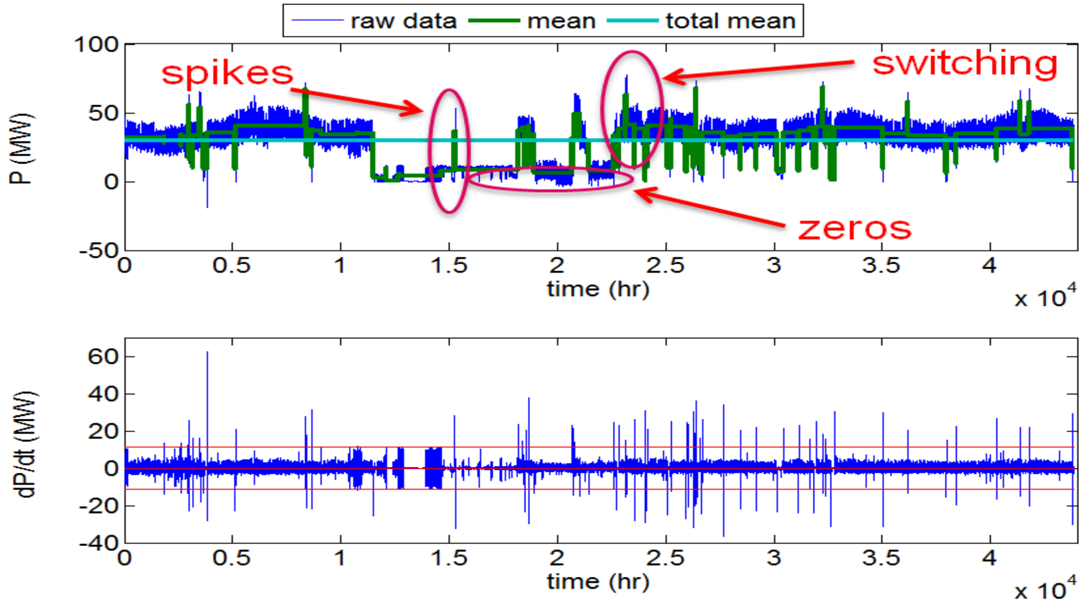
Measured demand + Monitored DG exports: Monitored component of true demand

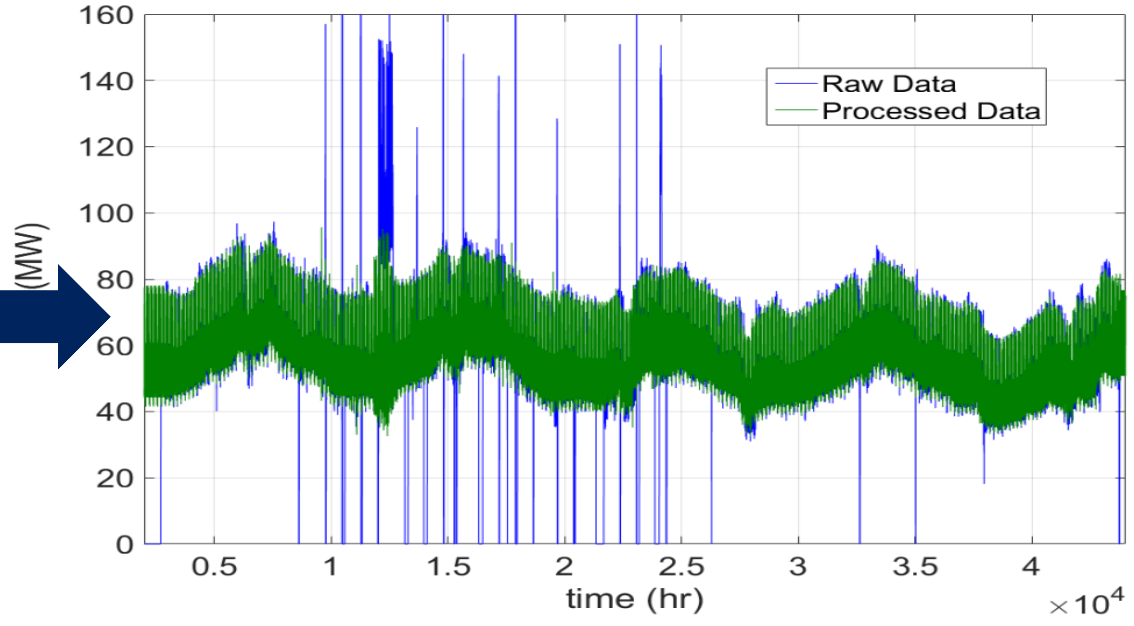
Effects of DG on reducing customer demand: At sites with export metering

Data processing for monitored component

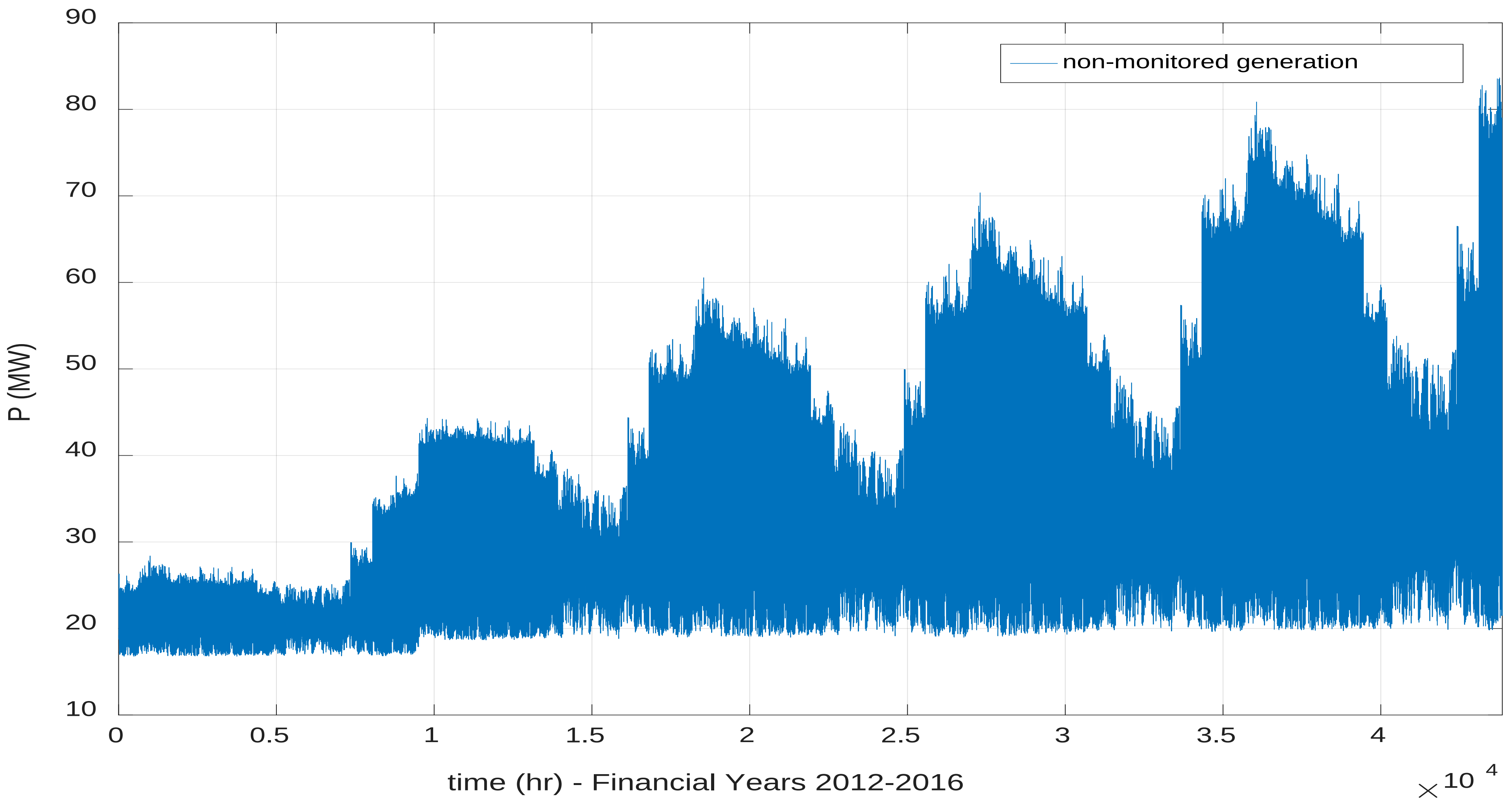
Identification of data problems

Data corrections (half-hourly & daily analyses)



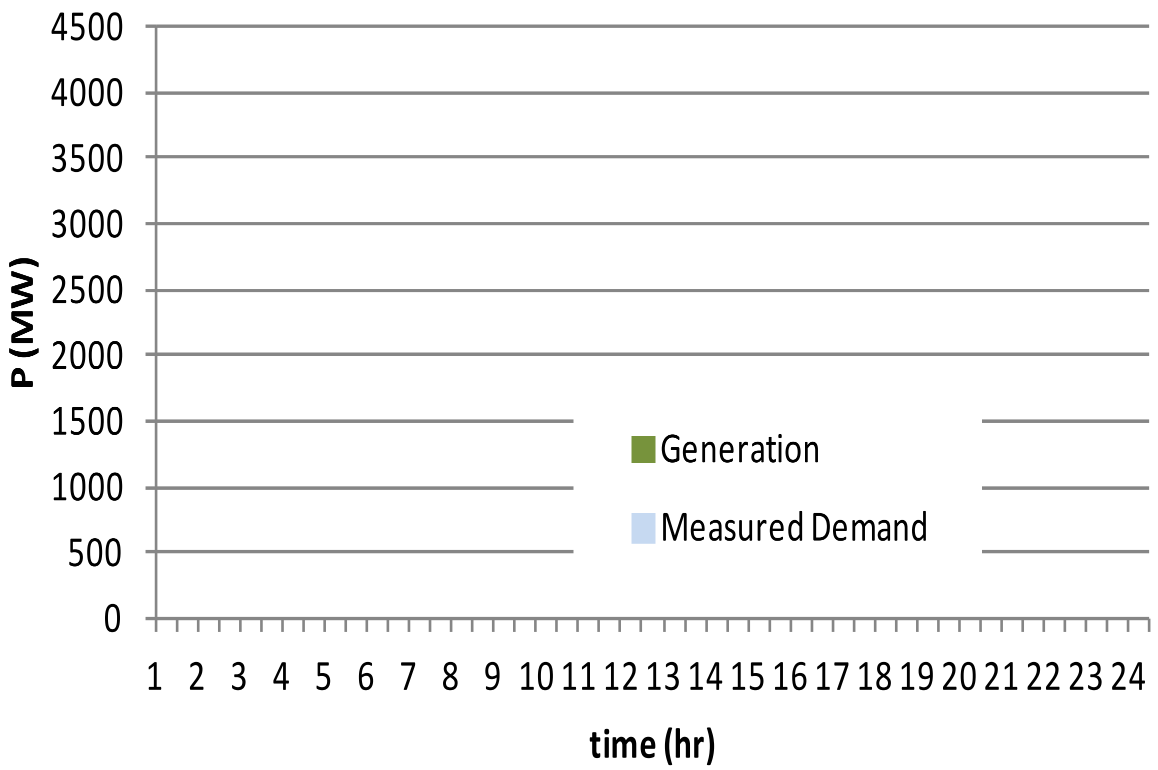


Estimation of non-monitored generation - – early draft

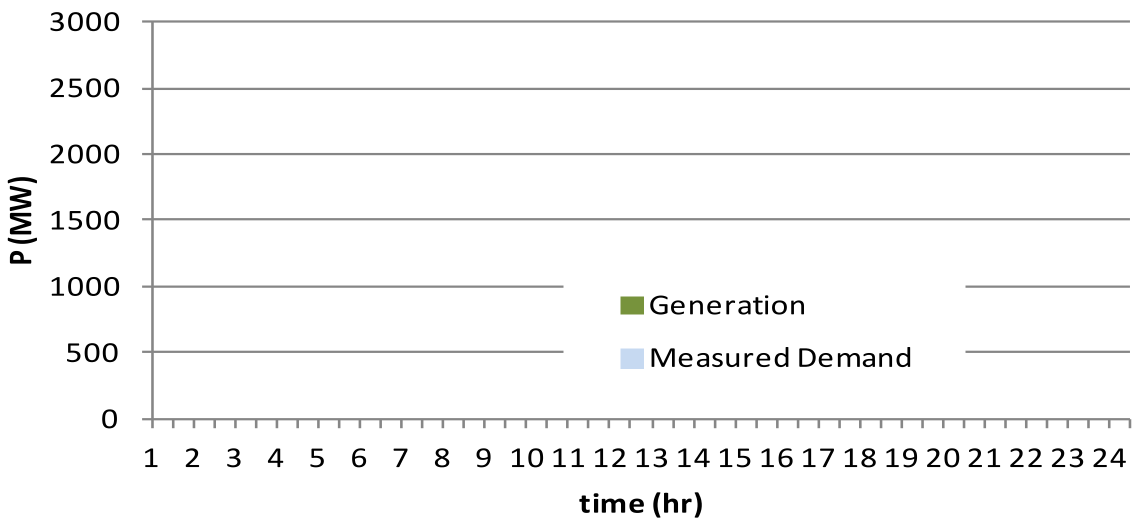


Aggregated P demand across GSPs – early draft

Peak true demand (23/11/2016)



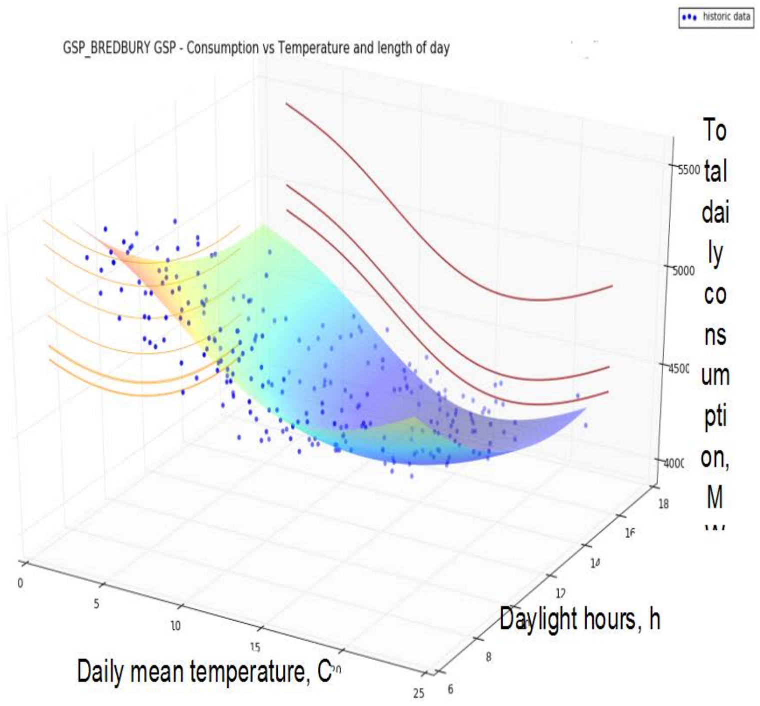
Min true demand (05/07/2016)



Substation-specific weather correction

Daily demand over five years correlated with daily temperature and daylight hours

Next, the total daily consumption is plotted against temperature and daylight:



Half-hourly true demand scaled to the mean temperature range of that month based on 30-year regional weather history

elementenergy

P forecast model per G&P substation

Working with Element Energy, extending their work with UKPN and NPg	Integrated approach from customer distribution per asset to produce scenarios for each of 17 GSPs – 76 BSPs – 396 primary substations	Scenarios presenting peak/average/ min diurnal profiles of demand and generation	Baseline uses processed hh true demand + database of installed DG	*Draft* models set up on FY16 baseline

elementenergy

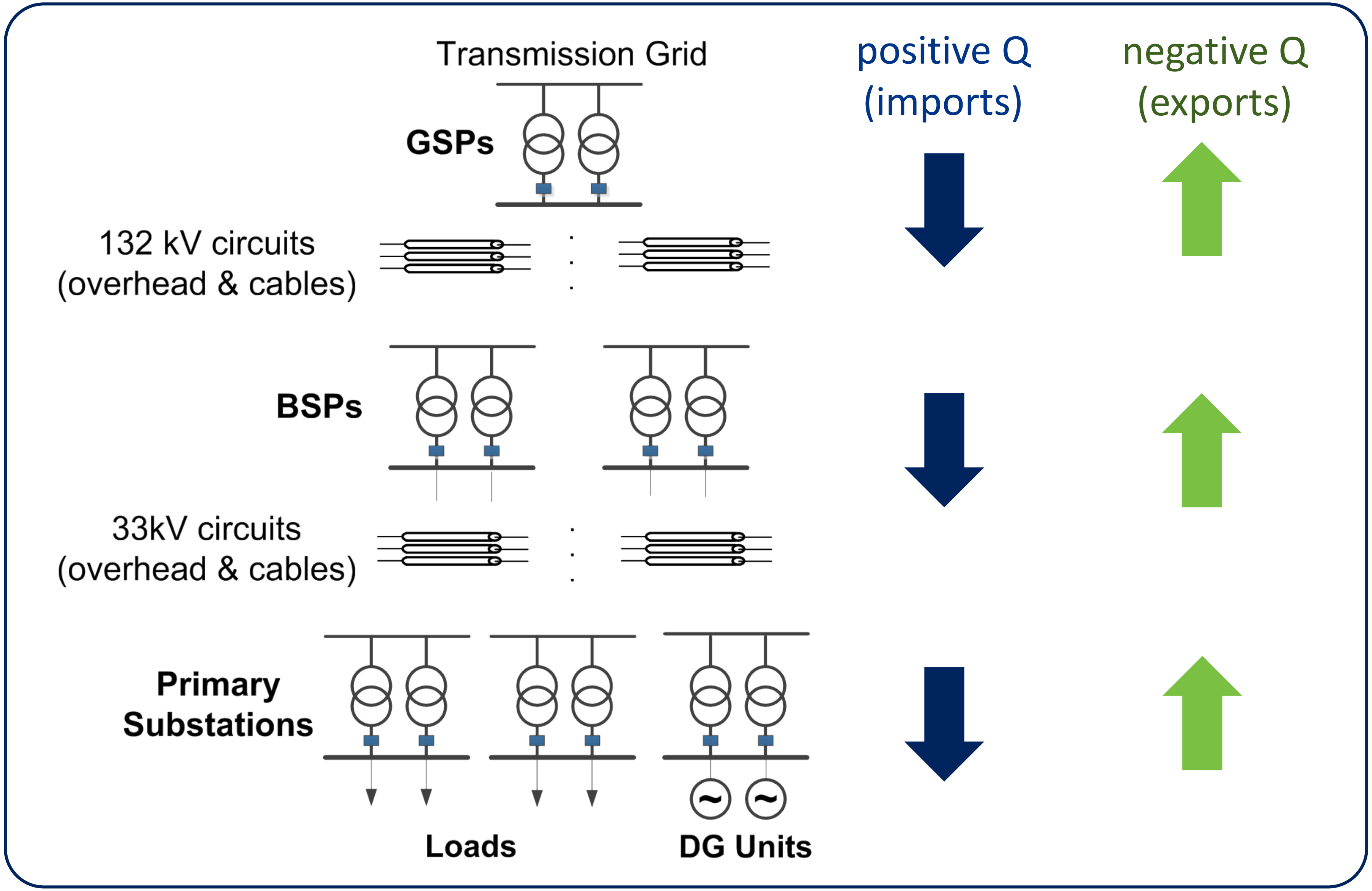
P forecast approach

Underlying demand based on 35 customer archetypes matched to substations

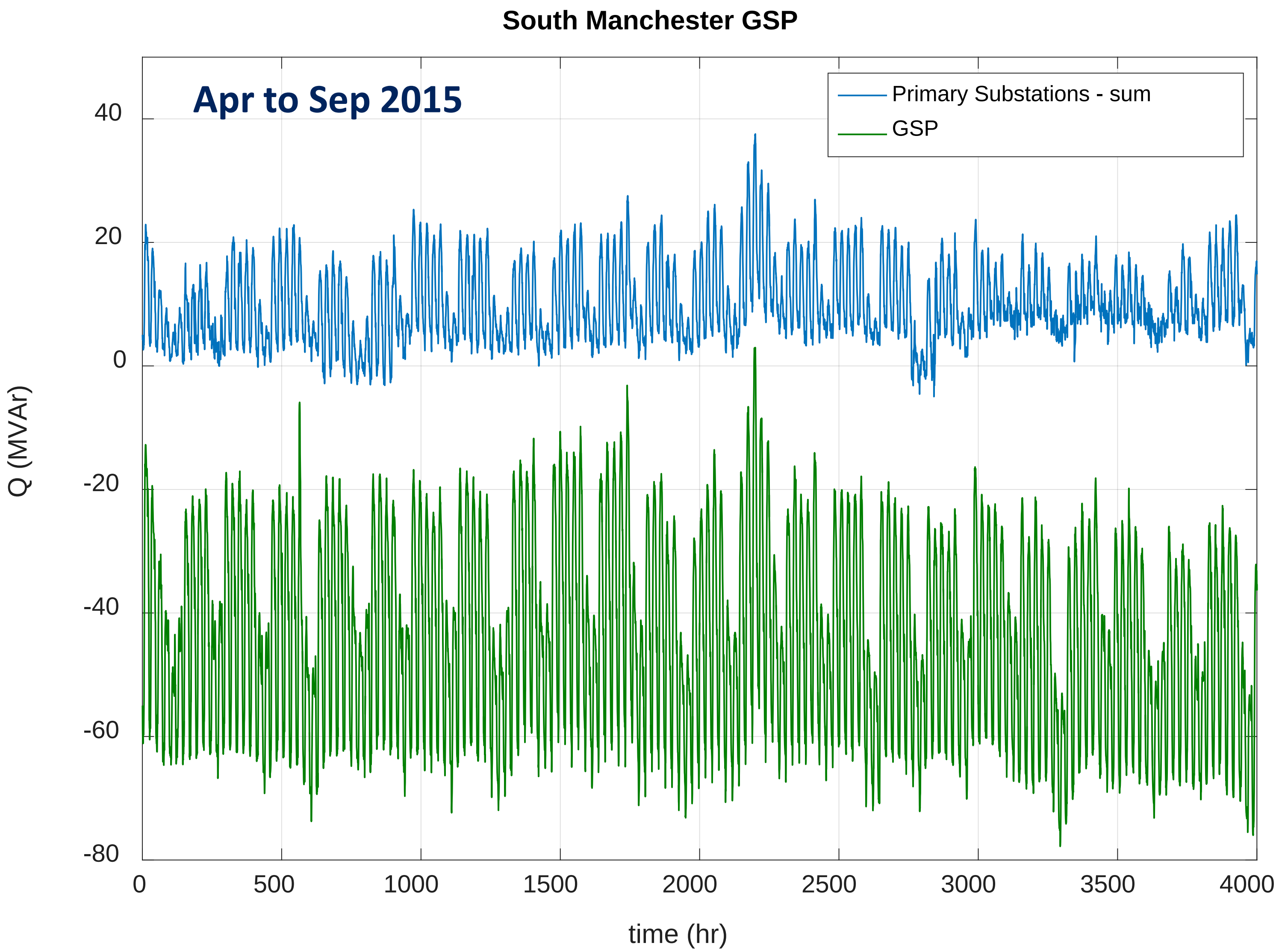
Demand Technologies	Generation Technologies	Energy Storage Technologies
Electric vehicles	Solar PV	Domestic storage (with solar PV)
Heat pumps (domestic and I&C)	Wind	I&C storage behind the meter
Air conditioning (domestic and I&C)	Micro and larger CHP	Frequency response
	Flexible generation	
	Other generation	

elementenergy

Q Demand – definitions



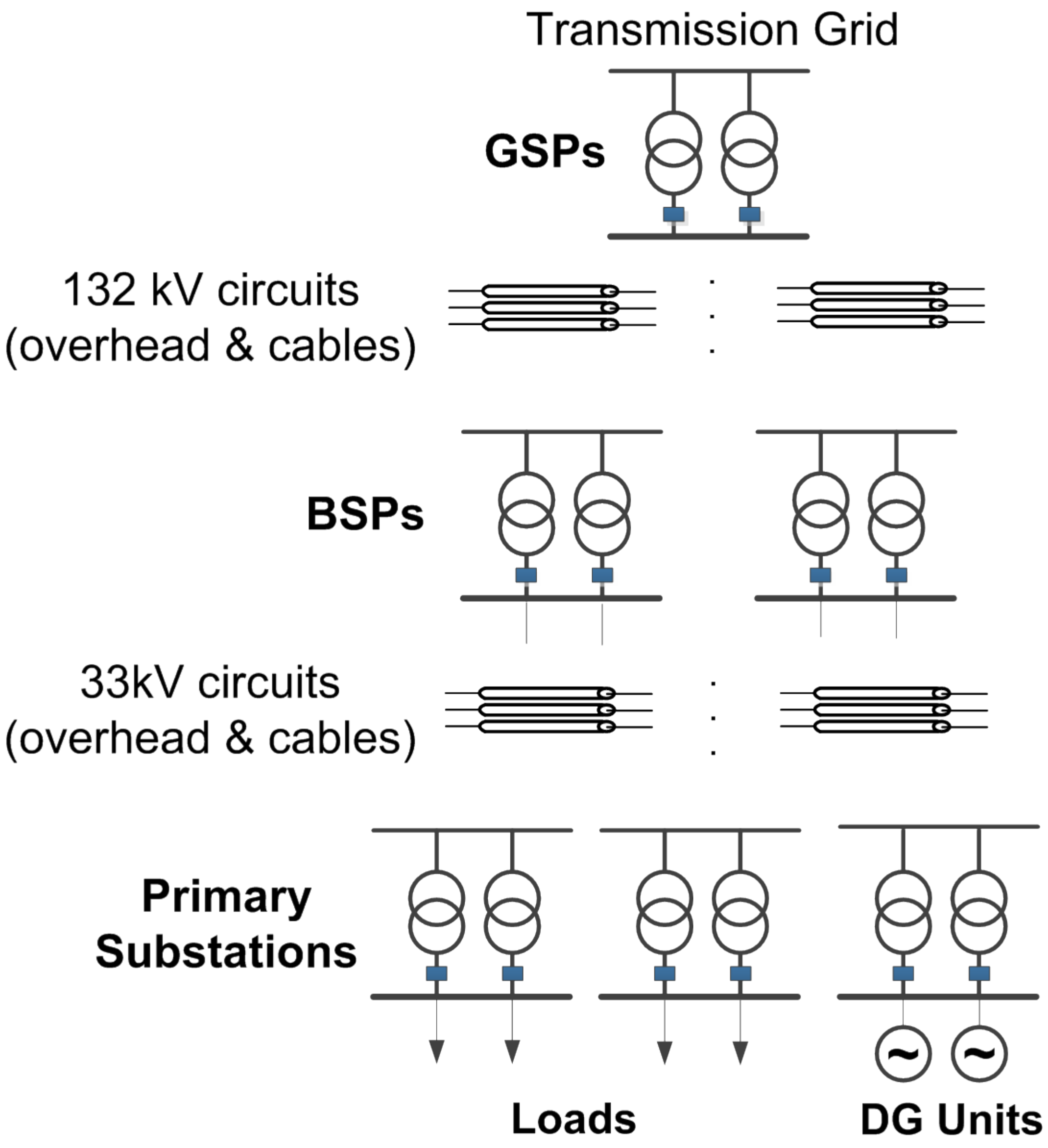
Q demand at GSP v. primaries



Aggregate of primary Q

EHV networks affect Q at GSPs

Simplified view of Q flows



Empirical Rule:

$Q_{GSP} = Q_{primaries}$
$+ Q_{EHV\text{-}losses} - Q_{EHV\text{-}gains}$

$= Q_{EHV\text{-}losses} - Q_{EHV\text{-}gains}$

I^2X $\quad$ $V^2C'\ell\omega$

$Q_{primaries}$

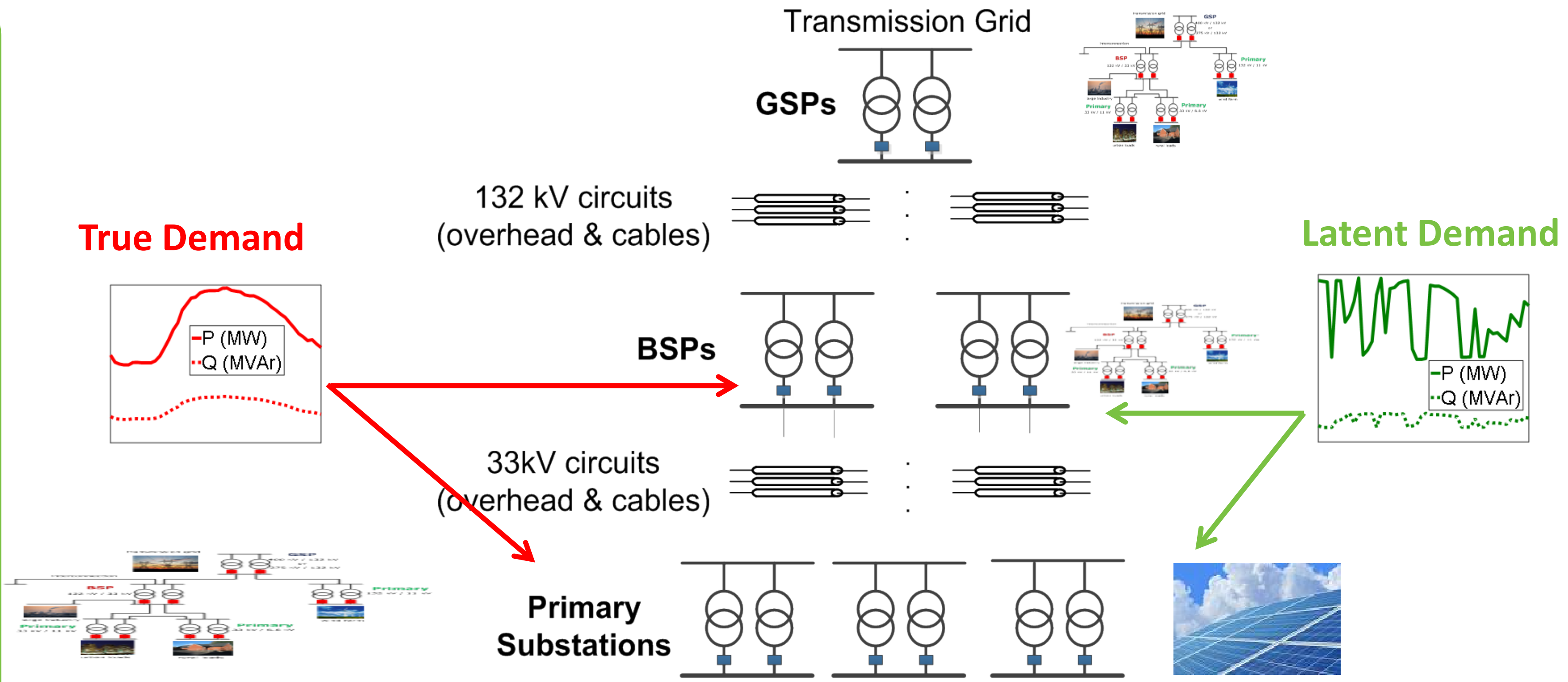
Q at GSPs using network modelling

Network Modelling

Time-series analyses (ie daily simulation using operational aspects)

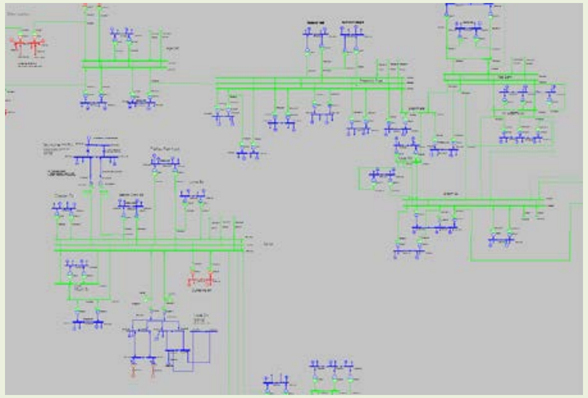
REACT approach... but with enhanced inputs

P and Q profiles at primaries (and BSPs for large customers)

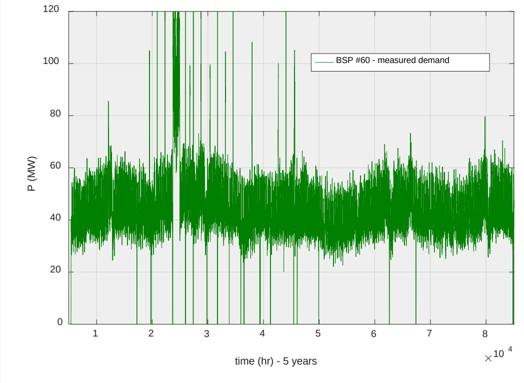


EHV Q forecast – prototype tool

IPSA network model
(GSP to primaries)



SCADA and metering data
(measured P and Q)



Data Processing tool
(Matlab script)

Modelling assumptions
(e.g., load allocations, scenarios)

IPSA-Python tool
(Python script for time-series power flows)

Post-processing of time-series outputs:
(Matlab script – automatic assessments)

- per scenario future Q profiles (from GSPs to primaries)
- loss profiles per asset and for whole network
- load factors (from GSPs to primaries)
- voltage and tap headroom profiles (132 to 11kV buses)
- half-hourly flagging of thermal and voltage issues per asset

Secondary networks – load analysis

Existing system

Load Allocation/

Future Capacity Headroom model

Estimates hh load and peak load (utilisation) in FY23, FY31, FY51 for every asset based on HV metering and customers served

New baseline

In 2018, new improved load estimate as part of new network management system

ATLAS will …

Specify the new 'Future Capacity Headroom' model to use this

Final thoughts

Current task	Remaining months	Remaining months	Want to hear more?
Updating Element Energy Load Growth model (P scenarios) and Q scenarios for FY2017 baseline	Comparisons to capacity for demand and generation	Assess how to transition to BAU	LCNI December 2017

Oil Regeneration

Dr Geraldine Bryson
Innovation Engineer

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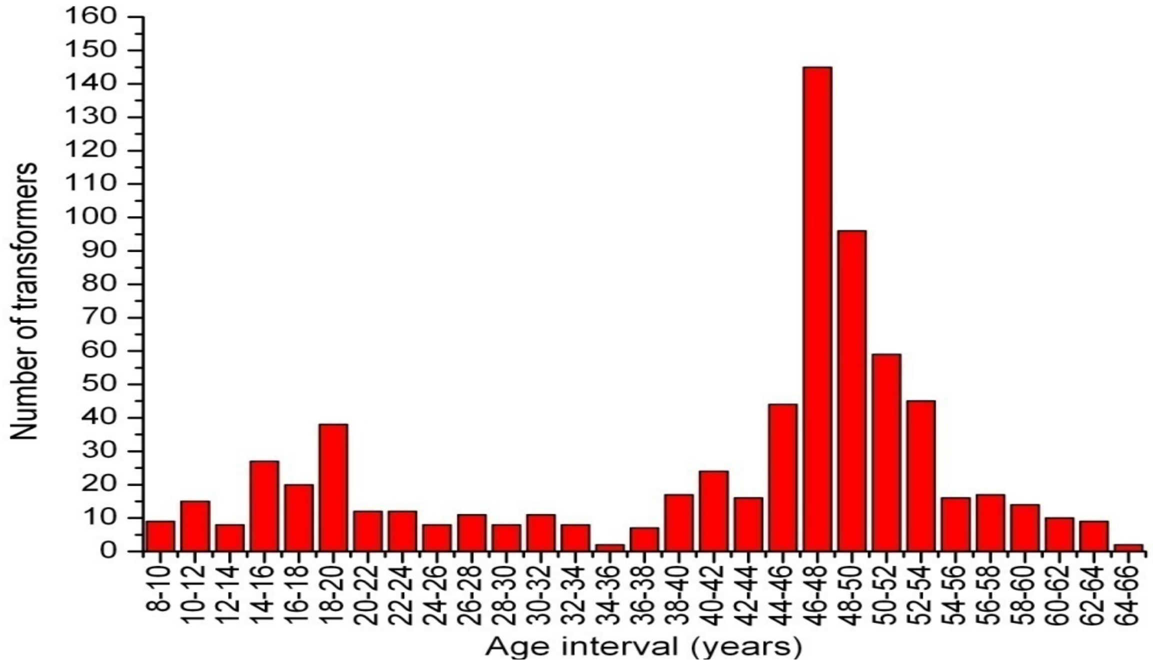
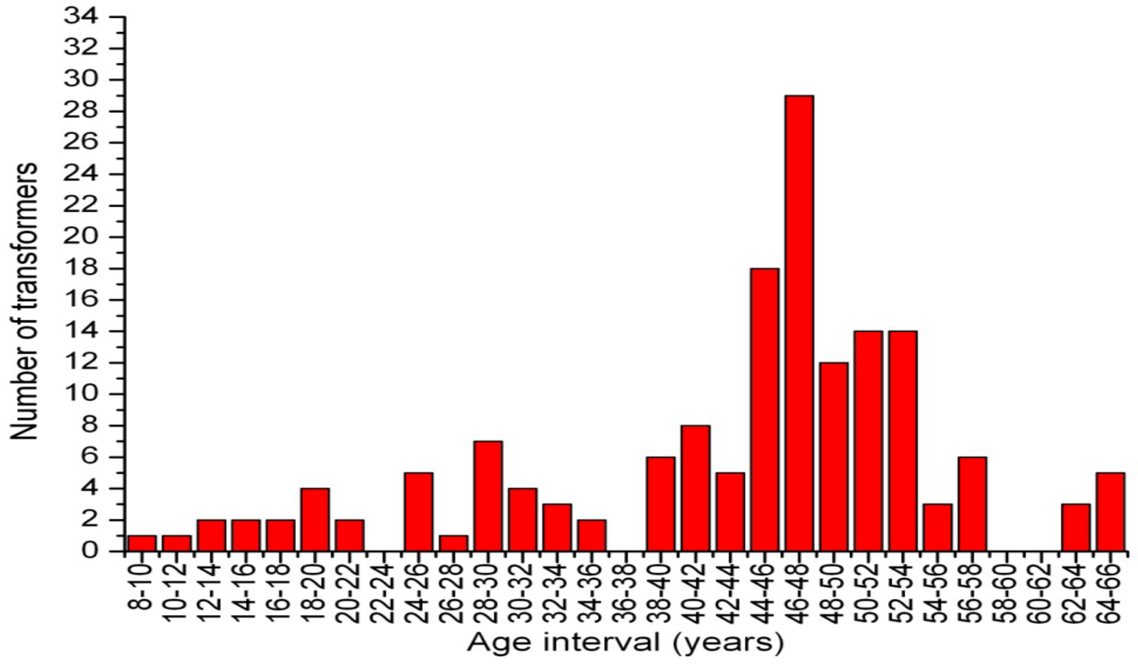
Transformer fleet

33 kV transformers



720 units
345 predicted end of life by 2023

132 kV transformers



180 units
45 predicted end of life by 2023

Ageing of oil-paper insulation system

Transformer's lifetime depends on mechanical strength of paper – the degree of polymerisation

Ageing and degradation of insulation is complex Influenced by thermal, electrical, mechanical and chemical stress

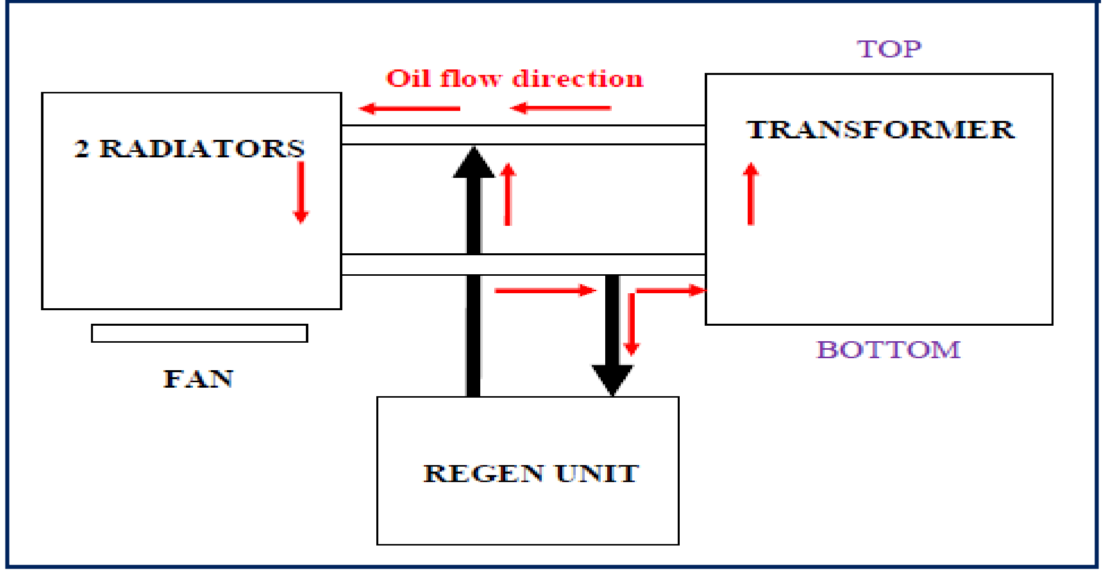
Three parameters dominates ageing rate of oil and paper: temperature, water and acids

New modular oil regeneration unit

Heating & coarse filtering – regeneration – fine filtering – drying and degassing

Trial on a 132kV transformer at Bredbury GT3

Oil regeneration process and oil flow direction during transformer on-load



The oil circuit is broken between the transformer and the radiator

'Old oil' removed from the bottom

'Reprocessed oil' fed back at the top

Became apparent during the process that the transformer had to be 'on-load'

Oil regeneration unit had to account for hot oil flowing out from the top more quickly than cold oil flowing back into the bottom

Results from Bredbury – post analysis

Parameter	Before oil re-generation	2 months after oil re-generation	8 months after oil re-generation	4 Years after oil re-generation
Acids (mg KOH/g)	0.2	0.01	0.02	0.02
Water (ppm)	20	13	13	14
Furans (ppm)	0.09	0.09	0.1	0.12
Breakdown voltage (kV)	32	60	60	60
Hydrogen (ppm)	11	0	17	12
Methane (ppm)	6.8	3.1	6	6
Ethane (ppm)	2.9	0	0	5
Ethylene (ppm)	3	4.2	6	5.8
Acetylene (ppm)	2.1	0	2	4
Carbon monoxide (ppm)	370	60	230	371
Carbon dioxide (ppm)	3010	530	1070	2782

Learning

Optimum window to carry out oil regeneration

Too early not cost effective

Too late limited benefit

Stage 1 - traditional oil cleaning process

Water and sludge in papers can migrate back into the oil

We will apply a second stage process to clean papers

95% of moisture in the papers

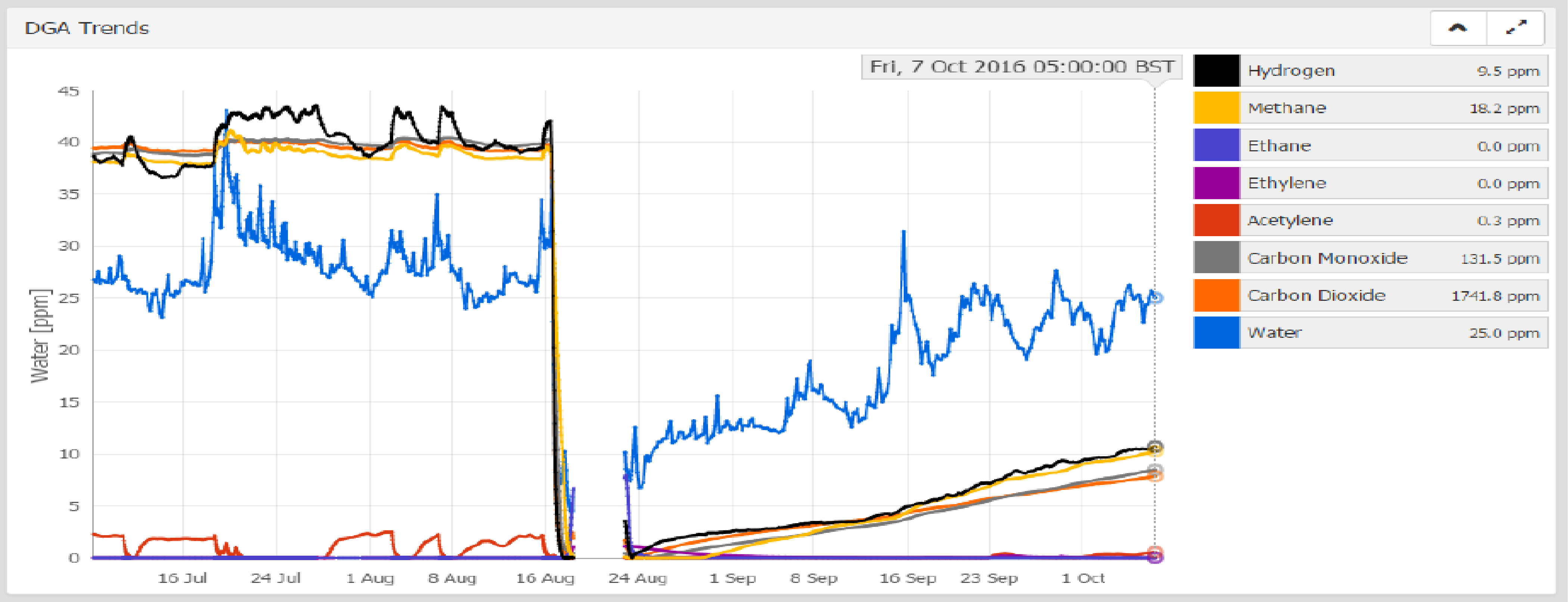
High temperature required - 65/85°C

Accelerate natural migration of water and sludge back into oil

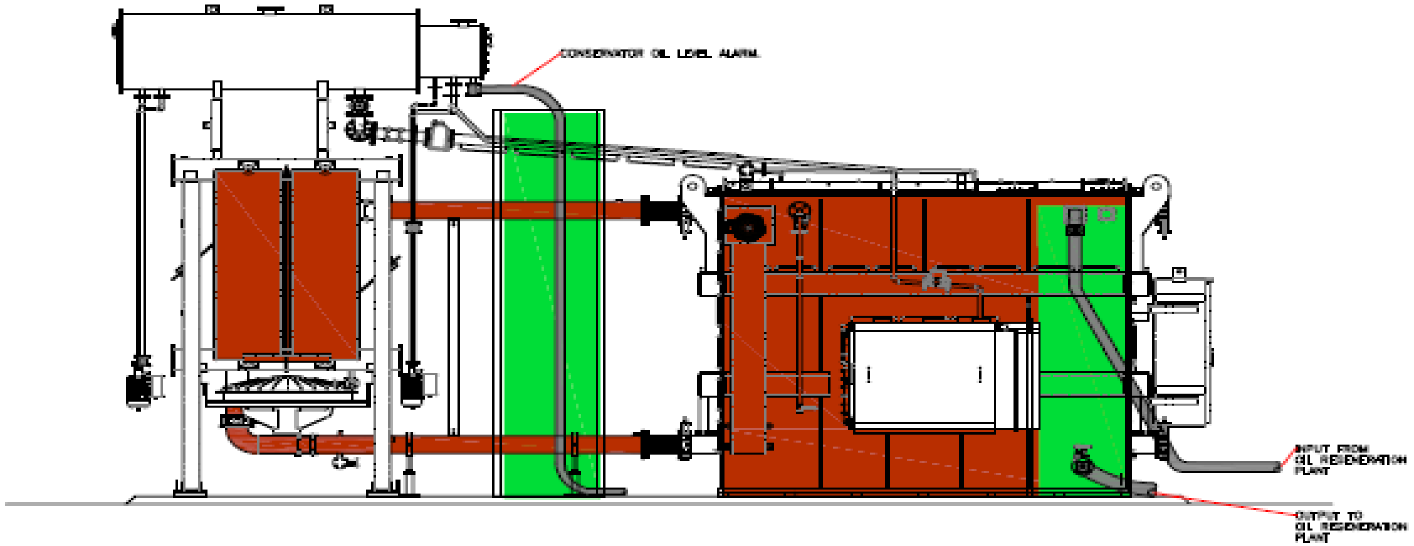
Carry out second stage for 7 to 10 days

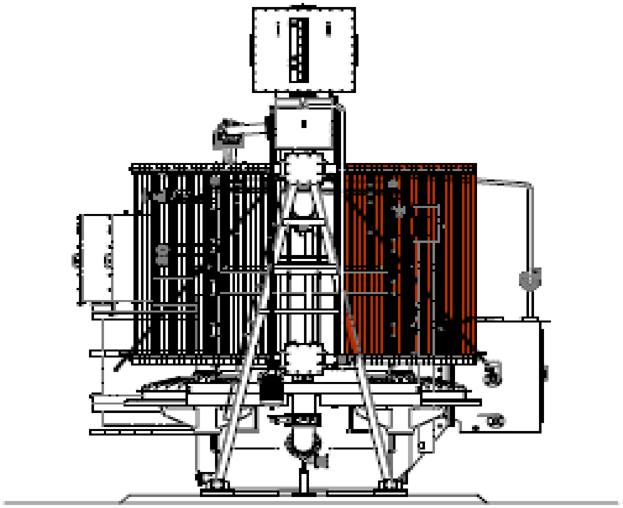
‘cleans the papers’ in the transformer

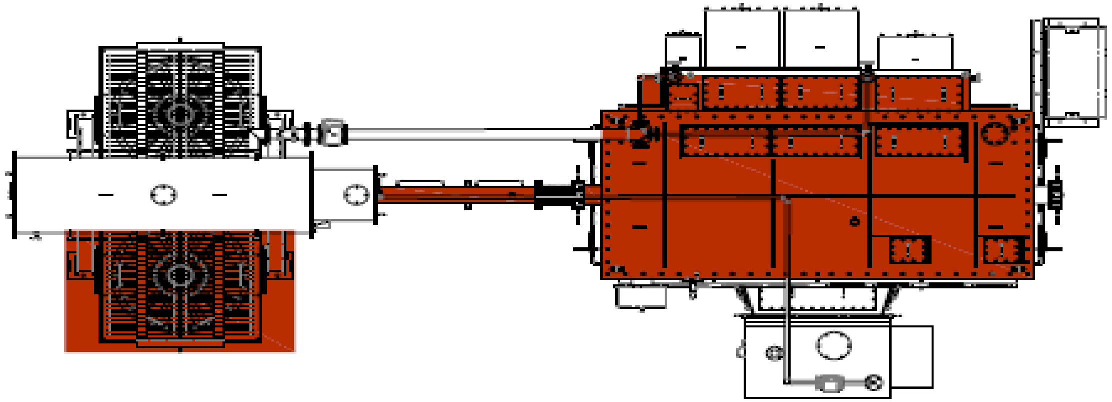
Trial of Stage 2 - Barton dock



Not getting core hot enough yet - Ideally 65 to 85 Deg C ● Barton dock was first attempt ran over a few days ● Moisture has returned to pre-regeneration levels ● Improved acidity and breakdown strength







KEY

THERMAL BLANKETS

SCAFFOLD ACCESS

ELECTRICITY NORTH WEST
FREDERICK ROAD
SALFORD M6 6QH

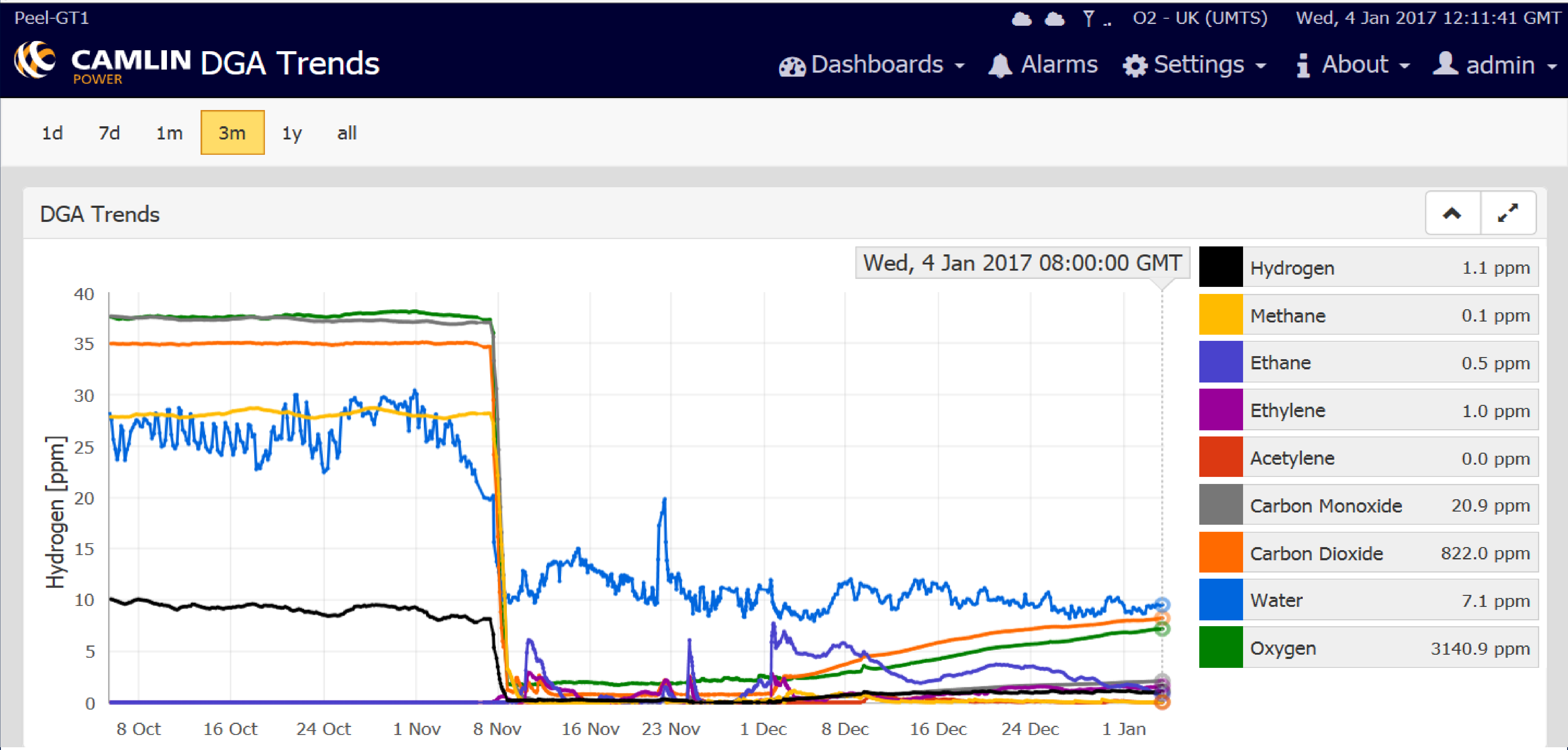
OIL REGENERATION CONNECTION ACCESS & THERMAL BLANKET COVERAGE

NOT TO BE SCALED. UNLESS OTHERWISE STATED DIMENSIONS ARE IN MILLIMETRES.

REV	AMENDMENTS	DRAWN	APP.	DATE

SCALE	1:25 @ A1	SITE NAME	CORD		
DRAWN	JEWB	PROJECT	–		
APPROVED	JAB	P.F.R. NO.	–	DWG. STATUS	INFORMATION
DATE	MAR 17	DRAWING NUMBER			REVISION
SHEET SIZE	A1	JAB/171800/001			P1

Peel Success

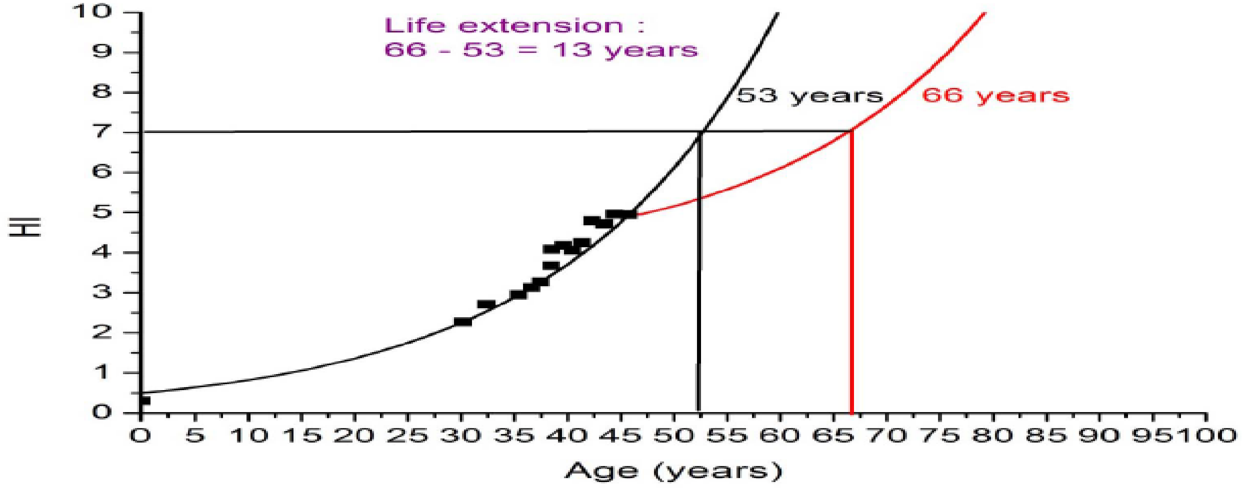


How are the results quantified

Life estimation of a regenerated transformer

Key is how it impacts on the CBRM health index

Life extension using existing HI model (Combined HI)



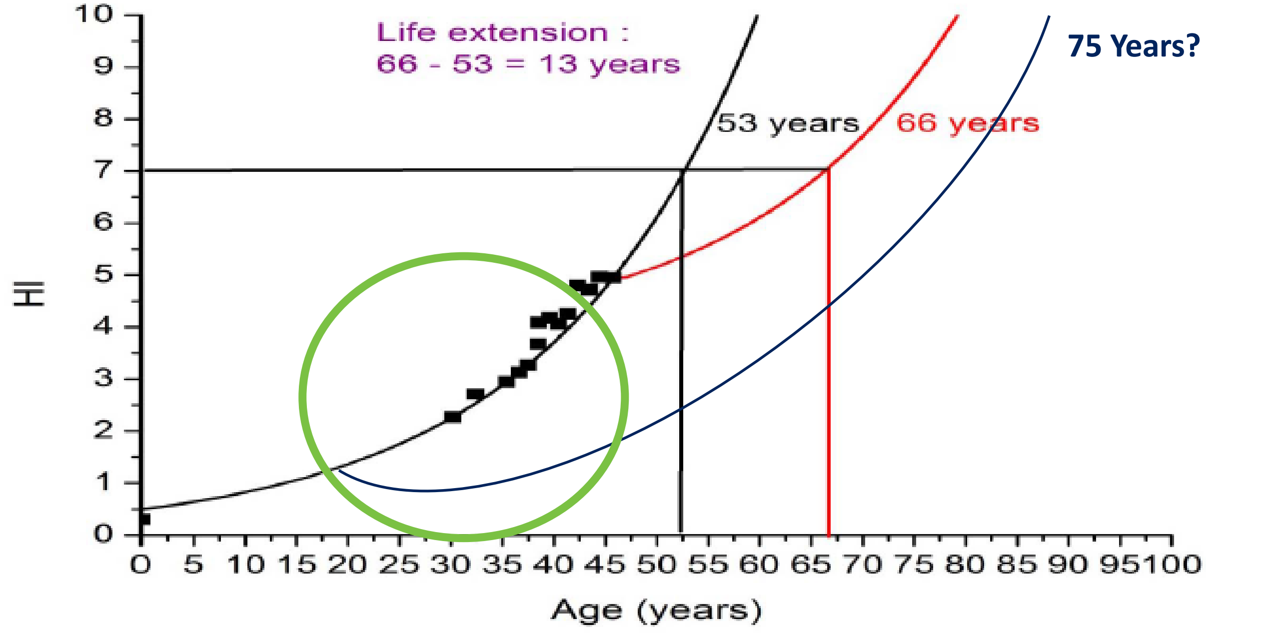
Before oil regen has 7 years left (HI reaches 7.0 @ 53 yrs)

After oil regen has 20 years left (HI reaches 7.0 @ 66 yrs)

Explore optimum life of transformer

Traditional life extension is normally at end of the assets life

Life extension using existing HI model (Combined HI)



What if we intervened earlier could we extended the asset life even further?

Optimising oil regeneration

'Sister' transformers at various stages of design life have been identified	Only one transformer per site will undergo oil regeneration	Monitoring to compare oil condition and determine life extension	Optimum point that oil regeneration can be applied to gain maximum benefit?

RIIO transformer management strategy

Transformer management	Oil regeneration	Replacement & refurbishment
CBRM health index driven	Major contributing factor to CBRM health index	CBRM health index and inspection driven
Cost effective intervention strategy	The timing of an intervention is critical to maximise the potential life extension	The chosen intervention(s) must be appropriate to manage the HI within unit cost
Safe and reliable management of ENW's transformer fleet	Online condition monitoring	Online condition monitoring

Customer engagement challenges

5 July 2017

Impact Utilities
Pursue, Discover, Act

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Capacity to Customers

20 trial participants

180 interviews

494 recruited to take part

1,513 organisations contacted

Electricity North West provided data for 2,071 customers

The challenges

- Accuracy of existing I&C contact information
- Finding the most appropriate person to speak to
- Range of senior decision makers involved (finance/ ops)

Lessons learned

- An engaged customer panel is the most effective way of testing and refining customer communication materials
- Incentives enhance response rates; online vouchers if completed within a certain timeframe and charitable donations
- The majority of I&C customers prefer to take part in an online self-completion format
- Customers respond better if approached by a contact at their respective DNO, rather than a third party aggregator

Respond

0 trial participants to date

91 interviews

303 identified to complete electronic survey

Telephone screened to ensure the organisation met key criteria to provide an FCL service

Electricity North West provided data for 1,639 customers

The challenges

- A niche I&C universe
- Risk vs. reward
- Contracts already in place (STOR)

Lessons learned

- Produce a range of communication materials with a breadth of technical complexity to satisfy varying stakeholder needs
- Increasing the incentive to encourage early survey completion is an effective strategy
- Consider recruiting an appropriate cross section of respondents, able to effectively represent their organisation
- It is important to clarify key units of measurement and terminology used with the survey

Power Saver Challenge

4 surveys

250 home energy visits completed

335 households signed up

1,639 households in the Heaton Moor and Heaton Norris areas

The challenges

Doubting that behaviour change would stimulate reductions in bill prices, perceiving there to be no need for energy saving advice and/or it not being a convenient time to dedicate full attention to the challenge.

Lessons learned

Similar challenges should be launched in the spring to allow sufficient time for recruitment

Link the project to trusted local groups (eg local authority) to overcome lack of DNO awareness – distinction vs suppliers

Use appropriate recruitment approaches for different customer groups (door knocking, telephone, f2f events)

Opportunity to win a prize was not an important aspect of the project, saving money through reducing bills was

Value of Lost Load

- Reconvened ECP
- 6000 targeted interviews among 32 quota groups
- ECP: Rural, Urban. SME, Worst Served
  Depths: Vulnerable, Community organisations
- c.60 million people (2011 census)

The challenges

Customers have limited understanding of a DNO’s responsibility and require education

Customers find it extremely difficult to imagine, or are unwilling to accept, future scenarios around electricity demand

A large number of attributes to include in a trade off exercise, requiring complex rotations

Lessons learned

A mixed methodology approach is beneficial, allowing flexibility in recruitment of niche respondents such as EV users

It is important to pilot a draft survey instruments with a range of customers who have no prior knowledge of the project

Keep explanatory text simple, non-repetitive and to a minimum to prevent the loss of important information
Use annotated images to help explain things

Quiz

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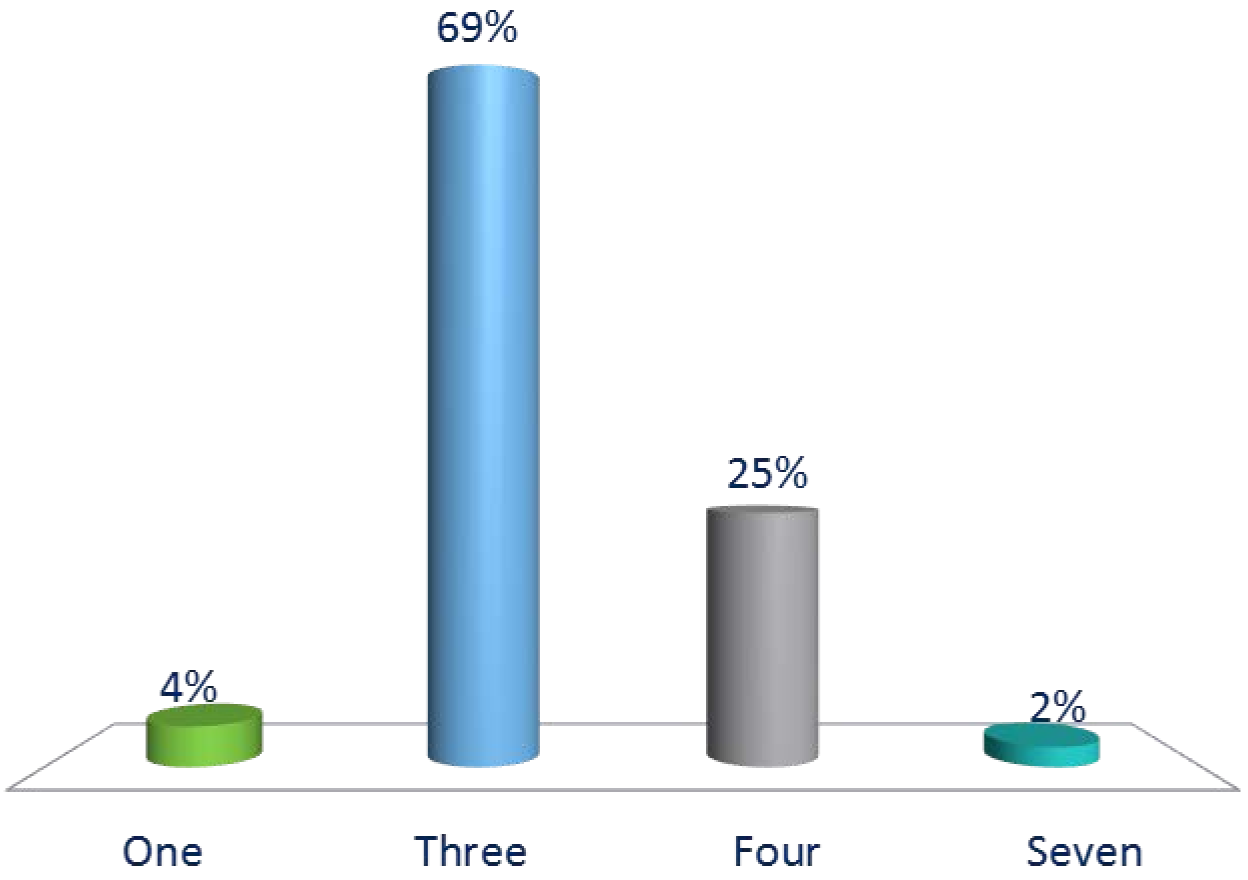
How many fault current limiting techniques are part of the Respond project?

A. One

B. Three

C. Four

D. Seven



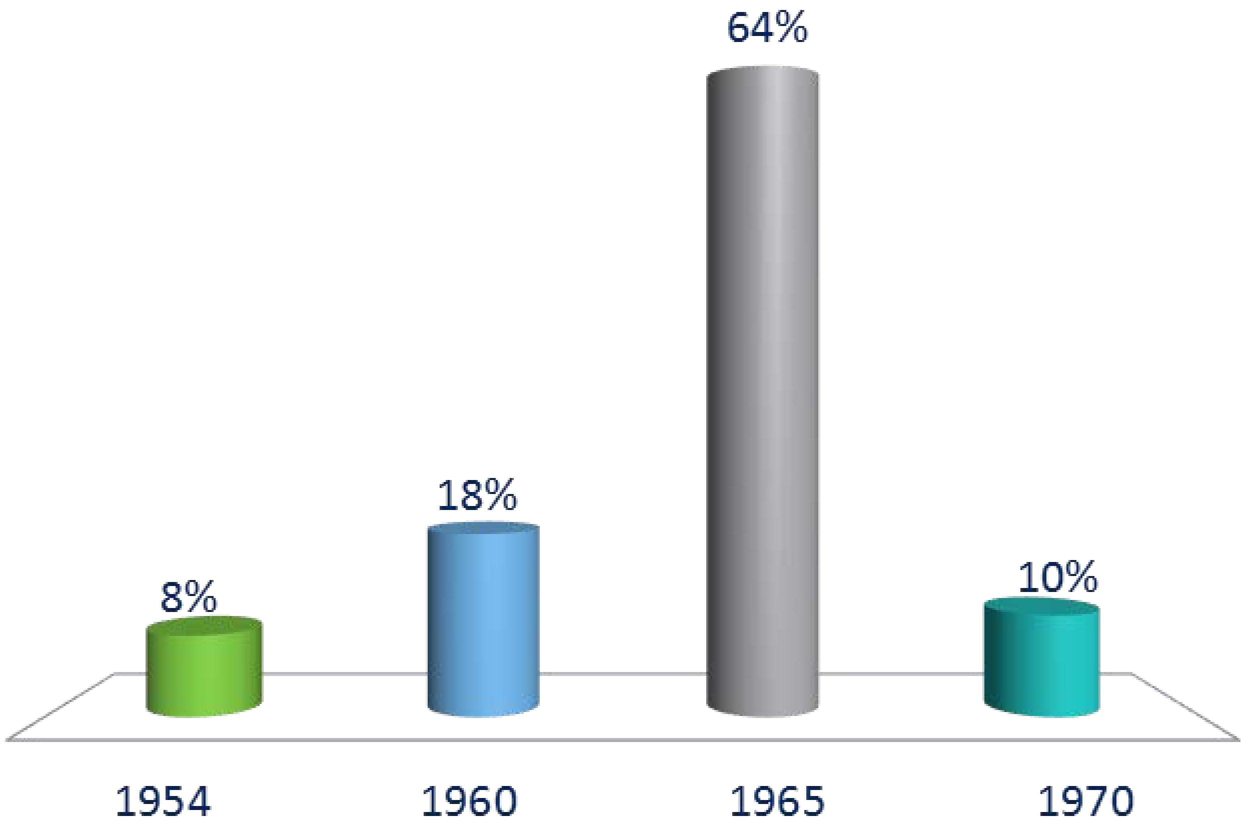
When was the peak for the estimated year of installation for our network assets?

A. 1954

B. 1960

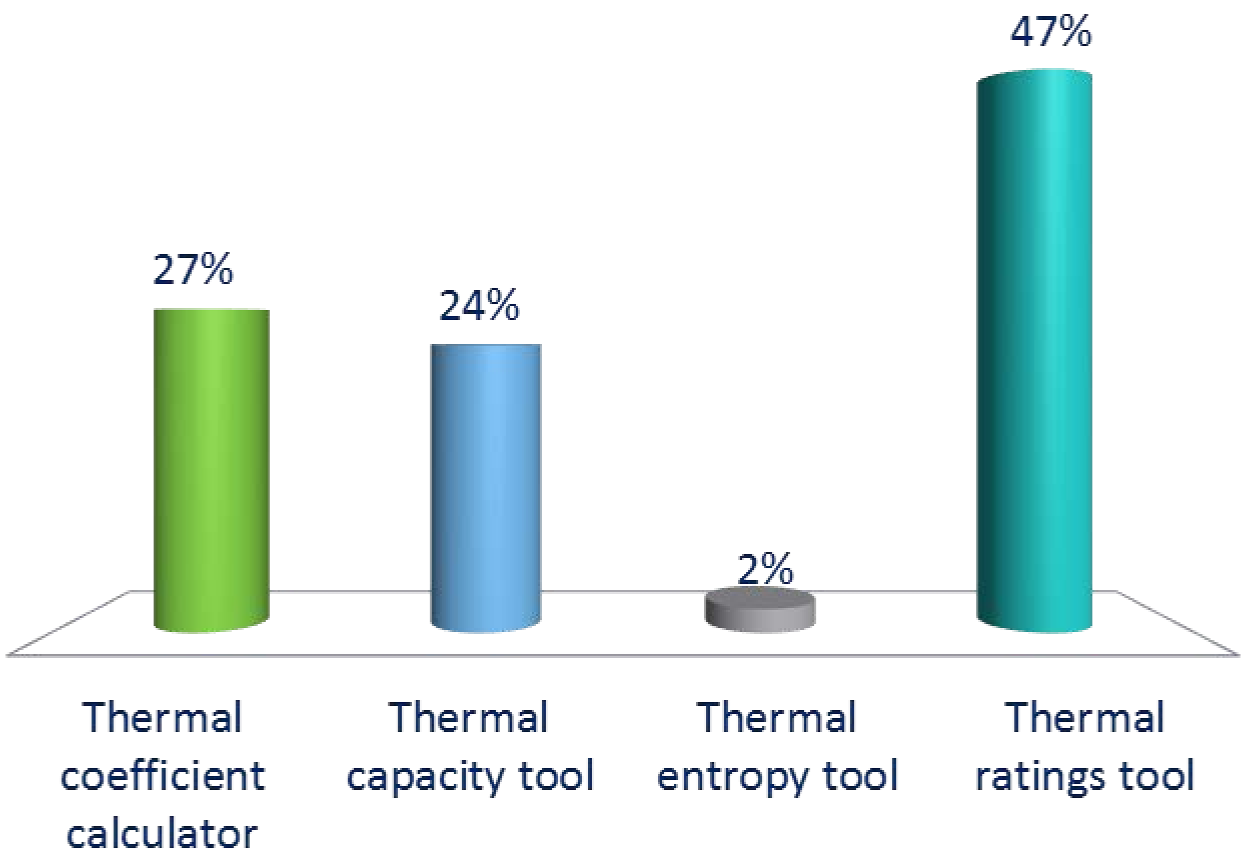
C. 1965

D. 1970



What's the name of the key deliverable of the Celsius project?

A. Thermal coefficient calculator
B. Thermal capacity tool
C. Thermal entropy tool
D. Thermal ratings tool



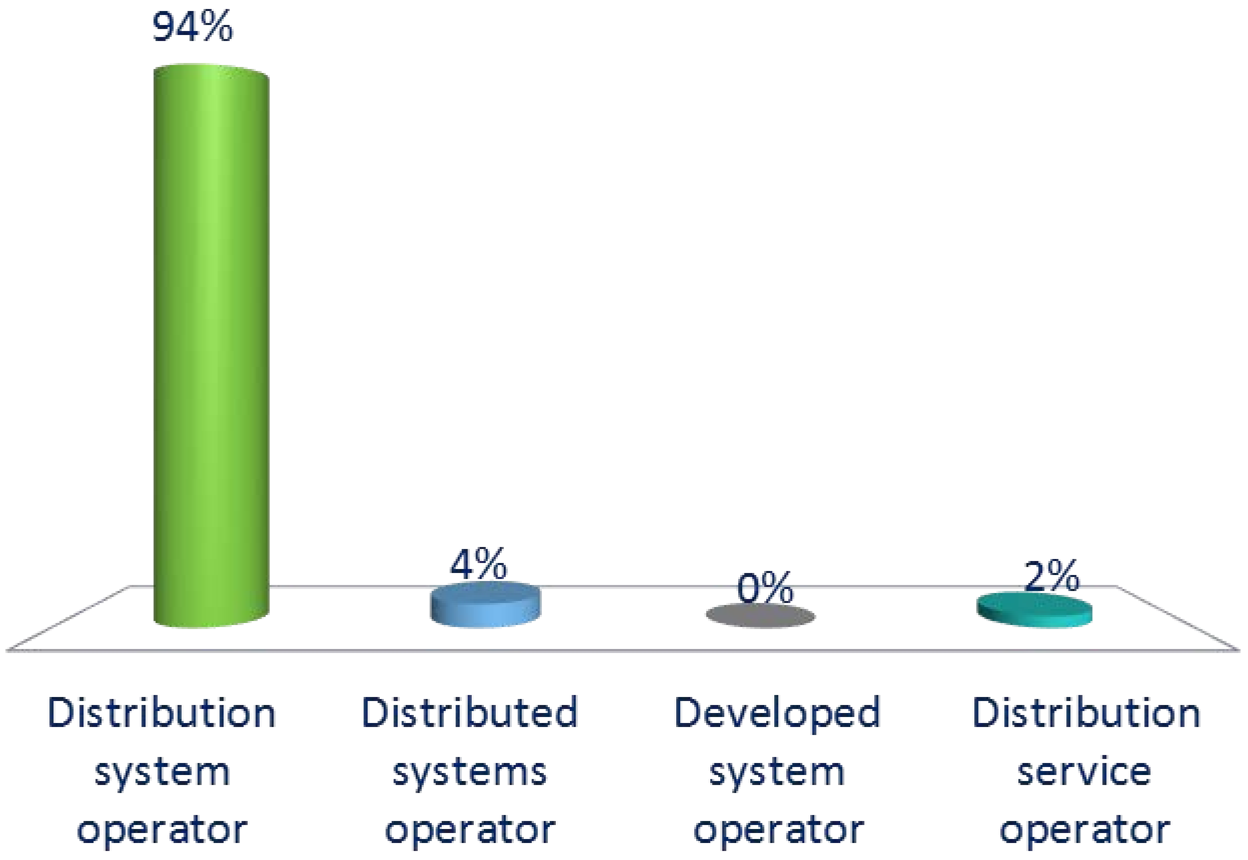
What does DSO stand for?

A. Distribution system operator

B. Distributed systems operator

C. Developed system operator

D. Distribution service operator



Feedback

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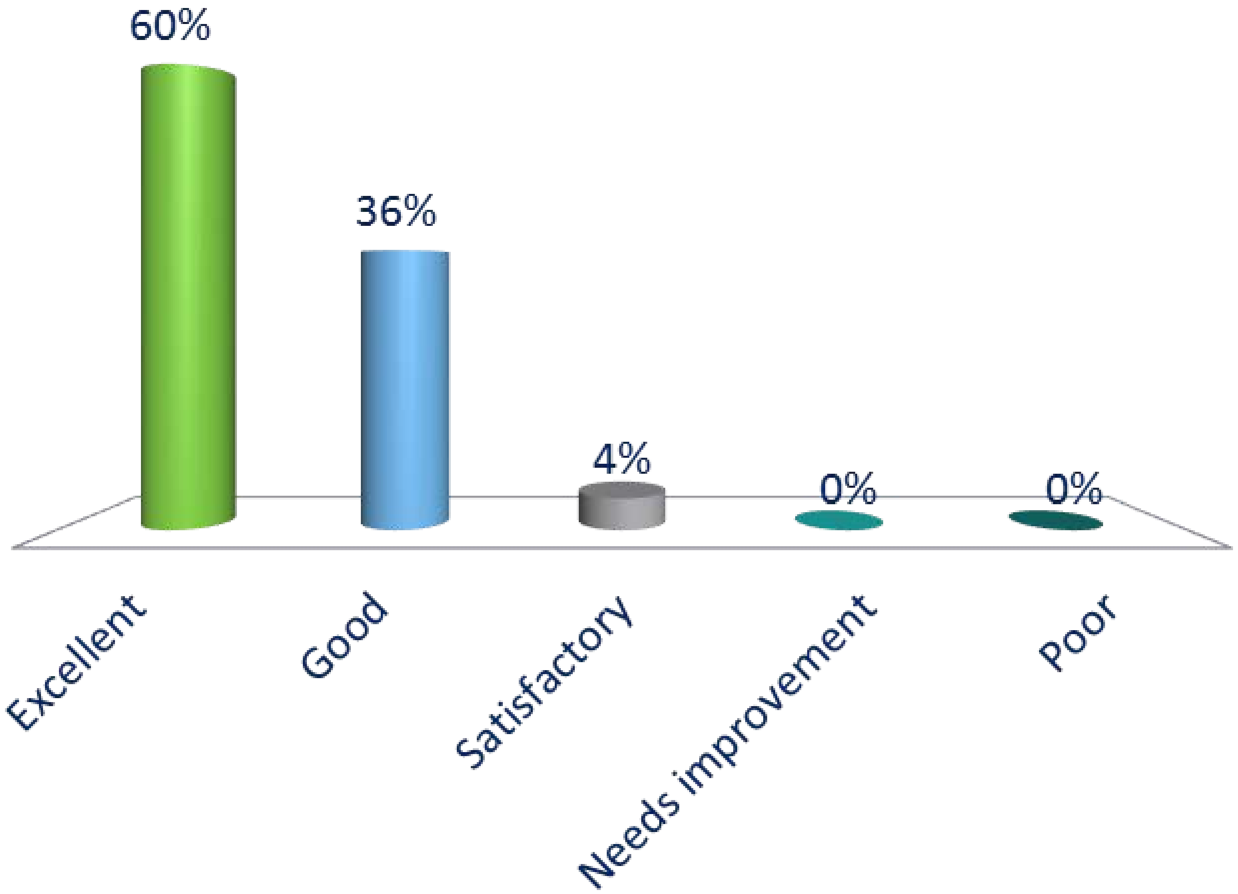
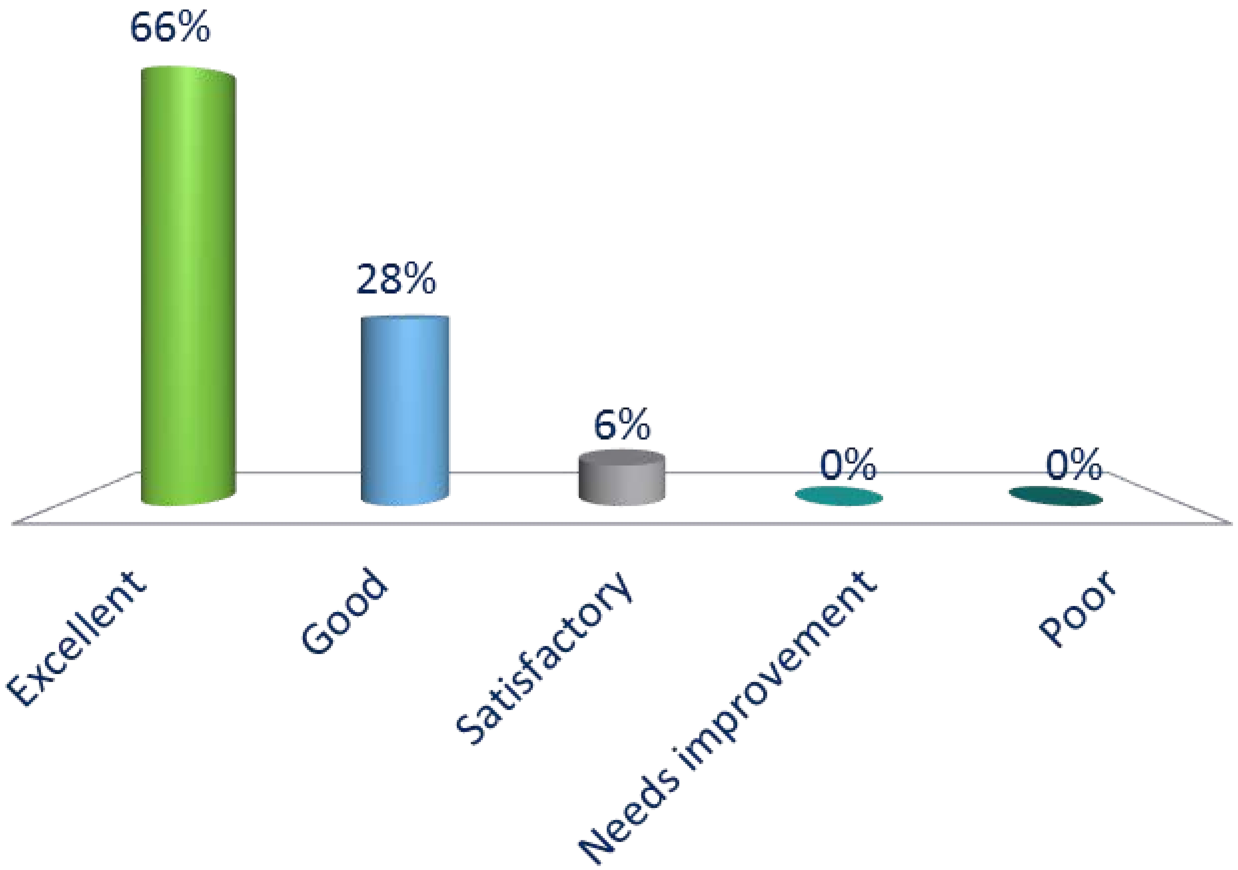
How do you rate the event for content?

A. Excellent
B. Good
C. Satisfactory
D. Needs improvement
E. Poor



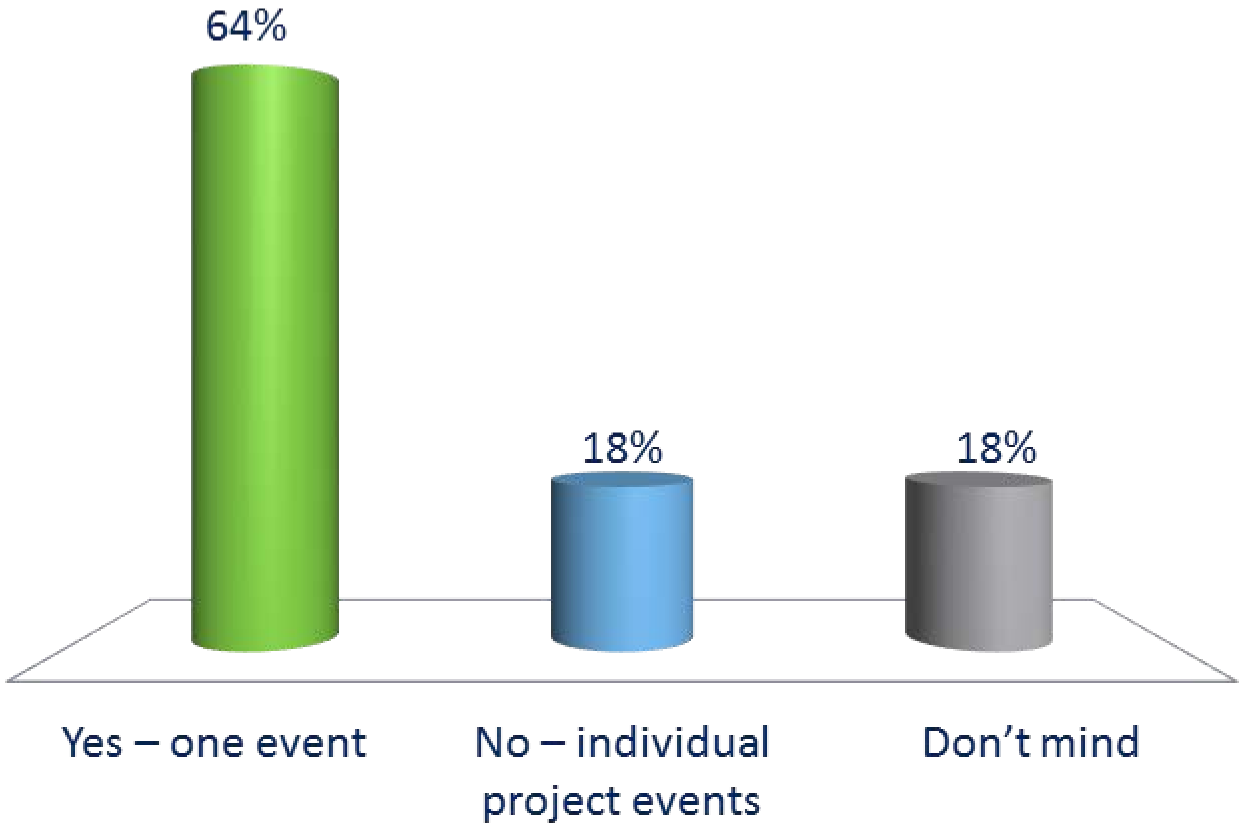
How do you rate the event 's format ie large presentations, partner networking and breakout sessions?

A. Excellent
B. Good
C. Satisfactory
D. Needs improvement
E. Poor



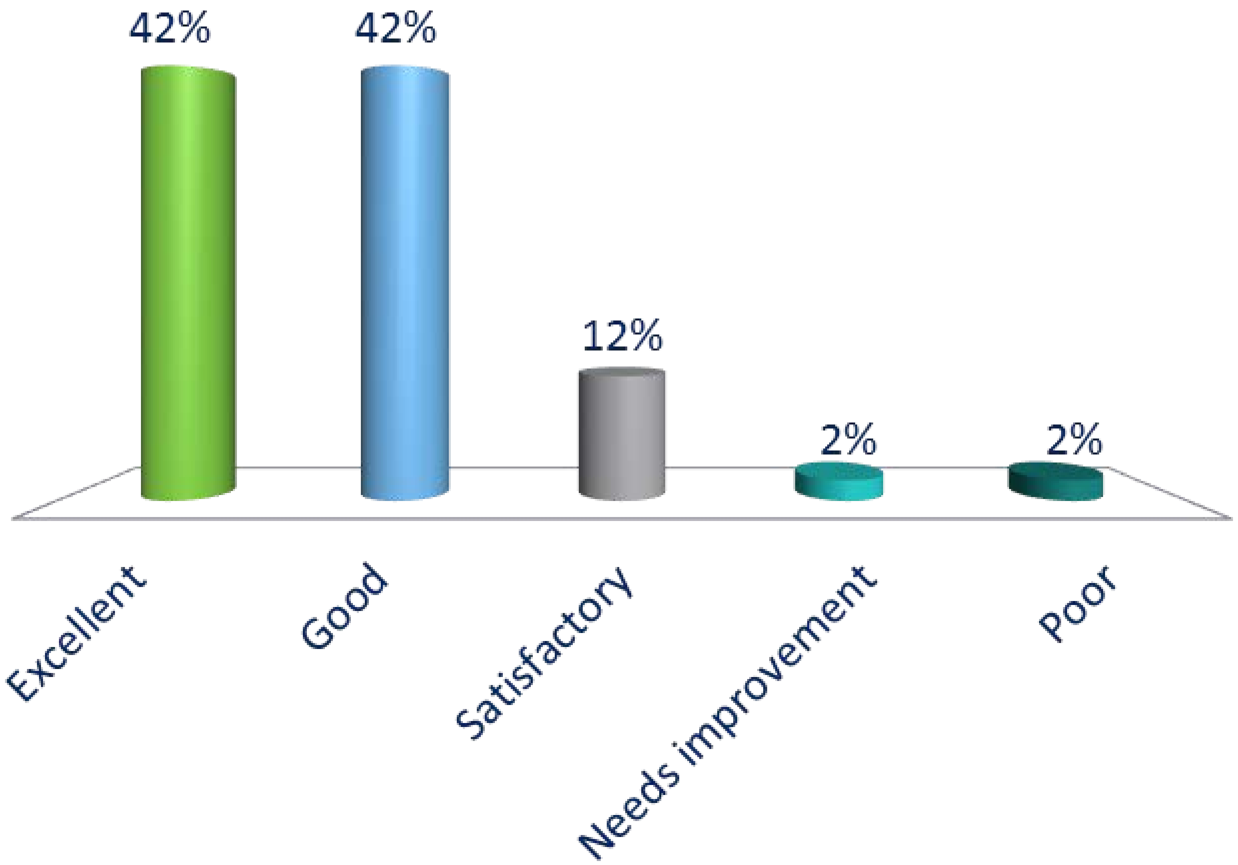
Do you prefer to have one annual learning event rather than several project-focused events?

A. Yes – one event
B. No – individual project events
C. Don't mind



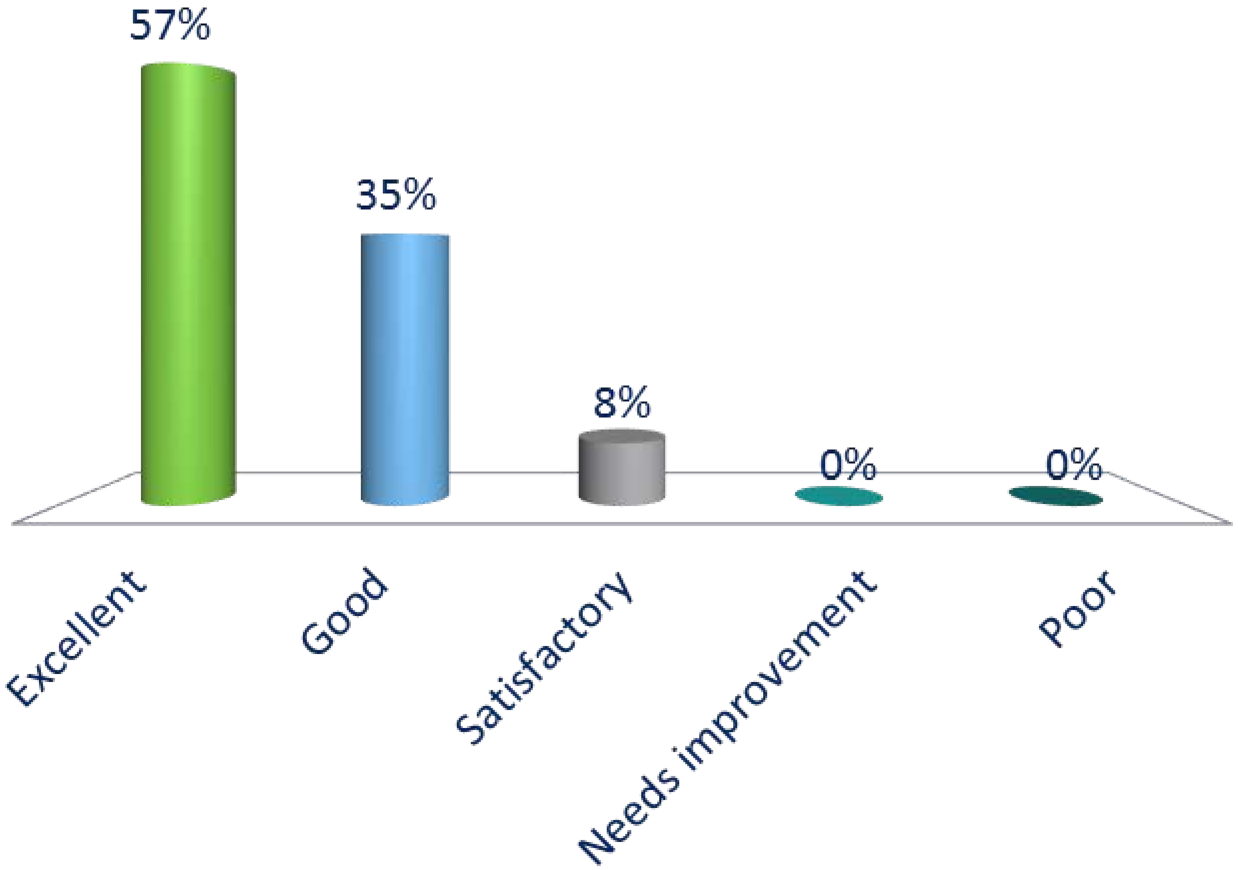
How do you rate the event for questions and networking opportunities?

A. Excellent
B. Good
C. Satisfactory
D. Needs improvement
E. Poor



How do you rate the overall experience of the event?

A. Excellent
B. Good
C. Satisfactory
D. Needs improvement
E. Poor



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Thank you for your time and attention